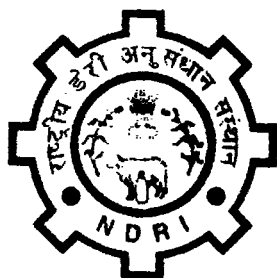


**PRODUCTION SYSTEM ANALYSIS OF THARPARKAR
CATTLE IN ITS BREEDING TRACT**



**THESIS SUBMITTED TO THE
NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF**

**DOCTOR OF PHILOSOPHY
IN
DAIRYING
(LIVESTOCK PRODUCTION AND MANAGEMENT)**

**BY
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KARNAL - 132001 (HARYANA), INDIA

2007

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PRODUCTION SYSTEM ANALYSIS OF THARPARKAR CATTLE IN ITS BREEDING TRACT

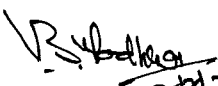
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EXTERNAL EXAMINER

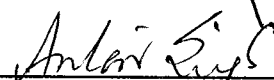

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This is to certify that the thesis entitled, "PRODUCTION SYSTEM ANALYSIS OF THARPARKAR CATTLE IN ITS BREEDING TRACT" submitted by Mr. Nawala Ram Chowdhry towards the partial fulfilment of the award of the degree of Doctor of Philosophy in Dairying (Livestock Production and Management) of the National Dairy Research Institute (Deemed University), Karnal (Haryana), India, is a bonafide research work carried out by him under my supervision, and no part of the thesis has been submitted for any other degree or diploma.

Dated: October, 15, 2007


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(N.R. Chowdhry)

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LIST OF ABBREVIATIONS

AAS	:	Atomic absorption spectrophotometer
ACU	:	Adult cattle unit
AGR	:	Annual growth rate
AI	:	Artificial insemination
AIA	:	Acid insoluble ash
AOAC	:	Association of official analytical chemists
BCS	:	Body condition score
BL	:	Body length
BW	:	Body weight
BW ^{0.75}	:	Metabolic body weight
CP	:	Crude protein
DMI	:	Dry matter intake
EBW	:	Estimated body weight
FCM	:	Fat corrected milk
HG	:	Heart girth
IDF	:	International Dairy Federation
Kg/d	:	Kilogram/ day
LO	:	Lactation order
Lt.	:	Litre
NC	:	Net cost
NRC	:	National Research Council
SAU	:	Standard animal unit
SCC	:	Somatic cell counts
SE	:	Standard error
SOL	:	Stage of lactation

थारपारकर गायों पर किये गये वर्तमान शोध कार्य का मुख्य उद्देश्य इनके प्रजनन क्षेत्र में इनकी विशुद्ध संख्या, उत्पादकता, प्रबन्धन, स्थानीय चारे की उपलब्धता, चरागाहों की स्थिति का अध्ययन एवम् दुग्ध उत्पादन का आर्थिक विश्लेषण करना था। पंचवर्षीय (1997-2003) व दशकीय (1992-2003) पशु गणना वृद्धि दर के अनुसार प्रजनन क्षेत्र में इनकी अनुमानित संख्या क्रमशः 44,580 व 55,072 थी, जो कि इस क्षेत्र के कुल पशुओं का क्रमशः 5.99 व 6.22 प्रतिशत था। इन गायों में प्रजनन हेतु केवल प्राकृतिक समागम ही पाया गया जिसमें कि व्यवस्थित समागम (32-50%) की तुलना में अव्यवस्थित समागम (67-50%) की बहुलता थी। इस क्षेत्र में पशुओं को केवल खुले आवासों में रखा जाता है जिसमें कि 56.25 प्रतिशत स्थायी आवास एवम् 43.75 प्रतिशत ऋतु परिवर्तित आवास पाये गये।

थारपारकर गायों में अनुमानित खाद्य पदार्थ ग्राह्यता ग्रीष्म, वर्षा एवं शीत ऋतुओं के दौरान क्रमशः 9.34 ± 0.15, 10.02 ± 0.38 व 9.35 ± 0.18 कि./पशु/दिन थी। औसत शुष्क खाद्य पदार्थ ग्राह्यता 9.48 ± 0.12 कि./पशु/दिन भी जिसमें 18.86 प्रतिशत दाने से व 81.14 प्रतिशत चारे से पूर्ति हुई। चरागाहों में घास की उपलब्धता वर्षा ऋतु में मध्यम चरागाहमान से गिरकर ग्रीष्म ऋतु में शून्य तक हो गई। वर्षा, शीत एवं ग्रीष्म ऋतुओं के दौरान औसत प्रति चौकोर (1m x 1m) बीजाकुर संख्या क्रमशः 199.50 ± 29.19, 27.70 ± 3.24 व 8.70 ± 1.31 थी। थारपारकर गायों में औसत रूप से 5.78 प्रतिशत थनैला तथा 0.655 x 10⁵/मिली दर से दैहिक कोशा गणना पायी गई। इन गायों की बछियों, शुष्क व दुग्ध देने वाली गायों का औसत शारीरिक स्थितांक क्रमशः 2.87 ± 0.02, 2.97 ± 0.02 व 3.20 ± 0.02 पाया गया जो कि एक दूसरे के सार्थक रूप से (P<0.01) भिन्न था। ऋतुओं का भी इनके शारीरिक स्थितांक पर सार्थक (P<0.01) प्रभाव देखा गया।

चयनित थारपारकर गायों का औसत दुग्ध उत्पादन 1629.80 ± 30.65 कि./305 दिन पाया गया। इन पशुओं में औसत सेवा काल, शुष्क अवधि, दुग्ध-उत्पादन अवधि व ब्यात अंतराल क्रमशः 184.55 ± 11.39, 144.12 ± 9.99, 318.76 ± 13.14 व 471.50 ± 11.40 दिन एवम् औसत गर्भाधान हेतु सर्विस संख्या 1.61 ± 0.13 थी। समग्र रूप से औसत दुग्ध उत्पादन की लागत 8.30 रुपये/लिटर थी जो कि ऋतुनुसार (ग्रीष्म, वर्षा व शीत) क्रमशः 12.39, 5.15 व 5.54 रुपये/लिटर का परिवर्तन देखा गया।

अतः थारपाकर गाय पालना अभी भी लाभदायक है तथा इस नस्ल के सरक्षण तथा संवर्धन की आवश्यकता है। इसके साथ ही पशुपालकों व पशुओं के सामने आने वाली समस्याएं मुख्यतः चारे व पानी की कमी को दूर करने के लिए आवश्यक उपायों की भी जरूरत है।

ABSTRACT

The main objectives of present study on Tharparkar cattle in its breeding tract were to find out the status of the breed in terms of population and productivity parameters, management practices, availability of local feeds and fodder, status of grazing land and economics of milk production. The estimated population of Tharparkar cattle based on quinquennial (1997-2003) and decadal (1992-2003) growth trend were 44,580 and 55,072, which accounted for 5.99 and 6.22 per cent, respectively of the total cattle population of its breeding tract. Natural mating system only was practiced for breeding of cattle, where indiscriminate mating of cows dominated (67.50%) over planned mating (32.50%) with pedigree bull. Cattle are only kept under loose/ open housing system with stable (56.25%) or seasonally movable (43.75%) temporary housing structures. The estimated mean dry matter intake of Tharparkar cows during summer, rainy and winter seasons was 9.34 ± 0.15 , 10.02 ± 0.38 and 9.35 ± 0.18 kg head⁻¹ day⁻¹ respectively. The overall mean dry matter intake was 9.48 ± 0.12 kg head⁻¹ day⁻¹, which included the concentrate and roughages dry matter in the proportions of 18.86 and 81.14 per cent, respectively. The grass cover of rangeland steeply declined from moderate grazing value in rainy season to near zero grazing value in summer season. The average number of seedlings per quadrat (1m x 1m) of grassland was 199.50 ± 29.91 , 27.70 ± 3.24 and 8.70 ± 1.31 in rainy, winter and summer seasons, respectively. The mean incidence of mastitis in Tharparkar cows in field was 5.78 per cent and the mean milk somatic cell count was found to be 0.655×10^5 cells ml⁻¹. The means of body condition scores of heifers, dry and lactating cows were 2.87 ± 0.02 , 2.97 ± 0.02 and 3.20 ± 0.02 , respectively, which differed significantly ($P < 0.01$) from each other. The season also affected the body condition score significantly. The average lactation milk yield of selected Tharparkar cows was 1629.80 ± 30.66 kg/ 305days. The corresponding mean service period, dry period, lactation length and calving interval were 184.55 ± 11.39 , 144.12 ± 9.99 , 318.76 ± 3.14 and 471.50 ± 11.40 days, respectively. The mean number of services per conception was 1.61 ± 0.13 . The overall estimate for net cost of milk production was Rs. 8.33 litre⁻¹ which considerably varied between seasons and was Rs. 12.39, 5.15 and 7.54 litre⁻¹ milk during summer, rainy and winter seasons, respectively. Thus rearing of Tharparkar cattle still remains profitable and the breed needs to be conserved and further improved in the area. Efforts also need to be made to ameliorate the hardships faced by the animals and livestock keepers particularly those pertaining to feed, fodder and water scarcity. Based on the study certain general suggestions have also been given.

CHAPTER – 1

Introduction

1. INTRODUCTION

Cattle play pivotal role in animal husbandry sector of our country with the population of 185 millions heads (Livestock census, 2003) distributed throughout the country and providing livelihood sustenance to millions of rural habitats. Indigenous cattle wealth, which contribute around 87 per cent of total cattle population is endowed with 30 recognized breeds of cattle with habitats spread over various states across the length and breadth of the country. Each breed has its own characteristic features; whether specific for milk production, draught power or both, having evolved over generations by natural selection and needs of the people to fulfill their specific local demands. Thus these breeds become well adapted with local agro climatic conditions and merged deeply in social, cultural and economical facets of human society. Among these breeds Tharparkar is one of the most important breed of western arid region of India, which can withstand harsh desert climatic conditions and provide livelihood security to the rural masses of the area.

Origin and distribution

Tharparkar was a erstwhile district of Sind province of Pakistan, which has since been divided (in 1955) into two districts namely Mirpurkhars and Sanghar. The western part of former district, the “Pat” is watered by the east Naro and the Jamrao canal and the eastern part called “Thar” is a tract of rolling sand hills running northeast and southwest composed of a fine but slightly coherent sand and forming part of the much larger Thar or Indian desert. The south-east of Thar is “parkar”, where there are ranges of rocky hills rising up to 350 ft. above the surrounding level and open plains of stiff clay (Encyclopaedia Britannica, 1963). Thus, the tract of rolling sand dunes Thar, demarcated in south-east by ranges of rocky hills parkar, was jointly named Tharparkar. The area is part of Great Indian Desert, located partly in Indian state of Rajasthan and Sind province of Pakistan, covering 77,000 square miles of territory.

The indigenous cattle breed of this region, well adapted to the desert climatic conditions and aptly named Tharparkar after its place of origin, is also known by other synonyms as *Thari* and *Grey Sindhi* in its native tract (Mason, 1996). Tharparkar, an important dual-purpose breed raised primarily for its milking potential are found in the vicinity of Amarkot, Nakot, Mirpurkhas, Khari Ghulam Shah, Dhor-Naro and Chor in

Pakistan. In India, these animals are found along the Indo-Pak border covering part of western Rajasthan *viz.*, Jaisalmer, Barmer and Jodhpur districts. The breeding tract of Tharparkar surrounded by Nagori in east, Kankrej in south, Rathi and Sahiwal in north and Red Sindhi breed of cattle in west.

The populous irrigated belt of Sind is attached to Great Indian Thar desert in east. This desert area since ancient times has been scarcely populated having huge free landmass available for grazing in the form of vast ranges. The semi-nomadic herders of Sind region migrated towards the range lands of Thar desert in the years of good rainfall, when desert flora and fauna flourished to its peak extent. The local inhabitants of the region, which mainly depended on livestock for their livelihood sustenance interacted with the cattle herders and picked up good genetic stock of cattle. In case of drought, the people of desert region migrated towards irrigated belt of Sind along with their cattle wealth in search of food and fodder. Thus the area was endowed with the good genetic stock of Thari cattle. After partition of India and Pakistan the Tharparkar belt was split in two parts and the best herds of Sind belt remained in Pakistan. Consequently the local herdsmen of Indian arid region changed their direction of migration during the drought towards Punjab, Haryana, U.P., M.P. and parts of Gujarat. Due to this migration and consequent intermixing with breeds/ strains like Nagori, Kankrej, Hariana, Malvi and Rathi, wherever they migrated, there has been loss of genetic purity of Thari cattle. Simultaneously the increasing human population competes with the livestock for their needs by cultivating the rangelands for food grain production causing decline in the free grazing land, which remains the main source of livestock nutrition in the arid zone.

Statement of problem

The importance of Tharparkar cattle is not only limited to local habitats of Thar desert, but is considered a valuable breed of cattle of tropical region and its breeding herds are being maintained at various livestock research stations. It has also been used in the development of crossbred strain Karan Fries at National Dairy Research Institute, Karnal. Moreover, many farmers are willing to maintain the Tharparkar herds but are unable to find the good parental stock from its breeding tract, where fast genetic erosion is occurring since past several decades.

Of late, the population of this important breed in pure form is in vulnerable stage, which might be due to the inadequate availability of breeding services, mechanization of agriculture, natural disasters and insufficient aid by government and other agencies (Mathur, 2005). As stated in 17th livestock census (2003), the population of indigenous cattle in Rajasthan has declined by 14.83 per cent as compared to 16th livestock census (1997). The net result being that, well-established breeds are losing its roots from their place of origin.

In arid tract, most of rangelands are available for the grazing of livestock as *Oran* and *Gochar* which comes under common property grazing resources (CPRs) and are accessible to every member of the specific village community with no exclusive ownership right to any one. This practice has resulted in every one getting free access to these common resources. As hardly any management practices were followed for the conservation of these lands, it has resulted in continuous over-exploitation of these CPRs. Their improvement is of key importance for the sustenance of these CPR's and towards this purpose, the knowledge of the existing vegetation, its condition and status are the pre-requisites.

The information regarding the Tharparkar cattle population statistics, management practices followed by the people rearing this breed, their production potential and economic viability in field, and potentiality as well as availability of feed and fodder resources in Tharparkar breeding tract of western dry region are still scanty to show the real picture at the ground level. Although, gaushalas and some NGOs/ state development agencies are making efforts toward the conservation and improvement of these valuable livestock resources, their efforts are yet to yield desired dividends as they face several constraints, both financial and technical to perform this enormous task.

Therefore, before preparing any meaningful policy guidelines for improvement and conservation program for this breed, comprehensive investigation needs to be conducted to make an objective assessment of the prevailing biophysical and socio economical characteristics of the habitat, status of the breed(s) in terms of population and productivity parameters, management practices, availability of local feeds and fodder, availability of grazing land, infrastructural framework etc. Thus, keeping these

points in view, the present study entitled “**Production system analysis of Tharparkar cattle in its breeding tract**” has been undertaken with the following specific objectives.

Objectives:

1. To document the existing management practices of Tharparkar breed in its breeding tract in western Rajasthan.
2. To evaluate the season-wise nutritional status of Tharparkar cows in its breeding tract.
3. To study the incidences of mastitis and milk Somatic Cell Counts in Tharparkar cows during different seasons.
4. To monitor body condition score and productive performance of cows under existing managerial conditions.

CHAPTER – 2

Review of Literature

2. REVIEW OF LITERATURE

The relevant literature available on different aspects of the present study has been reviewed under the following sub-headings.

- 2.1 Physical characteristics of Tharparkar cattle
- 2.2 Performance traits of Tharparkar breed
- 2.3 Nutritional resources in western dry region
- 2.4 Cattle management practices
- 2.5 Economics of milk production
- 2.6 Incidences of mastitis
- 2.7 Somatic cell counts and udder health
- 2.8 Factors affecting milk somatic cell counts

2.1 PHYSICAL CHARACTERISTICS OF THARPARKAR CATTLE

The animals of Tharparkar breed are strongly built, medium-sized, with straight limbs and good feet, and with an alert and springy carriage (As shown in plate 1 and 2). The usual color of the cattle is white or grey. In males, the grey color may deepen, particularly on the fore and hindquarters. All along the backbone there is a light grey stripe. The color of the cattle deepens during the winter months and also when the cows are pregnant. In the Thari tract, in addition to white and grey coat color, black and red or combinations thereof are usually encountered on account of the influence of the Red Sindhi and Gir (Joshi and Phillips, 1953).

The head is of medium size, the forehead broad and flat or slightly convex above eyes. The front of the horns and face are practically on one plane. The skin between the eyes is often wrinkled, which runs perpendicularly. The eyes are full and bright. The eyelashes are black and there is a small ring of black on the eyelids. The ears are somewhat long, broad and semi-pendulous and face forwards. Horns are set well apart curving gradually upwards and outwards in the same line as that of the poll with blunt points inclined inwards. A small portion of the skin with hairs extends over the base of the horns. In the males the horns are thicker, shorter and straighter than in the females. The hump in males is moderately well developed, firm and placed in front of the withers. The dewlap is of medium size and the skin is fine and mellow. The

sheath in the males is of moderate length, and is semi-pendulous. The navel flap in the females is prominent. The size is variable. Shoulders are light and legs are comparatively short, but in good proportion to the body. The hooves are hard and black, of moderate size and have no tendency to turn out. The color of the skin is black, except on the udder, under the belly, on the lower part of the dewlap and inside the ears where it is rich yellow. The hair is fine, short and straight, but in the male it is slightly curly on the forehead (Nivsarkar *et al.*, 1992 and Mason, 1996).

2.2 PERFORMANCE TRAITS OF THARPARKAR BREED

Performance traits aiming at describing the norms of the Tharparkar breed from the point of view of production, reproduction and growth have been reported by several workers particularly farm data study of various locations. The production performances viz., age at first calving, 305 days lactation yield, lactation length, dry period, service period and calving interval has been presented in Table 2.1.

The mean of age at first calving of Tharparkar cattle was reported as 38.45 ± 7.75 (Nagpaul, 1968), 41.10 ± 0.7 (Mahesh *et al.*, 1974), 43.2 ± 8.88 (Singh and Chaudhury, 1961), 48.70 ± 0.48 (Amble *et al.*, 1958) and 51.79 ± 0.9 months (Gahlot, 1999) at various institutional herds of different locations.

Average lactation yield of Tharparkar cows ranged from 1301.6 kg (Mahesh *et al.*, 1974) to 2399.09 kg (Annual report of LRS, Chandan, 2005-06) in 305 days of lactation, while the mean lactation length of Tharparkar cows varied from 268.18 ± 79.5 days (Nagpaul, 1968) to 313.25 ± 25 days (Kachwaha, 1993).

The mean dry period of Tharparkar breed was reported as 100.9 ± 1.08 (Gahlot, 1999), 103.38 ± 1.43 (Kachwaha, 1993), 125 (Annual Report, NDRI, 2003-04) and 153.0 ± 6.6 days (Mahesh *et al.*, 1974) at various locations of study.

The mean service period of Tharparkar breed was reported as 127.95 ± 1.36 (Gahlot, 1999), 130.99 ± 1.8 (Kachwaha, 1993), 131 (Annual Report, NDRI, 2003-04), 161.9 ± 7.67 (Reddy and Bhatnagar, 1971) and 169 ± 6.7 days (Mahesh *et al.*, 1974).

The mean calving interval of Tharparkar cows varied from 408 days (Annual Report, NDRI, 2003-04) to 456 ± 7.5 days (Mahesh *et al.*, 1974) at various institutional herds.



Plate 1: Tharparkar cow



Plate 2: Tharparkar Bull

Table 2.1 Mean (\pm SE) of various performance traits of Tharparkar cows

Performance trait	Worker	N	Location	Mean \pmS.E.
1. Age at first calving (months)	Amble <i>et al.</i> (1958)	422	Patna	48.70 \pm 0.48
	Singh and Chaudhury (1961)	90	Ranchi	43.20 \pm 8.88
	Nagpaul (1968)	1860	Karnal	38.45 \pm 7.75
	Prasad and Prasad (1972)	395	Patna	49.96 \pm 0.26
	Mahesh <i>et al.</i> (1974)	63	Jhansi	41.10 \pm 0.7
	Basu <i>et al.</i> (1979)	58	Karnal	37.25 \pm 0.62
	Gahlot (1999)	814	Chandan & Suratgarh	51.79 \pm 0.9
2. Average 305 days lactation yield (kg)	Singh and Chaudhury, (1961)	90	Ranchi	467.1
	Nagpaul (1968)	1860	Karnal	2146.62 \pm 966.1
	Mahesh <i>et al.</i> (1974)	63	Jhansi	1301.6 \pm 53.6
	Basu <i>et al.</i> (1979)	31	Karnal	1414.87 \pm 189.77
	Pandey (1985)	209	Karnal	2003.9 \pm 130.7
	Kachwaha (1993)	2339	Suratgarh	1993.26 \pm 13.59
	Gahlot (1999)	814	Chandan & Suratgarh	1957.8 \pm 0.9
	NDRI Annual report (2003-04)	13	Karnal	1645
	Annual report (2005-06)	40	LRS, Chandan	2399.09
	Kumarvelan and Obireddy, 2006	8	Tamil Nadu	1541 \pm 118.97

Contd. Table 2.1

Performance trait	Worker	N	Location	Mean \pmS.E.
3. Lactation length (days)	Nagpaul (1968)	1860	Karnal	268.18 \pm 79.5
	Mahesh <i>et al.</i> (1974)	63	Jhansi	299.0 \pm 5.2
	Pandey (1985)	209	Karnal	299.0 \pm 12.9
	Kachwaha (1993)	2339	Suratgarh	313.25 \pm 25
	Gahlot (1999)	814	Chandan & Suratgarh	307.3 \pm 1.1
	NDRI Annual report (2003-04)	13	Karnal	290
	Annual report (2005-06)	29	LRS, Chandan	302
	Kumarvelan and Obireddy, 2006	8	Tamil Nadu	315.87 \pm 15.41
4. Dry period (days)	Nagpaul (1968)	1264	Karnal	147.28
	Mahesh <i>et al.</i> (1974)	63	Jhansi	153.0 \pm 6.6
	Ram <i>et al.</i> (1976)	300	Chandenwell	133.22 \pm 10.45
	Basu <i>et al.</i> (1979)	28	Karnal	160.4 \pm 40.6
	Kachwaha (1993)	2339	Suratgarh	103.38 \pm 1.43
	Gahlot (1999)	814	Chandan & Suratgarh	100.9 \pm 1.08
	NDRI Annual report (2003-04)	12	Karnal	125
	Annual report (2005-06)	20	LRS, Chandan	113.3

Contd. Table 2.1

Performance trait	Worker	N	Location	Mean \pmS.E.
5. Service period (days)	Reddy and Bhatnagar, (1971)	497	Karnal	161.9 \pm 7.67
	Mahesh <i>et al.</i> (1974)	63	Jhansi	169 \pm 6.7
	Basu <i>et al.</i> (1979)	50	Karnal	90.60 \pm 24.32
	Kachwaha (1993)	2339	Suratgarh	130.99 \pm 1.8
	Gahlot (1999)	814	Chandan & Suratgarh	127.95 \pm 1.36
	NDRI Annual report (2003-04)	12	Karnal	131
	6. Calving interval (days)	Nagpaul (1968)	1264	Karnal
Mahesh <i>et al.</i> (1974)		63	Jhansi	456 \pm 7.5
Basu <i>et al.</i> (1979)		29	Karnal	410.46 \pm 34.62
Kachwaha (1993)		2339	Suratgarh	416.34 \pm 1.81
Gahlot (1999)		814	Chandan & Suratgarh	411 \pm 1.14
NDRI Annual report (2003-04)		12	Karnal	408
Annual report (2005-06)		24	LRS, Chandan	411.6

Krishna *et al.* (1976) reported that the average body weight of Tharparkar cows was 356 ± 30.54 kg and the means of body length and heart girth were 1.36 ± 0.10 and 1.86 ± 0.17 meters, respectively. The estimated body weight of farmer's Tharparkar herd in Tamil Nadu was reported as 317.75 ± 9.95 kg by Kumarvelan and Obireddy (2006).

2.3 NUTRITIONAL RESOURCES IN WESTERN DRY REGION

2.3.1 Types of Feeds and Fodder

The most common feeds and fodder available for animals are cultivated rain fed crops, grasses of rangeland and leaves of top feeds in the arid region of Rajasthan.

a) Cultivated rain fed crops

Stover of kharif cereals (bajra and jowar) and kharif legumes (guar, moong and moth) are the major crop residues available for feeding of livestock in arid region. The availability of these ingredients mainly depends on the monsoon rainfall. As reported by the Singh (2004) guar chara, phalgati (*Cyamopsis tetragonolobus*), moong chara (*Phaseolus mungo*), moth chara (*Phaseolus aconitifolius*) and sevan grass (*Lasiurus indicus*) were most common feeds and fodder available for feeding to camel in Jaisalmer district. Bajra is the predominant crop of the western arid zone which occupied 52 per cent of total cropped area followed by guar (34%), moong (10%) and moth (2%) with 73 per cent cropping intensity, where very high proportion of mixed cropping (bajra + moth and bajra + moong) was observed (Gupta *et al.*, 2005).

b) Grasses

Natural grassland or rangelands are the important forage resources for the livestock population of arid region. The grazing lands support adaptation of native vegetation comprising of predominately annual and perennial grasses, forbs and woody perennials. The availability of this herbage totally depends on monsoon rainfall. The grass cover of arid region of Rajasthan is *Dicanthium -Cenchrus - Lasiurus* type (Dabadghao and Shankarnaraynan, 1973).

Lasiurus indicus is dominant grass of rangeland in Jaisalmer district, which covers about 80 per cent of the total geographical area of district (Mertia, 1988). This grass species is drought resistance because it can draw moisture from nearly 100 cubic

metres soil and grow even in extreme arid conditions. Karad grass (*Dicanthium annulatum*), Dhaman (*Cenchrus ciliaris*), Moda Dhaman (*Cenchrus segitarus*), Bhurat (*Cenchrus biflorus*) Gramana (*Panicum antidote*) and Murath (*Panicum turgidum*) are the important perennial grasses of arid region commonly used for grazing of cattle (Beniwal and Singh, 2005 and Singh and Rathore, 2005). The leguminous species of *Indigofera* and non-leguminous species like Bakda (*Tribulus pentandrus*) and Kanti (*Tribulus terrestris*) are also important herbaceous forage in arid region grazed by sheep, goat, camel and cattle.

c) Fodder trees/ shrubs

Khejri (*Prosopis cineraria*) is the most important top feed resource in the arid region. Other top feeds such as Babul (*Acacia arabica*), Kumat (*Acacia senegal*), Pardeshi-Khejri (*Prosopis juliflora*), Soo-Babul (*Leucaenia leucocephala*), Jal (*Salvadora oleoides*), Khari-Jal (*Salvadora percica*), Neem (*Azadirachta indica*), Sirash (*Albizia lebbek*), and Rohida (*Tecomella undulate*) are also available for livestock in western dry region (Purohit and Mathur, 1982; Singh and Rathore, 2005).

Browse shrubs also play an important role in the leaf forage production in arid ecosystem. In extreme dry climatic condition, browse constitutes the only source of green forage to provide supplements of protein and energy. Jharberi (*Ziziphus nummularia*) shrub is well known species providing the quality leaf fodder and is known as *Pala* in arid and semi-arid region. Other arid browse shrubs like Lana (*Halozylon salicornium*), Phog (*Calligonum polygonoides*), Bawali (*Acacia jacquentontii*) and Luni (*Salsola barvosma*) are also utilized by the farmers as fodder for livestock along with other forages (Singh, *et. al.*, 2004)

2.3.2 Nutritive Value of Feeds and Fodder

Straws of rain fed crops and grasses are the staple fodder for the cattle in arid region. The leguminous straw viz., *Phaseolus aconitifolius*, *Cicer arietinum*, *Arachis hypogea* and *Cymopsis tetragonoides* (Table 2.2) are good source of crude protein contents. The average CP, CF and total carbohydrate in leguminous straw are 7.9, 33.6 and 78.8 per cent, respectively (Singh, 2005).

Table 2.2 Nutritive values of common straws and grasses (% on dry matter basis) of arid region

Feed and fodder	DM	CP	CF	TC*
A. Leguminous straw				
1. Moth chara (<i>Phaseolus aconitifolius</i>)	87.4	9.7	25.2	73.6
2. Gram chara (<i>Cicer arietinum</i>)	91.3	4.8	44.6	85.5
3. Groundnut straw (<i>Arachis hypogea</i>)	89.1	8.1	40.6	80.5
4. Guar phalgati (<i>Cymopsis tetragonoides</i>)	87.3	8.9	24.1	75.7
Average	88.8	7.9	33.6	78.8
B. Cereal straw				
1. Bajra straw (<i>Pennisetum typhoides</i>)	87.8	2.6	37.2	85.6
C. Grasses				
1. Sewan (<i>Lasiurus indicus</i>)	88.0	3.1	36.8	84.4
2. Dhaman (<i>Cenchrus ciliaris</i>)	83.9	8.2	30.5	73.8
3. Bakaria (<i>Indigofera cordifolia</i>)	82.2	6.2	28.2	73.1
4. Gramna (<i>Panicum antidotale</i>)	91.4	7.26	40.5	83.6
5. Karad (<i>Dichanthium annulatum</i>)	85.3	7.4	28.2	75.8
6. Makara (<i>Dactyloctenium aegyptiacum</i>)	87.7	8.3	35.2	75.7
7. Gokhru (<i>Tribulus terrestris</i>)	83.7	19.1	16.8	62.1
8. Lampa (<i>Aristida depressa</i>)	86.9	2.1	42.3	84.2
9. Bui (<i>Aerva pseudotomentosa</i>)	87.9	5.0	32.1	82.4
Average	86.3	7.4	32.3	77.2

* TC = Total Carbohydrate

Bajra straw, which is commonly used cereal straw in the arid region, is poor source of CP (2.60%) content. The average CP, CF and total carbohydrate in grasses are 7.4, 32.3 and 77.2 per cent, respectively (Singh and Saini, 2002). *Tribulus terrestris* grass is rich in crude protein (19.10%) compared to other grasses, which also has medicinal property as aphrodisiac.

Top feeds are important feed resource for livestock in the arid region, especially in drought and or lean period. As revealed in Table 2.3, the top feeds are good source of crude protein (CP), which varies from 7.40 per cent in *Calligonum polygonoides* to 21.45 per cent in *Leucaenia leucocephala*. The crude fibre (CF) content varies from 9.30 per cent in *Salvadora oleoides* to 31.50 per cent in *Albizia lebbeck*.

Table 2.3 Chemical composition of some top feeds (% on dry matter basis) of western arid region of Rajasthan

Name of feed	CP	CF	EE	NFE	Ash	Ca	P
<i>Acacia senegal</i>	10.30	9.70	-	56.70	16.40	6.90	0.05
<i>Albizia lebbek</i>	16.80	31.50	4.00	36.20	11.50	2.57	0.15
<i>Azadirachta indica</i>	14.50	23.08	2.31	51.59	8.52	2.39	0.14
<i>Calligonum polygonoides</i>	7.40	12.50	-	67.30	9.10	3.70	0.10
<i>Prosopis cineraria</i>	13.98	17.80	1.88	43.44	22.90	2.73	0.15
<i>Prosopis juliflora</i>	21.40	20.80	-	50.00	7.70	1.50	0.20
<i>Salvadora oleoides</i>	9.60	9.30	-	40.20	40.80	11.90	0.11
<i>Salvadora percica</i>	14.20	9.40	-	44.90	31.40	8.80	0.20
<i>Tecomella undulate</i>	12.20	15.80	-	63.00	8.90	3.40	0.20
<i>Ziziphus nummularia</i>	14.24	15.73	4.34	57.12	8.56	2.43	0.14
<i>Acacia arabica</i>	10.95	13.75	0.97	58.03	5.69	1.21	0.06
<i>Leucaenia leucocephala</i>	21.45	14.25	6.54	49.48	8.28	2.70	0.71
Average	13.92	16.13	3.95	51.50	14.98	4.19	0.18

Top feeds are of poor in ether extract (EE), while nitrogen free extract (NFE) ranges from 36.20 per cent in *Albizia lebbek* to 67.30 per cent in *Calligonum polygonoides*. Top feeds are rich in inorganic matters (ash contents), especially *Salvadora* species viz., *Salvadora oleoides* and *Salvadora percica*, which have 40.80 and 31.40 per cent total ash contents on dry matter basis, respectively (Bhatia, 1982 ; Purohit and Mathur, 1982). The average CP, CF, EE, NFE, Ash, Ca and P in top feeds are 13.92, 16.13, 3.95, 51.50, 14.98, 4.19 and 0.18 per cent, respectively. Top feeds are rich in calcium, which is 2-3 times more in tree leaves than the cultivated fodder and grasses. The phosphorus content is low in general; this results in very wide calcium to phosphorus ratio in leaves.

2.3.3 Status of Rangeland in Western Arid Region

In arid tract, the animal husbandry is the main occupation of people, but overstocking and irrational grazing of the grasslands has deteriorated them to their lowest level. Singh and Roy (1998) reported that the rangeland of arid region of Rajasthan was severely degraded due to higher grazing intensity (6.63 Adult Cattle Unit/ ha) as compared to carrying capacity of rangeland (0.2 - 0.5 ACU/ ha). As reported by Bhimaya and Ahuja (1969) the carrying capacity of different condition

class of rangelands viz., excellent, good, fair and poor were as 1.1, 0.3, 0.2 and 0.17 ACU/ ha, respectively in arid region of western Rajasthan. About 80-85 per cent of rangelands in the area are classified under poor condition class.

Pratap Narain and Bhati (2004) also reported that the productivity of grazing land in arid region of Rajasthan is negligible (0.4 to 0.5 tones/ ha), due to over and indiscriminate grazing and such areas have become potential sites for land degradation and desertification.

Singh and Rathore (2005) also reported that the grazing pressure of rangelands in arid region is very high viz., 1 to 4 ACU/ ha against the normal 0.2 to 0.5 ACU/ ha. Change in botanical composition of natural grazing lands take place due to selective grazing by animals leading to the domination of undesirable species in the grasslands.

2.3.4 Grazing Systems and Pastoralism

The grazing activity mainly depends on the availability of grazing resources from pasture and other grazing lands. A grazing practice termed as “*Gols*” is prevalent in western Rajasthan in which the local habitants or tribal families, complete or part of the family, move forward along with livestock in search of grazing resources. The movement is towards the area receiving good rainfall and where plenty of rangeland is available for grazing of livestock. Once the rangeland is utilized they move to other grazing sites.

Mittal (1987) and Bharawa (1989) reported that under adverse circumstances, the animal keepers in Rajasthan follow a definite pattern of migration to areas like Madhya Pradesh, Punjab, Haryana and Gujarat where sufficient grazing land is available and return to their home land only when favourable conditions exist for grazing of animals.

Agarwal (1992) reported that nomadic pastoralism is critically important to the economy of Rajasthan. Aridity and poor soils, especially in the western districts, where the homes of most migrant shepherds are located, make it well suited to a combination of agriculture and livestock rearing. However, existing fodder resources cannot support the large number of animals in these districts. While part of the fodder deficit in the state is met by importing fodder from the neighboring states of Punjab and Haryana, a significant proportion is met through the migration of animals, especially sheep.

Köhler-Rollefson (1999) reported that in arid region of Rajasthan more than 80 per cent of farmers own their livestock in form of small ruminants (sheep and goat) which are raised on common grazing resources, while the large ruminants particularly cattle is integrated with agriculture.

2.3.5 Phosphorus Content of Feeds and Fodder

Pasture based animal husbandry has been shown to be an economically viable and ecologically successful land use in arid region. Besides meeting the energy requirement, the grass species are the major source of mineral for animals. Knowledge of mineral status of different species of grasses, top feeds and other fodder is useful for maintaining diet and feeding schedule to fulfill micro nutrients requirement of animals.

Dhir *et al.* (1982) reported that the top feeds of arid region were poor in phosphorus content which range from 0.09 per cent in *Salvadora oleoides* to 0.24 per cent in *Azadirachta indica*. The phosphorus content of various grass species of arid region has been reported to range between 0.11 and 0.22 per cent (Dhir *et al.*, 1984; Sharma *et al.*, 1984). The mineral contents of grasses are optimum during the stage of flowering and subsequently decline during maturity of grasses.

Changes in phosphorus content along with maturity of three dominant arid zone grass species *viz.*, *Lasiurus indicus*, *Cenchrus ciliaris* and *Cenchrus segiterus* have been reported by Dutta and Dhir (1980). They observed that in all the above three grass species phosphorus content continuously decline reaching values up to half to one third of those observed at early stage. Grazing also appeared to have depressing effect on mineral contents of grass species (Gupta and Joshi, 1984).

Micronutrient imbalance was found in the livestock of Bituja, Ramdeo ki Basti, Mitisar and Derasar villages as well as in Barmer town (CAZRI Annual Report, 2004). Although the level of calcium was in normal range but phosphorus was low as compared to that in normal Indian livestock. Low level of phosphorus might be responsible for reduced reproductive efficiency of livestock in the region.

2.4 CATTLE MANAGEMENT PRACTICES

2.4.1 Breeding Practices

Nivsarkar *et al.* (1992) reported that, there was no planned mating system in Tharparkar belt but usually farmers select bulls on the basis of phenotype and some

times dam's milk yield. Natural service is the common method for breeding in animals. Madan Lal (1996) reported that the cows were, as a rule, bred naturally by the breeding bull/s maintained by the village panchayats in spite of the AI facilities available in the selected villages of Nagori tract. The males (prospective breeding bulls) were selected by a committee of village elders at around one year of age and maintained on a general subscription by the village panchayats.

2.4.2 Housing Practices

Nivsarkar *et al.* (1992) observed that in northwestern part of Rajasthan animals are generally not provided with shelter or houses throughout the year excepting on certain chilly nights or during extreme summer season. Animal houses are located near human dwellings and are made up of *katcha* walls with thatched roofs. The investigation concerning the housing of Nagori cattle in its breeding tract was studied by Madan Lal (1996) and he observed that the majority of small farmers kept their cattle in fenced paddock with a shed inside house, which is either inside or attached to human dwelling, whereas most of the large farmers had walled open paddock with barn for their cattle, generally outside the human dwelling.

2.4.3 Healthcare Practices

According to a survey conducted by Rathore and Köhler-Rollefson (1997) in Pali district of Rajasthan revealed that majority of livestock keepers resort to their own resources and experience and consult to local knowledgeable person and if all else fails, adopt occult practices for treating their sick animals. A study of Ellen (2001) on sheep husbandry and ethnoveterinary knowledge of pastoralists community of *Raika* in Rajasthan revealed that they mainly rely on self treatment and traditional healers and rarely avail services from government veterinary hospitals and veterinarians. This is partly due to the inconvenience of taking animals to the hospital but the most important reason seems to be the communication problems from both sides.

A survey of ethnoveterinary plants, which were used for livestock healthcare in arid zone, was done by Suresh Kumar *et al.* (2004). They reported that *Calotropis procera* is the most important plant species which cure maximum numbers of ailments *viz.*, worm infestation, gingivitis, topical disinfectant for wound healing and hasten the suppuration of cyst. *Citrullus colocynthis*, *Salvedora oleoides*, *Trachyspermum ammi*,

Capparis deciduas, *Leptadenia pyrotechnica*, *Sesamum orientale*, *Ziziphus nummularia*, *Acacia nilotica*, *Fagonia indica* and *Ricinus communis* are the other plant species in the region having ethnoveterinary properties.

2.4.4 Major Constraints Faced by Livestock Keepers

The farmers of arid region face various constraints in the adoption of improved practices of animal husbandry as investigated by Jangid and Rohilla (2004) in Pali district of western Rajasthan. They revealed that non-availability of green fodder round the year, lack of artificial insemination facilities, lack of improved breed of milch animals, lack of training and knowledge of improved practices, low risk bearing capacity, high cost of fodder and concentrate, high cost of modern medicine, non-availability of loan facilities, lack of initiative and motivation, traditional attitude of people, uncertainty of monsoon, lack of information about various development programs and non-availability of extension services as the major constraints confronted by the farmers in the adoption of improved animal husbandry practices.

2.5 ECONOMICS OF MILK PRODUCTION

Anatha Ram (1983) worked on economics of dairying in selected co-operative societies of Jodhpur and Pali districts of western Rajasthan. He revealed that the average cost per litre milk production of cow was Rs 1.47, in which the cost of feed, labour and fixed cost accounted 64.62, 23.13 and 12.25 per cent, respectively.

The study of Dev Raj and Gupta (1994) on economic analysis of milk production in Churu district of arid region of Rajasthan revealed that milk production from cows and buffaloes was not profitable enterprise. The average cost per litre of milk production of local cow was Rs 5.44 with seasonal variation of Rs 7.98, 6.29 and 3.99 in summer, rainy and winter, respectively. The net returns were not positive any season and to any group of households.

2.6 INCIDENCES OF MASTITIS IN FIELD

Mastitis, the inflammation of one or more quarters of the mammary gland is a serious problem, which greatly influences the productivity of dairy cows. Verma (1978) conducted a study for incidence of sub clinical mastitis in milch cows of four breeds (Gir, Tharparkar, Red Dane and cross bred of Holstein-Friesian x Tharparkar). He reported that average quarter incidences on herd basis were 23.97 per cent ranging from

12.50 per cent (Tharparkar) to 26.99 per cent (Gir). Tharparkar breed seemed to have relatively better resistance for mastitis compared to other breed categories.

Sharma (1983) reported that mastitis alone contributed 14 per cent in total clinical cases under field conditions of Mathura district of Uttar Pradesh. Singh *et al.* (1985) reported that the cows in the third lactation had higher incidences of mastitis (28.6%) than in second (22.2%) and lowest in first (4.5%) lactation. The report also indicated that incidence was highest during mid-lactation as compared to early and late lactation.

Singh and Singh (1994) revealed the average incidences of clinical mastitis in cows in India were 6.4 per cent in their extensive field survey. Rai (1997) observed in his field study of Darjeeling hilly tract that 28.89 per cent udder quarters among studied cases were effected by clinical and/ or sub-clinical mastitis. The incidences of sub-clinical mastitis were high during winter season. The seasonal dependency in the occurrence of sub-clinical mastitis was highly significant ($P < 0.01$).

2.7 SOMATIC CELL COUNTS AND UDDER HEALTH

Somatic cell count (SCC) is a quantitative index of inflammatory condition of udder. These cells serve as an important tool for determining the health of mammary gland as well as milk quality. Milk somatic cells are primarily leukocyte and some epithelial cells shed from lining of the mammary gland (Harmon, 1994). The leukocytes are derived from blood and consist of macrophages, lymphocyte and polymorpho nuclear (PMN) cells, primarily neutrophils. The macrophages are involved in immune recognition and are of predominant cell type present in milk from uninfected glands. The PMN are a small proportion of cells in milk from uninfected quarters, but become the predominant cell type in milk from infected quarters (Harmon, 1994 and Hamann, 1996). Normal milk does contain cells, and the concentration of these cells are mostly below 1×10^5 (cells/ml) in milk from uninfected/ uninflamed mammary quarters (Doho and Meek, 1982; Harmon, 1994 and Hamann, 1996).

The average normal values of SCC in milk of Tharparkar cows of National Dairy Research Institute's herd were 1.26×10^5 cells/ml and the mean values were 1.04, 1.49 and 1.10×10^5 cells/ml in hot dry, hot humid and winter seasons, respectively (Singh, 2002).

2.8 FACTORS AFFECTING MILK SOMATIC CELL COUNTS

Somatic cell counts are affected by several factors like breed, season, geographical region, type of housing, stage of lactation, parity, level of milk production and use of teat disinfectants.

2.8.1 Stage of Lactation

Sethar *et al.* (1979) observed highest somatic cell counts just after calving which decreased up to days 31 to 60 of lactation and thereafter increased slowly to the end of lactation. Kennedy *et al.* (1982) observed that the effect of stage of lactation was significant for all lactation age groups (≤ 2 to ≥ 6 lactations). Somatic cell counts were highest shortly after calving, declined rapidly between days 25 to 45 and then rose slowly throughout the remainder of lactation. The period of lowest somatic cell count coincided fairly closely with peak lactation. Prasad and Singh (2001) observed that the normal values of SCC in buffalo milk during early lactation (average 42.5 days) varied from 0.54 to 0.75×10^5 cells/ ml in buffalo milk. Singh and Ludri (2001a) reported that the mean SCC values in the milk of 1st lactation buffaloes were higher during early lactation (<90 day) ($1.10-1.27 \times 10^5$ cells/ ml), which decreased during mid-lactation (90-120 day) ($0.90-0.99 \times 10^5$ cells/ ml) and increased marginally during late lactation ($0.99-1.07 \times 10^5$ cells/ ml). Similarly overall mean SCC values in cows (Singh and Ludri, 2001b) were reported higher during first 30 days of lactation ($1.54 \pm 0.07 \times 10^5$ cells/ml) which decreased during day 31-60 ($1.41 \pm 0.08 \times 10^5$ cells/ ml) and thereafter fluctuate up to day 300 of lactation. The effect of stage of lactation on SCC was not significant.

2.8.2 Season

Wegner *et al.* (1976) observed that the highest SCC generally occurs during the summer (July-August) and the lowest during the winter (November). In buffalos milk, SCC were found to be significantly high during hot humid season (Aug.-Sep.; 1.36×10^5 cells/ml) as compared to hot dry (May – June; 1.08×10^5 cells/ ml) and cold seasons (Dec.–Jan.; 0.76×10^5 cells/ ml) as reported by Singh and Ludri (2001a). The hot humid season provides favourable environment for the growth of bacteria causes more stress on udder of cow and results in rise of SCC. Verma (2007) reported that the

seasonal effect on milk somatic cell counts was highly significant ($P < 0.01$) in buffaloes. The season wise SCC in buffaloes were 0.939, 1.091 and 0.818 x 10⁵ cells/ml in summer, rainy and winter seasons, respectively. The highest somatic cell count in rainy season could be due to prevailing high humidity and ambient temperature during rainy season leading to stress on animals. In buffaloes higher cell counts in rainy may also be attributed due to seasonal calving habit, a majority of calving in buffaloes are concentrated in rainy season, reason to early lactation tend to have higher milk somatic cell counts.

2.8.3 Parity

Kennedy *et al.* (1982) observed that the effect of age of cows on SCC was significant ($P < 0.01$) for ≤ 2 , 3, and ≥ 6 years old cows but it was not significant ($P > 0.05$) for 4 and 5 years old cows. The mean values of SCC were 275, 348, 421, 496 and 645 x 10³ cells /ml for ≤ 2 , 3, 4, 5 and ≥ 6 years age respectively. Reneau (1986) reported that the order of lactation had the greatest influence on the variations in somatic cell count and older cows had consistently higher average cell counts than younger cows. The average milk SCC irrespective of infection status was reported to be 232,000 in first lactation cows and 868,000 in cows more than 7 years of age. Randy *et al.* (1988) also found that the somatic cell counts in milk also rose with increase in the age and parity of cows, where somatic cell counts were lower in first calvers as compared to those in other parities. Randy *et al.* (1988) also found that the somatic cell counts in milk also rose with increase in the age of cows. Geneurova *et al.* (1993) reported that the somatic cell counts were affected by parity with first calvers having lower somatic cell counts as compared to those in other parities. The interaction of month of lactation and order of calving was significant in Murrah buffaloes reared in the Sao Paul, Brazil. In the first parity, the somatic cell count was lower than in all other parities (Munoz *et al.*, 2002).

2.8.4 Milk Yield and Somatic Cell Counts

Jones *et al.* (1984) observed that in second and older lactations mean somatic cell count was $< 50 \times 10^3$ cells/ ml and the milk yield was 28.0 kg. As SCC increased to 1600×10^3 cells/ml, milk yield decreased up to 24.6 kg. The relationship between milk yield & SCC is depicted as under.

SCC (x 000)	Milk yield (kg/d)
< 50	28.0
100	27.4
200	26.9
500	26.0
800	25.4
1600	24.6

Randy *et al.* (1988) also reported low and negative correlation coefficients between the milk yield and somatic cell counts.

Singh and Ludri (2001a) observed significant ($p < 0.05$) correlation coefficients between SCC and milk yield during different stages of lactation and parities. They also reported that the changes in milk yield of primiparous and multiparous buffaloes were significant. Jorge *et al.* (2005) studied the somatic cell counts and milk production of 38 Murrah buffaloes in 2002 and 2003. The average somatic cell counts was 63,380 cells /ml of milk while average milk production and milk production adjusted (270 days) were 4.07 ± 1.3 kg and 1214.25 ± 293.54 kg, respectively, the correlation between the two being non significant.

CHAPTER – 3

Profile of the Study Area

3. PROFILE OF STUDY AREA

The purpose of this chapter is to describe important features of the study area. The detailed information is presented under the following sub-heads.

- 3.1 Geographical location
- 3.2 Climatic conditions
- 3.3 Land utilization pattern
- 3.4 Livestock population
- 3.5 Population distribution pattern in villages
- 3.6 Socio-economic profile of sampled households

3.1 GEOGRAPHICAL LOCATION

Present study was conducted in Jaisalmer, Barmer and Jodhpur districts of western Rajasthan (As shown in plate 3), which together comprise the breeding tract of Tharparkar cattle in India. The area lies between 24⁰, 4' to 28⁰, 0' north latitude and between 69⁰, 30' to 73⁰, 52' east longitude. The demarcation of breeding tract was done based on the information furnished by the state animal husbandry department (Department of Animal Husbandry, Government of Rajasthan, 2002), knowledge of local herders, NGOs working in field of Tharparkar conservation, district husbandry officers and local habitats. Based on the above information the breeding tract was delineated in all the three tehsils (Jaisalmer, Pakaran and Fatehgarh) of Jaisalmer; Shiv, Barmer, Ramasar, Chohtan and Baytu tehsils of Barmer and Phalodi and Shergarh tehsils of Jodhpur districts.

3.2 CLIMATIC CONDITIONS

Rajasthan, the largest state of India with a geographical area of 3, 42,239 squares km has distinct physiographic features on account of the existence of oldest mountain ranges of Aravalli, which differentiate the state into two distinct climatic regions i.e. semi arid, lying towards the east of Aravalli ranges and the arid region which lies west-wards. The breeding tract of Tharparkar, which lies in western arid region, experiences the extremes of temperature, high velocity of wind and very low humidity. The average annual rainfall of the area between years 1990 to 2002 was a mere 29.64 cm (Table 3.1). The ambient temperature fluctuates from average maximum of 45.83⁰ C to an average minimum of 5.15⁰ C with relative humidity of 50.65 per cent.

Low rainfall coupled with erratic behaviour of monsoon makes the area more vulnerable to drought, as seen by its occurrence once in every three years.

Table 3.1 Mean of climatic factors (1990 - 2002) in Tharparkar breeding tract

District	Rainfall (cm)	Temperature (^o C)			Relative Humidity (%)
		Max.	Min.	Average	
Jaisalmer	21.43	46.40	4.72	26.48	49.02
Barmer	32.75	45.89	6.36	28.57	50.75
Jodhpur	34.74	45.18	4.38	27.19	52.17
Pooled	29.64	45.83	5.15	27.41	50.65

Source: District profile, Directorate of economics, Government of Rajasthan

3.3 LAND UTILIZATION PATTERN

Grazing is major source of livestock feeds, which is reflected by land utilization pattern of the area. On perusal of land utilization pattern (Table 3.2) in year 2001-02, only 29.97 per cent area was used for the cultivation, excluding the forest (0.66%) remaining 69.37 per cent area including; non-agricultural land (10.03%), uncultivable land (45.40%) and fallow land (13.92%) is used directly or indirectly for grazing of livestock. The area has limited irrigation facilities, where only 5.24 per cent of net sown area was being used for sowing more than once with the cropping intensity of 106.20 per cent.

Table 3.2 Land utilization pattern in Tharparkar breeding tract

Classification	Land utilization in 2001-02	
	Land in hectares	Percentage of Total area
A. Geographical area for land utilization purpose	6856600	100.00
1. Forest	45051	0.66
2. Land put to non agriculture use	181441	2.65
3. Barren and un-cultivable land	506174	7.38
4. Permanent pasture & other grazing land	344598	5.03
5. Cultivable waste	2767883	40.37
6. Current fallow	328632	4.79
7. Other fallow land	627661	9.15
8. Net area sown	2055160	29.97
B. Area sown more than once	107664	-
C. Total cropped area	2182565	-
D. Cropping intensity	106.20	-

* Percentage of net sown area, Source: District profile (2003), Directorate of economics, Government of Rajasthan



Location of Rajasthan

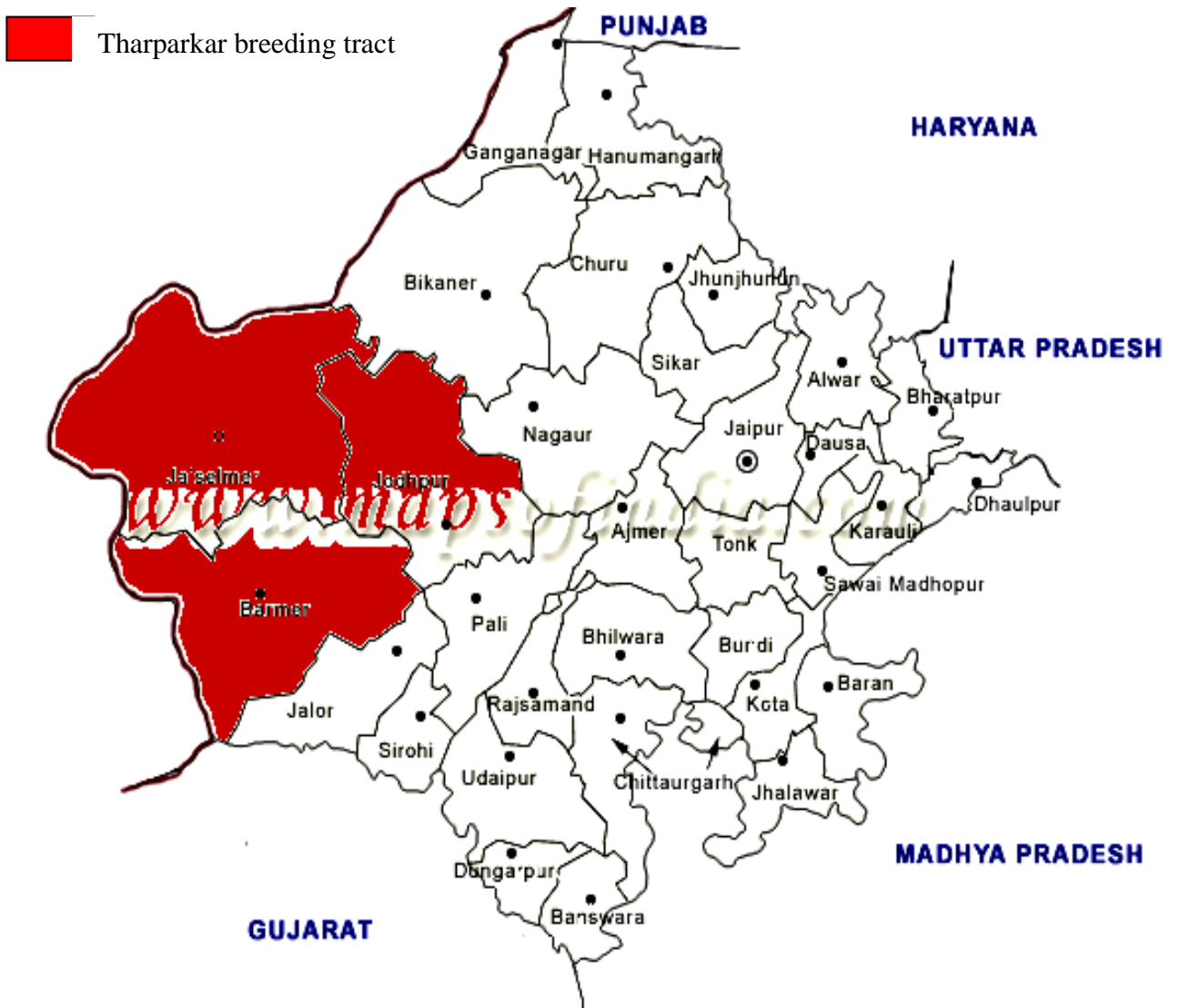


Plate 3: Location of Tharparkar breeding tract in India

These figures of land utilization indicated that area has plenty of free land for grazing of livestock but the productivity of these areas, being heavily dependent on the weather is suspicious and far from satisfactory.

3.4 LIVESTOCK POPULATION

3.4.1 Livestock Population Trends

As revealed by Table 3.3 almost all species of domestic livestock in the area have experienced decline in the population during the recent past, except the population of buffalo, which increased with annual growth rate of 4.88 per cent per annum from 16th livestock census (1997) to 17th livestock census (2003). The annual rate of decline in cattle, goat, sheep, camel and other livestock were; -2.50, -6.51, -6.62, -6.11 and -1.03 per cent, respectively. The overall livestock decline rate was -5.81 per cent per annum from 1997 to 2003 in Tharparkar breeding tract.

Table 3.3 Livestock population trends in Tharparkar breeding tract

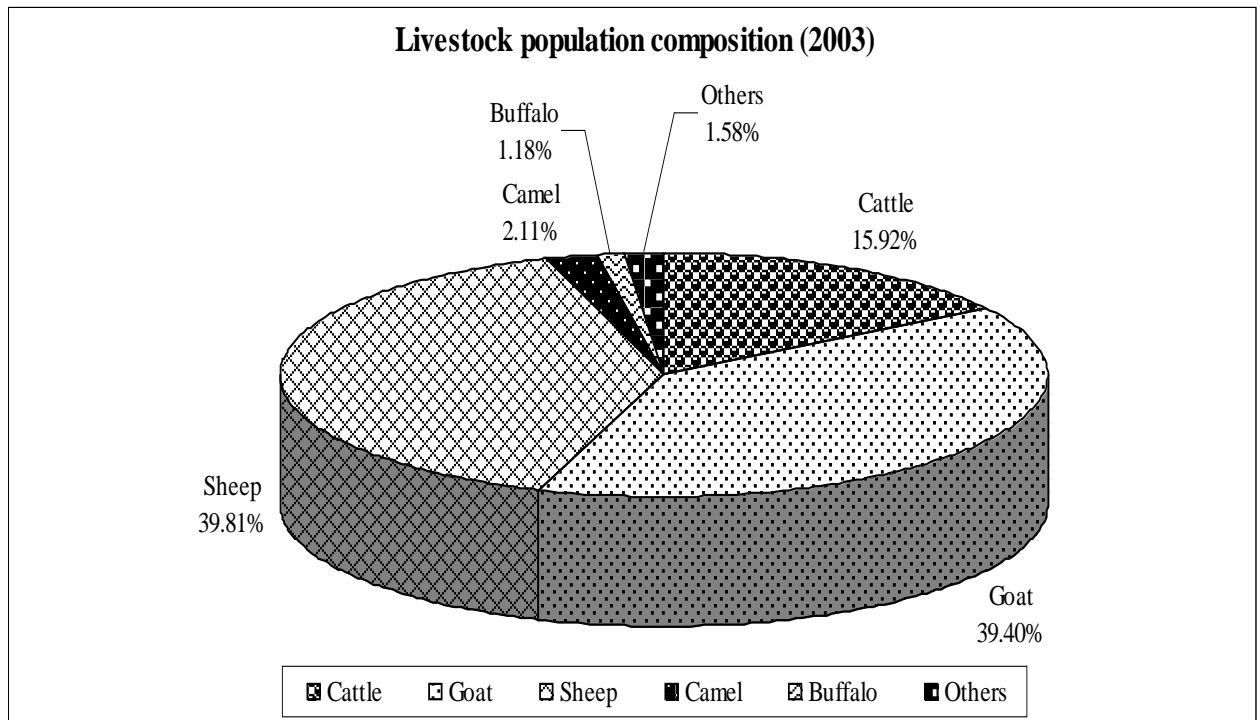
Sl. No.	Livestock species	Livestock census year			Annual growth rate (%) from 1997 to 2003
		1992	1997	2003	
1	Cattle	535945	926250	795894	- 2.50
2	Goat	2086708	2948701	1969300	- 6.51
3	Sheep	1729806	3001474	1990181	- 6.62
4	Camel	164920	154261	105649	- 6.11
5	Buffalo	26368	44226	58871	+ 4.88
6	Others	66415	83983	78940	- 1.03
7	Total	4610162	7158895	4998835	- 5.81

Source: Data of livestock population collected from district statistical office

3.4.2 Livestock Population Composition

As shown in Figure 1, the sheep, goat, cattle, camel, buffalo and other livestock numerically contributed 39.81, 39.40, 15.92, 2.11, 1.18 and 1.58 per cent, respectively in total livestock population of Tharparkar breeding tract in 17th livestock census (2003). Sheep, goat and cattle are the major livestock species reared by the farmer.

Fig.1: Livestock population composition of Tharparkar breeding tract



3.5 POPULATION DISTRIBUTION PATTERN OF VILLAGES

The human population of the area is distributed in three types of pattern *viz.*, concentrated, dispersed and mixed.

Concentrated type: In this distribution, the concentrated proportion of the population lives in the village/ around the village habitats and owns their land and other common grazing land. These villages are generally established at the points where watering facilities are available. Such villages are concentrated in whole of the Jaisalmer district and parts of Shiv tehsil of Barmer and Phalodi tehsil of Jodhpur districts.

Dispersed type: The residents of such villages live in their respective landholdings and the houses of peoples are thus scattered throughout the territory of village. The people concentrate more on agriculture and allied activities; and adopt diversified livestock farming to get better remuneration and to tackle the vagaries of the nature. These types of villages are common in Barmer and Jodhpur districts.

Mixed Type: In this type of distribution, the people, who have no/small land holdings with poor resources, are living in villages especially labourer class whereas the farming community lives at their farm houses.

3.6 SOCIO-ECONOMICAL PROFILE OF SAMPLED HOUSEHOLDS

The important socio-economic characteristics of sampled households of study area have been documented in this section. These information were collected by using the structural schedule (Annexure II).

3.6.1 Family Size

The average family size (Table 3.4) in the area was 7.80 members, where the concept of joint family still dominates with 73.12 per cent respondents still living in the joint families as against 26.88 per cent of the respondents living in nuclear families.

Table 3.4 Mean (\pm SE) family size and land holding of sampled household

Sl. No.	Characteristics	Mean	Range
1	Family size	7.80 \pm 0.15	04 - 17
2	Landholding (ha)	10.99 \pm 0.42	02 - 32

3.6.2 Landholding Size

The population is scarcely distributed with low density in the area, where the average landholdings of respondents are 13.7 hectares. The respondents selected for this study are essentially the livestock keepers generally having plenty of land so the figure of landholding might not be a true representative of the overall population.

3.6.3 Average Livestock Numbers

Cattle, goat and sheep are most preferred (Table 3.5) livestock species by the sampled households with average numbers of 7.36, 18.68 and 36.01, respectively. The numbers of camel, buffalo, horse and donkey per household averaged 1.44, 3.76, 2.00 and 2.33, respectively.

Table 3.5 Details of livestock of sampled households

Sl. No.	Livestock species	Numbers of household	Total Numbers	Mean	Range
1	Cattle	160	1178	7.36 \pm 0.30	3 - 23
2	Goat	154	2877	18.68 \pm 0.76	4 - 60
3	Sheep	93	3349	36.01 \pm 2.59	5 - 125
4	Camel	59	85	1.44 \pm 0.07	1 - 3
5	Buffalo	17	64	3.76 \pm 0.29	2 - 6
6	Horse	10	20	2.00 \pm 0.29	1 - 4
7	Donkey	06	14	2.33 \pm 0.42	1 - 4

3.6.4 Diversified Livestock Production System

The western dry region, constrained by low and erratic rainfall, experiences frequent failure of agricultural crops forcing the local habitants to give more emphasis on animal husbandry. They adopt diversified livestock production system to fulfill most of their needs by getting some remunerations from all species of livestock on account of selling livestock or their produce e.g. milk from cattle and goat, wool from sheep, fibre from goat and camel, draught power from camel and bullock and cash on need by selling kids and lambs.

The major diversified livestock production systems being practiced by households of study area were; cattle, goat, sheep (25.63%); cattle, goat, sheep, camel (25.00%); cattle, goat (21.25%) and cattle, goat, camel (10.00%) along with cropping (Table 3.6).

Table 3.6 Various livestock production systems of sampled households

Family occupation	Households	
	Number	Per cent
Cropping + Cattle + Goat + Sheep	41	25.63
Cropping + Cattle + Goat + Sheep + Camel	40	25.00
Cropping + Cattle + Goat	34	21.25
Cropping + Cattle + Goat + Camel	16	10.00
Cropping + Cattle + Goat + Buffalo	8	5.00
Cropping + Cattle + Buffalo	7	4.37
Cropping + Cattle + Goat + Sheep + Equine	6	3.75
Cropping + Cattle + Goat + Equine	5	3.12
Cropping + Cattle + Goat + Sheep + Camel + Equine	2	1.25
Cropping + Cattle + Equine	1	0.63
Total	160	100.00

Other minor livestock production systems being practiced by the respondents included; cattle, goat, buffalo (5.00%); cattle, buffalo (4.37%); cattle, goat, sheep, equine (3.75%); cattle, goat, equine (3.12%); cattle, goat, sheep, camel, equine (1.25%) and cattle, equine (0.63%).

CHAPTER – 4

Materials and Methods

4. MATERIALS AND METHODS

The chapter has been discussed under the following sub-headings:

- 4.1 Sampling design
- 4.2 Parameters studied
- 4.3 Data collection
- 4.4 Statistical analysis of data

4.1 SAMPLING DESIGN

The present Ph.D. research project was designed to undertake a comprehensive study of Tharparkar breed of cattle in its breeding tract to cover all aspects of cattle husbandry practices. Multistage stratified sampling procedure was used to select the districts, tehsils, villages and respondents.

4.1.1 Selection of Districts

Jaisalmer, Barmer and Jodhpur districts of western Rajasthan, which lie in the breeding tract of Tharparkar cattle, were selected for the study.

4.1.2 Selection of Tehsils

In second stage of sampling, eight tehsils viz., Jaisalmer, Pakaran and Fatehgarh of Jaisalmer district; Shiv, Barmer and Chohtan of Barmer district and Phalodi and Shergarh tehsils of Jodhpur district were selected purposively for the study.

District	Total Tehsils	Tehsils come under the Tharparkar breeding tract	Tehsils selected for the study
Barmer	8	Shiv, Barmer, Baytu, Ramasar and Chohtan	Shiv, Barmer*, and Chohtan
Jaisalmer	3	Pokaran, Jaisalmer and Fatehgarh	Pokaran, Jaisalmer Fatehgarh
Jodhpur	9	Phalodi and Shergarh	Phalodi and Shergarh

**Incorporating the Ramasar and Baytu tehsils, whichever previously part of Barmer tehsil and have similar agriculture and animal husbandry practices*

4.1.3 Selection of Villages

Two villages were selected from each block randomly for the study of breed profile and cattle management practices, thus a total of sixteen villages (Baleba and Tanu from Shiv, Bhadaka and Vaishala from Barmer, Bijidiyar and Shobhala from Chohtan, Mohangarh and Deva from Jaisalmer, Randha and Devikot from Fategarh,

Lathi and Sankara from Pokaran, Chaba and Tena from Shergarh and Kanasar and Lohawat from Phalodi) had been incorporated for the first step objective assessment. The existing numbers of Tharparkar cattle and other relevant information of all the selected villages have been collected through schedule (Annexure I). In the second step, two villages (Baleba and Randha), which lie in the centre of breeding tract and truly represent the agro-climatic conditions of the region were incorporated for the intensive study of production performance, nutrients availability and economics of milk production of Tharparkar cows and the status of grazing resources for cattle.

4.1.4 Selection of Respondents

Step1: After completing the survey of village for the cattle population, 160 respondents were selected randomly through probability proportion of numbers of households with Tharparkar cattle from all the sixteen villages for the documentation of existing management practices.

Step2: From among the two villages selected under second step, the farmers, owning Tharparkar cattle, were selected as respondents for the intensive study of production performance, nutrients availability and economics of milk production of Tharparkar cows.

4.2 PARAMETERS STUDIED

4.2.1 Documentation of Existing Management Practices

A structured schedule (Annexure II and III) was developed for the collection of various information on cattle management practices *viz.*, breeding practices, feeding practices, housing management practices, milking practices and healthcare practices, which were adopted by the respondents and to delineate the major constraints of cattle production system. The schedule was pre-tested for the purpose under existing field conditions before finalizing. Each selected respondent was interviewed personally for the collection of desired information.

4.2.2 Evaluation of Seasonal Nutritional Status of Cows

4.2.2.1 Seasons for Study

Three main seasons of a year *viz.*, summer, rainy or monsoon and winter were incorporated for the present study to find out the seasonal variations in nutritional status and the status of open grazing lands.

Seasons

Season	Months	Month of observation
Summer	March - June	May
Monsoon	July - October	September
Winter	November - February	January

4.2.2.2 Nutritional Status of Cows

Twenty lactating cows (10 from each village) were selected for the study of seasonal variation in the availability of nutrients during summer and winter seasons during the year 2006-07, while numbers were reduced to ten cows in rainy season due to the prevailing drought situation at another location (Randha village) following severe deficit in the grazing resources. Milk yield, milk fat per cent and the body weight (Table 4.1) of individual selected Tharparkar cows were closely monitored.

- (i) Milk yield: The test day milk yield was recorded in the form of kg day⁻¹.
- (ii) Milk Fat: Milk fat was recorded in per cent by using Milko-tester at milk collection centre of Barmer district head-quarter.
- (iii) Body weight: Body length and heart girth of Tharparkar cows were measured to predict the body weight by using the Shaeffer's formula (Sastry *et al.*, 1994)

$$\text{Shaeffer's formula: Live weight in Kg} = \frac{\{(BL") \times (HG")^2\}}{(300 \times 2.2)}$$

Body Length (BL): The distance between points of shoulder to hook.

Heart Girth (HG): The circumference of barrel measured just behind the elbow.

": Measurements in inches

Assessment of nutrient intake

- i) *During Stall-feeding (summer and winter)*: The amount (in kg) of roughage and concentrate consumed by cows were recorded on the test day (feed offered – feed left over). The samples of fodder and concentrate were taken for proximate analysis (AOAC, 1995).
- ii) *Under Grazing (rainy or monsoon)*: Dry matter intake during grazing period was predicted through double indicator method. Acid insoluble ash (AIA) and chromic sesquioxide (Cr₂O₃) were taken as internal and external indicators, respectively.

Table 4.1 Details of experimental Tharparkar cows

Cow No.	Summer					Rainy					Winter				
	EBW (kg)	SOL	LO	MY kg/d	Fat %	EBW (kg)	SOL	LO	MY kg/d	Fat %	EBW (kg)	SOL	LO	MY kg/d	Fat %
T1	350	Mid	3	5.50	4.9	380	Late	3	3.50	4.8	360	Early	4	11.00	4.8
T2	330	Early	2	7.50	4.5	335	Mid	2	5.50	5.4	355	Late	2	2.50	5.4
T3	315	Early	2	8.00	4.7	325	Mid	2	6.50	5.0	326	Dry	-	0.00	0.0
T4	326	Late	2	2.00	5.5	292	Early	3	10.75	5.2	326	Mid	3	5.50	4.9
T5	367	Early	4	7.50	4.6	370	Mid	4	5.50	5.1	380	Late	4	2.00	5.7
T6	315	Late	2	3.50	5.1	329	Early	3	6.50	5.0	335	Mid	3	6.50	4.5
T7	321	Late	1	4.50	4.8	325	Early	2	8.50	4.6	332	Mid	2	7.00	4.8
T8	370	Early	4	9.00	4.7	306	Mid	4	7.50	4.9	343	Late	4	2.50	5.3
T9	295	Late	1	2.50	5.4	320	Dry	-	0.00	0.0	310	Early	2	9.50	4.5
T10	348	Mid	4	4.50	4.5	368	Late	4	3.00	5.6	365	Dry	-	0.00	0.0
T11	304	Late	1	2.00	5.1						335	Dry	-	0.00	0.0
T12	289	Mid	1	5.50	5.1						298	Early	2	7.50	4.5
T13	334	Early	3	10.50	4.2						337	Late	3	4.00	5.2
T14	290	Early	1	7.00	4.8						312	Dry	-	0.00	0.0
T15	372	Mid	4	6.50	4.9						374	Early	5	8.00	5.2
T16	320	Late	2	2.00	5.0						320	Early	3	7.50	4.8
T17	295	Mid	1	5.50	4.7						320	Dry	-	0.00	0.0
T18	314	Early	2	8.50	4.8						340	Late	2	2.00	5.5
T19	286	Late	1	2.50	4.5						289	Early	2	7.75	4.5
T20	341	Mid	3	5.50	5.0						355	Dry	-	0.00	0.0
Mean ± SE	324.10 ± 6.10			5.50 ±0.57	4.84 ±0.07	335.00 ± 9.12			6.25* ±0.86	5.02* ±0.10	335.60 ±5.43			5.95* ±0.78	4.97* ±0.11

Stages of lactation: Early (1-90 days), mid (91-180 days) and late (above 180 days); * wet average

Procedure:

- a) *External indicator:* 12 g chromic sesquioxide per animal was drenched daily continuously for 7 days (Meijs, 1981) and grabbed dung samples were collected on 6, 7 and 8th days during morning and evening. The collected dung samples were dried, ground and digested in triple acid mixture (Concentrated nitric acid, perchloric acid and sulphuric acid mixture in the ratio of 3:1:1). The concentration of chromium in dung samples was determined by atomic absorption spectrophotometry (Williams *et. al.*, 1962). The cows were closely observed during grazing and representative samples of forages during grazing were collected and composited for proximate analysis.
- b) *Internal indicator:* Acid insoluble ash was measured in representative grazing fodder and grabbed dung samples of experimental cows by AOAC (1995).

Prediction equation:

The following equation was used for the prediction of dry matter intake (Crampton and Harris, 1969);

- i) Fecal dry matter output (g/d) =
$$\frac{\text{External indicator fed (e.g., 12g Cr}_2\text{O}_3) \times 100}{\% \text{ external indicator in grabbed dung sample}}$$
- ii) Dry matter consumed (g/d) =
$$\frac{\text{Fecal dry matter output} \times \% \text{ internal indicator in dung}}{\% \text{ internal indicator in forage}}$$

Estimation of nutrients intake requirement

The dry matter intake and crude protein requirements of these experimental cows were calculated based on NRC standard.

i) *Dry matter intake:*

The following prediction equation (NRC, 2001) was used;

$$\text{DMI (kg/d)} = 0.372 \times \text{FCM} + 0.0968 \times \text{BW}^{0.75} \times (1 - e^{(-0.192 \times (\text{WOL} + 3.67))})$$

Where,

FCM = 4 per cent fat corrected milk (kg/day),

BW^{0.75} = Metabolic body weight (kg)

WOL = Week of lactation

The term $1 - e^{(-0.192 \times (\text{WOL} + 3.67))}$ adjusted for depressed DMI during early lactation (first 10 weeks of lactation).

$$4\% \text{ FCM} = (0.4 \times \text{kg milk yield}) + (15 \times \text{kg fat})$$

ii) ***Crude protein***

Interpolated the tables of CP requirement.

4.2.2.3 Phosphorus content in feeds

The samples of grasses and other staple fodder of cattle were collected from the study area, dried, ground and digested in triple acid mixture (Concentrated nitric acid, perchloric acid and sulphuric acid mixture in the ratio of 3:1:1) and phosphorus content was measured by Calorimetric method.

4.2.2.4 Rangeland status

a) **Palatability rating of grasses for cattle**

The palatability rating of the common grasses available in the grassland is a best indicator for the range value for cattle. The grasses were grouped in three categories based on their comparative desirability of consumption viz., more-palatable, less palatable and un-palatable for cattle. The criteria used for this categorization was based on the knowledge of herders/ farmers in consultation with agronomists and range management specialists of Krishi Vigyan Kendra of the area.

b) **Botanical composition**

Botanical composition is important because it gives information on the basic elements of the pasture that provide energy, protein and minerals to fulfill the nutritional requirement of the animals. The study was carried out on the common rangeland situated in two villages (Baleba from Barmer and Randha from Jaisalmer district) of arid region. The vegetation of the area was analyzed from the representative forage samples collected from protected quadrates (1m x 1m), using the technique of random sample location in selected rangelands. The phytosociological observations were estimated by 'direct estimation of percentage composition' technique (Whalley and Hardy, 2000) and classified them in palatability groups during summer, rainy and winter seasons of year 2006-07.

4.2.3 Mastitis and Milk Somatic Cell Counts

4.2.3.1 Incidences of mastitis in field

For the study of incidences of mastitis, randomly selected lactating Tharparkar cows (N = 346) were screened for the mastitis in field condition. The procedure adopted to detect mastitis was as follows,

- (i) Present history of mastitis.
- (ii) The cows were systematically examined by palpation for evidence of any physical abnormalities and injuries to teat canal.
- (iii) “MASTRIP” was used to test the milk sample for detection of mastitis.
- (iv) Simultaneously past history of mastitis, if any, was collected and physical examination of teat was done for any abnormalities.

MASTRIP (Daber India Pvt.) is unique cellulose based bromothymol blue strip impregnated with stabilized ions, which are sensitive indicators for detection of mastitis. The testing of milk sample was done during morning milking after discarding the first few strippings; one single drop of milk was put on one strip and the resultant immediate change in colour of the strip was compared with the standard colour chart provided along with the MASTRIP.

The per cent incidences of mastitis were determined by the following formula.

$$\text{Incidences of mastitis (\%)} = \frac{\text{Numbers of cows positive for mastitis}}{\text{Total numbers of cows examined}} \times 100$$

4.2.3.2 Somatic cell count (SCC)

Somatic cell count of milk was measured microscopically as per method mentioned in IDF bulletin, No.168 (1984).

Preparation of dye

Ethyl alcohol (54 ml) and tetrachloroethene (40 ml) was mixed in a bottle and heated in a water bath 60 to 70°C for 15 minutes. Methylene blue dye (0.6g) was added to the solution carefully and the solution was kept in the refrigerator at 4°C for 30 min, after which the glacial acetic acid (6 ml) was added. The dye solution so prepared was filtered using a filter paper with a pore size of 10 to 12 micron and stored in a coloured bottle. The dye was prepared a fresh every few days.

Procedure

Using micropipette, 10 µl of fresh milk sample was spread over a glass slide having marked area of 10 mm x 10 mm. The fine milk smear so prepared was air dried. The slides were dipped into xylene for 1-2 minutes to remove fat globules and dried subsequently. The slides were then stained using methylene blue dye for a period of 15

minutes and were dried at room temperature. The excess stain was removed from smears under running tap water and the slides were again dried at room temperature. Somatic cell counts (SCC) were measured under microscope using 60 X (lens radius= 0.0135mm) in 50 fields and were multiplied by microscopic factor (1,04,712) to obtain the number of cells per ml of milk.

$$\text{Somatic cells/ ml of milk} = \text{Average number of cells per field} \times 1,04,712$$

4.2.4 Body Condition Score and Production Performances

4.2.4.1 Body condition scoring in field

Body condition of the animal can provide valuable guidelines with regards to the energy status of the cow. Body condition scoring system is based on visual observations and/or palpation of vertebral column, transverse processes, tail head region and ribs of the animal and assigning numerical values to each point based on the amount of fat deposition over these points and differ only on account of the weightage given to the respective point and the scale used. To assess the body condition of animals following points were taken into account;

- (i) Flesh covering at spinous processes of vertebral column (Chine, Loin and Rump region)
- (ii) Prominence of spinous processes
- (iii) Sharpness of spinous processes
- (iv) Tail head region: prominence of depression between backbone and pins and in between pins and hook bones.

Considering these points Prasad (1994) formulated a six point score chart which was used for measuring body condition score of cows and heifers in field condition during different seasons and the animals were subsequently classified them under following 3 body condition classes (Prasad and Tomer, 1998).

Body condition class	Body condition score
Low	BC score < 3.0
Medium	BC score \geq 3.0 - < 4.5
High	BC score \geq 4.5

4.2.4.2 Production performance under field condition

The production and reproduction performance traits of Tharparkar cows under existing field conditions of its breeding tract were recorded in two ways.

a) *Individual performance recording sheet.*

The representative cows in early stage of lactation with Tharparkar like characteristics were selected (N = 33) for recording of various parameters of production traits with the help of individual performance recording sheet (Annexure IV). The following parameters were recorded;

- ❖ Identification mark
- ❖ Approximate age
- ❖ Date of calving
- ❖ Lactation order
- ❖ Date of first service after calving
- ❖ Date of conception
- ❖ Date of drying
- ❖ Milk recording schedule

In milk recording schedule, monthly test day milk recording was taken for selected Tharparkar cows. The mean of the recordings was taken for estimation of lactation yield of 305 days through test day interval method, which approved by the International Committee on Animal Recording (ICAR). Simultaneously other parameters *viz.*, number of services per conception, service period, dry period, lactation length and calving interval were generated through above recorded information.

Note:- For the maintenance of individual performance recording sheets of selected cows, help was taken from the village level workers of NGO named Society to Uplift Rural Economy, working on the project of Tharparkar cattle improvement program at field level.

b) *Production performance based on the information provided by respondents*

Production performance traits (Annexure III) of Tharparkar cows were recorded during the interview of selected respondents for the management practices.

4.2.4.3 Economics of milk production

Expenditure incurred on different items of cost of milk production and methodology used for calculating the cost of milk production is illustrated below.

a) **Cost of milk production**

The cost involved in milk production had been categorized into fixed cost and variable cost.

i) ***Fixed cost (FC)***

It refers to those costs which remain unchanged over a short period of time. The relevant components of fixed cost that were taken into milk production are;

Depreciation (D):

It is the loss in value of an asset due to wear and tear. Depreciation in cattle shed, dairy equipments and animals was considered. An annual depreciation of 20 per cent was assumed on kutchha movable shed structure as prevalent in the study area, while 10 per cent depreciation was assumed for dairy equipments. The depreciation of milch cow was taken as per procedure given by Patel (1979). The annual depreciation expenses were apportioned per Standard Animal Unit (SAU) as given by Kumbhare *et al.* (1983).

Interest on fixed capital (IFC):

The value of milch cow, cattle shed and other equipment related to milk production was taken as the fixed capital. The interest on fixed assets was calculated at the rate of 8.5 per cent, which match the interest rate provided by the commercial bank on fixed deposits. The annualized interest was worked out per SAU per day.

ii) ***Variable cost (VC)***

The important items of expenses included in the variable costs were green fodder, dry fodder, concentrate, human labour, veterinary and miscellaneous expenses such as ropes, chains, electricity, water, minor repairs and other minor expenses. The variable cost of inputs, namely feed and labour was computed by ascertaining the actual quantities utilized per lactating animal per day and multiplying the physical units by their respective market prices or actual cost incurred depending on whether the input cost was farm produced or purchased.

iii) Gross cost (GC)

The gross cost of milk production is computed as the sum total of fixed costs and variable costs. This gives a picture of total implicit and explicit costs that have been incurred in the milk production.

iv) Net cost (NC)

The net cost of milk production of the sampled households was worked out by deducting the imputed value of dung from the gross cost. The dung of cow has wide range of utility in the area such as construction of kutcha human shelter, cooking of food and manuring of field. The assumed market value of dung was taken as Rs. 2.00 day⁻¹ SAU⁻¹ in summer and winter seasons while Rs 1.50 day⁻¹ SAU⁻¹ in rainy season due to losses of droppings during grazing.

b) Returns from milk production

The income from milk production was categorized on the following pattern.

i) Gross Income (GI)

It was worked out by adding the value of milk and dung produced by the milch cows of the sampled households.

ii) Net Income (NI)

This is the true reflection of the income, which was calculated by deducting gross cost from gross income.

4.3 DATA COLLECTION

The procedure for collection of data has been described under as per objectives.

4.3.1 Estimation of Population Figure of Tharparkar Cattle

For the estimation of total Tharparkar cattle population in its breeding tract the following types of primary and secondary data were collected.

Primary data

- Complete survey of all selected villages (N = 16) for the cattle population during year 2006 (Annexure I).
- To identify the Tharparkar like cattle in each selected village.

Secondary data

- Data of cattle population of all tehsils (Livestock census 1992, 1997 and 2003) were collected from district animal husbandry office of each district.

4.3.2 Documentation of Existing Cattle Management Practices

The primary data of management practices were collected by using the structured schedule as given in annexure ii and iii.

4.3.3 Body Condition Score

The data of BCS of Tharparkar breed were classified according to animal type and season.

Animal type

The animals were categorized as;

Animal Type	Code	Numbers of observation
Heifers	1	468
Dry cow	2	433
Lactating cow	3	410

Season

Three seasons were classified as;

Season	Code	Numbers of observation
Summer	1	474
Monsoon	2	454
Winter	3	383

4.3.4 Milk Somatic Cell Counts

The data of SCC of Tharparkar breed were classified according to parity, stage of lactation, level of production and season. All these parameters were taken into consideration as the factors influencing the somatic cell counts.

Parity

All the animals were categorized under different parities according to their lactation number.

Parity	Code	Numbers of observation
1	1	56
2	2	64
3	3	73
4	4	63
5 & above	5	70

Stage of lactation

The whole lactation has partitioned into three stages of lactation as given below:

Stage of lactation	Days of lactation	Code	Numbers of observation
Early	1 to 90	1	131
Mid	91 to 180	2	132
Late	Above 180	3	63

Level of production

The cows were divided into three milk production categories considering the average test day milk yield.

Level of production	Criteria	Code	Numbers of observation
Low yielder	$< \mu - \sigma$	1	77
Medium yielder	$\mu \pm \sigma$	2	177
High yielder	$> \mu + \sigma$	3	72

μ = mean of test day milk yield; σ = Standard deviation

Season

Three seasons for the purpose of the present study were classified as;

Season	Code	Numbers of observation
Summer	1	122
Monsoon	2	111
Winter	3	93

4.4 STATISTICAL ANALYSIS OF DATA

4.4.1 Estimation of Population Figure of Tharparkar Cattle

Estimated the Tharparkar cattle population based on quinquennial (1997 - 2003) and decadal (1992 - 2003) growth rate as follow;

$$p = x / n \dots\dots\dots(1)$$

$$T = p \times N \dots\dots\dots(2)$$

Where,

p = Proportion of Tharparkar cattle in sample

n = Sample size

x = Numbers of Tharparkar cattle in sampled population

N = Total predicted cattle in year 2006 based on previous growth trend

T = Total estimated Tharparkar cattle

Confidence interval (CI):

$$95\% \text{ CI} = 1.96 \sqrt{\{(p)x(1-p) / n\}}$$

Where,

p = Proportion of Tharparkar cattle in sample

n = Sample size

4.4.2 Documentation of Existing Cattle Management Practices

Cattle management practices were documented by tabular analysis (Snedecor and Cochran, 1989).

4.4.3 Body Condition Score

The data were analyzed through least squares analysis of variance procedure (Harvey, 1976) by using the following mathematical model:

$$Y_{ijk} = \mu + A_i + S_j + e_{ijk}$$

Where,

Y_{ijklm} = k^{th} observation in i^{th} animal type and j^{th} season.

μ = Population mean

A_i = Effect of i^{th} animal type ($i^{th} = 1, 2$ and 3)

S_j = Effect of j^{th} season ($j^{th} = 1, 2$ and 3)

e_{ijk} = Random error. NID ($0, \sigma_e^2$)

The pair wise comparison of least squares means was done by using Duncan's Multiple Range Test (Kramer, 1957).

4.4.4 Milk Somatic Cell Counts

The following mathematical model was used to analyze the SCC data through least squares analysis of variance.

$$Y_{ijklm} = \mu + P_i + L_j + O_k + S_l + e_{ijklm}$$

Where,

Y_{ijklm} = m^{th} observation in i^{th} parity, j^{th} stage of lactation, k^{th} level of production and l^{th} season.

μ = Population mean

P_i = Effect of i^{th} parity ($i^{\text{th}} = 1, 2 \dots 5$)

L_j = Effect of j^{th} stage of lactation ($j^{\text{th}} = 1, 2$ and 3)

O_k = Effect of k^{th} level of production ($k^{\text{th}} = 1, 2$ and 3)

S_l = Effect of l^{th} season ($l^{\text{th}} = 1, 2$ and 3)

e_{ijklm} = Random error. NID ($0, \sigma_e^2$)

The pair wise comparison of least squares means was done by using Duncan's Multiple Range Test.

CHAPTER – 5

Results and Discussion

5. RESULTS AND DISCUSSION

The results of the present study on production system analysis of Tharparkar cattle in its breeding tract have been presented under the following sub-heads.

- 5.1 Population statistics of Tharparkar cattle
- 5.2 Cattle management practices in Tharparkar breeding tract
- 5.3 Nutritional status of Tharparkar cows
- 5.4 Mastitis and milk somatic cell counts
- 5.5 Body condition score and production performances of Tharparkar cows
- 5.6 Economics of milk production

5.1 POPULATION STATISTICS OF THARPARKAR CATTLE

The population statistics of Tharparkar cattle included the present population figures, proportionate contribution and geographical distribution in its breeding tract.

5.1.1 Estimated Tharparkar Population based on Quinquennial Growth Trend

The seventieth quinquennial livestock census (2003) showed that cattle population of Tharparkar breeding tract has declined with the annual growth rate of -2.49 per cent from year 1997 to 2003. Based on this growth trend the existing population of Tharparkar like cattle was estimated to be 44,548, which contribute 5.99 per cent to the total cattle population of its breeding tract (Table 5.1). The major fraction of Tharparkar population is located in Jaisalmer district with 29,986 (62.82%) heads of pure bred Tharparkar cattle followed by 12,834 (28.81%) and 3,729 (8.37%) in Barmer and Jodhpur districts, respectively. The proportion of Tharparkar cattle to total cattle population in Jaisalmer, Barmer and Jodhpur districts was worked out to be 12.94, 3.81 and 1.95 per cent, respectively.

The probable reasons behind this decline in cattle population could be; continuous increase in human population coupled with consequent depletion of grazing resources, recurrence of droughts causing chronic shortage of feed and fodder in the area, rise in the proportion of unproductive and/ or low productive cattle uneconomical to maintain on limited resources. In addition to the aforesaid reasons increase in employment opportunities in other sectors results in shifting of the population from

traditional occupation of primary sector to secondary and tertiary sectors and consequent decline in the proportion of people engaged in cattle rearing.

5.1.2 Estimated Tharparkar Population based on Decadal Growth Trend

The decadal growth trend (1992 - 2003) of cattle population in Tharparkar breeding tract showed drastic fluctuation, while during first 5 year period (1992 - 1997) the cattle population increased by 72.82 per cent by 1997, which subsequently declined by 14.07 per cent (1997 - 2003) by the year 2003. The overall trend during the decade showed 3.45 per cent annual growth rate. Based on decadal growth rate the present population figure of Tharparkar like cattle (Table 5.2) has been estimated to be 55,072, which accounted for 6.22 per cent of total cattle population of its breeding tract. The major proportion of Tharparkar animals is located in Jaisalmer district with 35,936 (65.26%) numbers of pure bred Tharparkar cattle followed by 14,665 (26.63%) and 4,468 (8.11%) in Barmer and Jodhpur districts, respectively. The proportion of Tharparkar cattle to total cattle population of Jaisalmer, Barmer and Jodhpur districts was estimated to be 12.95, 3.87 and 1.95 per cent, respectively.

The spatial distribution of Tharparkar shows that, the proportion of these cattle to the total cattle population in Pokaran, Jaisalmer and Fatehgarh tehsils are 12.59, 13.37 and 12.64 per cent, respectively. In the rest of the tehsils of the breeding tract viz., Barmer, Chohtan, Shiv, Phalodi and Shergarh, it was 2.76, 2.73, 7.12, 1.93 and 1.99 per cent, respectively.

The higher proportion of Tharparkar specimens in Jaisalmer district might be due to the fact that this belt is an integral part of the place of origin of Tharparkar breed. Additionally the area is scarcely populated with plenty of free land available for grazing and no need of migration of stock in search of feed and fodder in the vicinity of other breeds. Few *Rajput* and *Muslim* community people are good herders and they are very keen and interested to maintain their indigenous stock. The parts of Barmer and Jodhpur districts falling under Tharparkar breeding tract are surrounded by the breeding tracts of Kankrej, Nagori and Rathi breeds of cattle. Frequent migration of animals and herders often cause inter-mixing of the characters of these breeds with Tharparkar cattle, resulting in loss of the characteristic breed specimens in its territory. Simultaneously the farming communities of these districts are living in their farm houses (dispersed type) and more concentrated on agriculture and livestock husbandry.

Table 5.1 Estimated Tharparkar cattle population based on quinquennial growth trend (1997 - 2003)

Tharparkar breeding tract		Cattle population in Tharparkar breeding tract				Estimated Tharparkar population in 2006	
District	Tehsil	1997	2003	AGR (%)	2006*	Numbers	Proportion (%)
Jaisalmer	Jaisalmer	127331	103481	- 3.40	93288	12468	13.37 (12.13 - 14.63)
	Fatehgarh	63065	40178	- 7.24	32069	4039	12.60 (11.36 - 13.83)
	Pokaran	119801	99616	- 3.03	90837	11479	12.64 (11.42 - 13.85)
Barmer†	Barmer	143625	157350	+1.53	164697	4539	2.76 (2.15 - 3.36)
	Chohtan	88931	89840	+0.17	90298	2464	2.73 (2.09 - 3.36)
	Shiv	100727	87762	- 2.27	81919	5831	7.12 (6.21 - 8.03)
Jodhpur	Phalodi	181529	135594	- 4.75	117189	2261	1.93 (1.38 - 2.48)
	Shergarh	101241	82073	- 3.44	73896	1468	1.99 (1.41 - 2.56)
Total		926250	795894	- 2.49	744194	44548	5.99

Values in parenthesis indicate 95% confidence interval in percentage

† Include cattle population figures of Baytu and Ramsar tehsils

** Predicted cattle population bases on quinquennial growth rate (1997 - 2003).*

Table 5.2 Estimated Tharparkar cattle population based on decadal growth trend (1992 - 2003)

Tharparkar breeding tract		Cattle population in Tharparkar breeding tract					Estimated Tharparkar population in 2006	
District	Tehsil	1992	1997	2003	AGR (%)	2006*	Numbers	Proportion (%)
Jaisalmer	Jaisalmer	52206	127331	103481	6.08	123521	16510	13.37 (12.13 - 14.63)
	Fatehgarh	29580	63065	40178	2.47	43235	5445	12.60 (11.36 - 13.83)
	Pokaran	66117	119801	99616	3.56	110652	13983	12.64 (11.42 - 13.85)
Barmer†	Barmer	95660	143625	157350	4.52	179690	4952	2.76 (2.15 - 3.36)
	Chohtan	56286	88931	89840	4.20	101648	2773	2.73 (2.09 - 3.36)
	Shiv	58401	100727	87762	3.57	97493	6940	7.12 (6.21 - 8.03)
Jodhpur	Phalodi	118239	181529	135594	1.05	139907	2699	1.93 (1.38 - 2.48)
	Shergarh	59456	101241	82073	2.76	89048	1769	1.99 (1.41 - 2.56)
Total		535945	926250	795894	3.45	885193	55072	6.22

Values in parenthesis indicate 95% confidence interval in percentage

† Include cattle population figures of Baytu and Ramsar tehsils

** Predicted cattle population bases on decadal growth rate (1992 - 2003).*

In general psychologically they are more interested on numbers of livestock compared to less numbers with good quality to get more cumulative remuneration

The results of this study are near similar to the findings of Sharma (2004). He estimated the population of Tharparkar cattle in its breeding tract as around 48,000 under the survey program of NATP project. But his findings differed with regard to the spatial distribution of Tharparkar cattle within its breeding tract. Whereas, he reported that highest numbers of Tharparkar cattle were found in Barmer district followed by Jaisalmer and Jodhpur district, in this study the highest concentration of Tharparkar animals was in Jaisalmer, followed by Barmer and Jodhpur districts.

5.2 CATTLE MANAGEMENT PRACTICES IN THARPARKAR BREEDING TRACT

5.2.1 Breeding Practices

The average numbers of cattle in respondent households were 7.36 (Table 5.3) and the proportion of lactating cows, dry cows, breedable heifers (> 3 yrs.), young stock, bull and bullock was 26.49, 18.48, 9.24, 35.19, 3.94 and 6.66 per cent, respectively. The ratio of milch stock with that of the follower was 1: 1.22 among the respondent households.

Table 5.3 Mean (\pm SE) herd composition of respondent households

Category	Mean for household	Proportion (%)
Lactating cows	1.95 \pm 0.09	26.49
Dry cows	1.36 \pm 0.06	18.48
Breedable heifers	0.67 \pm 0.06	9.24
Young stock	2.59 \pm 0.09	35.19
Bull	0.29 \pm 0.04	3.94
Bullock	0.49 \pm 0.05	6.66
Mean herd size	7.36 \pm 0.30	100.00

As under prevalent cattle rearing system in this region, animals roam freely within the village territory or its outskirts, resulting in majority of cows (67.5% respondents) being mated indiscriminately with any approachable bull, while 32.5 per cent respondents take care of their cows, by mating with best option bull whenever the animal comes in heat. Thus the majority of respondents were not particularly interested

in getting good progeny, and instead aimed at getting their animals pregnant at the earliest opportunity even at the cost of the genetic worth of the bull; this might be due to the inadequate knowledge of breeding, non-availability of pedigree bull and/or reluctance of farmers to take pain for regular monitoring of cows for heat and breeding in extensive system. There is no reach of artificial insemination (AI) services in the distantly scattered villages of the area due to non availability of infrastructural facilities as well as unfavourable climatic conditions.

The results of this study are similar to those reported by Nivsarkar *et al.* (1992) who also did not find a planned mating system in Tharparkar belt and reported that natural service was the common method for breeding the animals.

Table 5.4 Cattle breeding practices followed by the respondents

Characteristics	Households	
	Number	Per cent
1. Method of service		
a. Natural	160	100.00
b. AI	0	0.00
2. System of mating		
a. Controlled or planned	52	32.50
b. Uncontrolled or indiscriminate	108	67.50
3. Castration of male calves		
a. Yes	88	55.00
b. No	72	45.00
4. Method of castration		
a. Open traditional	80	90.91
b. Burdizzo	8	9.09
5. Age of castration		
a. 1 – 2 years	75	85.23
b. > 2 years	13	14.77

Majority of respondents (55.00%) practiced castration in their male calves; on the contrary 45.00 per cent respondents were averse to castration practices owing to social and religious taboos and simultaneously reducing the market value of bullocks due to mechanization of agriculture. Some castes of the region *viz.*, *Vishnoi*, *Brahmin*,

Cattle management practice in Tharparkar breeding tract



Plate: 4 Natural controlled mating



Plate: 5 Natural uncontrolled mating



Plate: 6 Housing structure in summer



Plate: 7 Housing structure in winter



Plate: 8 Common watering trough



Plate: 9 Pond (harvested rain water)



Plate: 10 Storage of hay (wedge shaped)

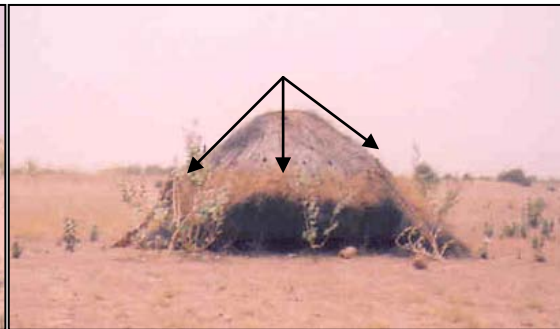


Plate: 11 Storage of hay (pyramid shaped)

Suthar, Rajpurohit, Charan and Jain are reluctant to castrate their male calves and let them loose, even if they did not have any genetic worth for being reared as a bull.

Generally the male calves were castrated by traditional method (90.91%), at the age of 1-2 years, while the scientific method of castration (use of burdizzo castrator) was restricted in the area of few villages where veterinary hospital/ dispensary available and corresponding staff took interest in castration practice and was found to be adopted by only 9.09 per cent respondents. The traditional method of castration is practiced by a specific backward community named as *Satia*. In this method the tip of scrotum is incised, testicles removed and wound left open for drainage. This practice is totally unhygienic and painful to the animal.

5.2.2 Housing Practices

The various types of cattle housing practices (Table 5.5) revealed that all the respondents followed loose housing system with stable (56.25%) or seasonally movable (43.75%) housing structure. The type of housing structure depends on the population distribution pattern of respondents in villages. The respondents of densely populated villages adopted stable/ fixed housing structure, while the respondents of villages having widely dispersed households often living in their farm houses adopted seasonally movable housing structure for livestock, which helps in better manuring of field, especially barren spots. Further, the required modifications in housing structure following seasonal changes in weather are also easily managed in this system. Similarly the location of cattle shelter, whether part/ near the human dwelling or separate also depends on the concentration of respondent households in the village. The location of cattle shelter inside or near human dwelling was being followed by 45.00 per cent respondent families and separate from human dwelling was in practice in case of the remaining 55.00 per cent farm families. The majority of respondents, who lived in thickly populated villages have less free space around their residence so they practiced to shelter their cattle in part of the residential area, while the respondents who lived at farmhouses had plenty of free space and hence maintained separate housing structure for the animals.

Majority of respondents (93.75%) housed their cattle only at night; else they roam freely for grazing and/ or watering, while 6.25 per cent housed their cattle both

during day and night, especially their milch stock and calves. The *kutchha* manger made up of cow dung and clay soil, which was either small sized and movable and/ or stable and large sized was commonly used by 68.12 per cent respondents followed by 11.88 and 20.00 per cent respondents using *pucca* (concrete) and wooden (locally termed as *Audi*), mangers respectively for feeding their cattle. Mostly the cattle housing structure of respondents (90.62%) had no provision of roof and adopted only soil bedding as a floor in which animals feel more comfortable.

Table 5.5 Cattle housing practices followed by the households

Characteristics	Households	
	Number	Per cent
1. Housing system		
a. Close house	0	0.00
b. Loose house	160	100.00
2. Housing structure		
a. Stable/ Fixed	90	56.25
b. Seasonally movable	70	43.75
3. Location of sheds		
a. Inside/ near dwelling	72	45.00
b. Separate from dwelling	88	55.00
4. Type of feed manger		
a. Kutchha	109	86.87
b. Pucca	19	6.88
c. Wooden	32	6.25
5. Type of roof		
a. Thatched	15	9.38
b. Open	145	90.62
6. Cattle kept under shed		
a. Only at night	150	93.75
b. Both day and night	10	6.25

Seasonal alterations in cattle shelter were regularly practiced by respondents, especially in winter, thick wind breaking barriers raised towards northern side to protect their animals from cold wind, while provision of shadow in cattle shelter in

summer was very infrequent and farmers left their animals loose to seek shadow of trees especially at and around common watering resource of the village.

Thus it could be inferred that the main purpose of the farmers in housing the animals is to restrict the movement of animals for milking (evening milking to next morning milking) and collection of dung, which is utilized for cooking of foods, as raw material for construction of kutchha houses and for manuring the fields. These findings are in conformity with the observations of Nivsarkar *et al.* (1992) who inferred that in northwestern part of Rajasthan animals are generally not provided any shelter or houses throughout the year excepting on certain chilly nights or during extreme summer season.

5.2.3 Milking Practices

The information on milking practices (Table 5.6) revealed that women were generally accomplishing the milking process in 97.50 per cent cases with knuckling method of milking. They customarily adopt hygienic measures during milking viz., washing of hands before milking, washing of teats, cleaning of utensils and milking premises with few exceptions of economically and socially backward classes. Mostly calf was allowed to suckle for let down of milk and later on tightly tied along side its dam and was subsequently let loose on completion of milking to suckle the left over/residual milk. In latter stage of lactation calf was replaced with concentrate feed for initiation of milk let down stimulus. Farmers generally practiced twice a day milking in cows, except in a very few cows which were milked thrice during the early stage of lactation.

The milk is staple food for the predominantly vegetarian society in this area and almost all of the milk produced at the household is utilized at home by 68.13 per cent of the respondents either as raw milk or curd/ butter milk. Among these households some (23.75%) churned part of the milk produced into butter milk and Ghee and sold surplus ghee to the local customers or in nearby local market to partially fulfill their monetary requirements. On the other hand 31.87 per cent respondents, who generally lived in densely populated villages and/ or lived near the town or a city, sold their surplus milk to get remunerative price. The milk was utilized at home as liquid milk, milk in tea, as curd or as ghee and butter milk. The major fraction of milk was utilized for the separation of ghee (clarified butter) and butter milk. Ghee is the highly preferred milk

product and is utilized for daily consumption as well as kept stored for any social functions or for sale on local demands. The butter milk is consumed directly as such or used for the preparation of food ingredients locally named *Kadhi* and *Rabari* and surplus butter milk is fed to the animals.

Table 5.6 Milking management practices followed by households

Characteristics	Households	
	Number	Per cent
1. Gender of milker		
a. Man	4	2.50
b. Woman	156	97.50
2. Method of milking		
a. Knuckling	156	97.50
b. Full hand	4	2.50
3. Milk disposal		
a. Home consumption only	66	44.38
b. Home consumption + sale of ghee	38	23.75
c. Home consumption + sale of milk	56	31.87

The findings are similar to those reported by Dev Raj (1991) who reported that around 73 per cent of total milk produced in rural areas of Churu district of western dry region was consumed at home.

5.2.4 Health Care Practices

The data of health care practices followed by respondents (Table 5.7) revealed that majority of respondents (93.12%) were not adopting prophylactic measures against numerous prevalent diseases in cattle viz., black quarter (BQ), foot-and-mouth disease (FMD), hemorrhagic septicemia (HS), brucellosis and anthrax. Although the indigenous stock has high disease resistance and low mortality, the health and productivity of the animals are severely hampered in case of the occurrence/ outbreak of the diseases. Inadequate knowledge of prophylactic measures, non availability of veterinary staff and vaccines and non serious attitude of people might be the reasons for low adoption of preventive veterinary health care practices.

Most of the respondents (84.38%) used to control endo-parasites in sheep, while only 8.75 per cent used anthelmintic preparation on their cattle. Sheep may be

affected more by the endo-parasites owing to close grazing habit and the use of deworming practice in sheep often provide immediate results in the form of higher weight gain and reduction in mortality, which in turn makes farmer more eager to adopt deworming in sheep than in cattle wherein the results may be slow and not clearly evident. Although use of deworming in calves would lessen the intestinal worm burden and improve the weight gain, a prerequisite for attaining early maturity, farmers are often unaware of it.

Table 5.7 Healthcare practices adopted by respondents

Characteristics	Households	
	Number	Per cent
1. Vaccination		
a. Practiced	11	6.88
b. Not practiced	149	93.12
2. Deworming practices in cattle		
a. Yes	14	8.75
b. No	146	91.25
3. Deworming practices in other animal (Sheep/ goat)		
a. Yes	135	84.38
b. No	25	15.62
4. Treatment of sick animals		
a. Self medication and/ or LKP	104	65.00
c. Veterinary staff	56	35.00

LKP: Local knowledgeable person

The data on the treatment of sick animals reflected that 65.00 per cent respondents attempt some conservative approaches based on their traditional knowledge and later consult local knowledgeable person for the treatment of sick animals, who were expert to some extent in traditional methods of treatment. On the other hand 35.00 per cent respondents got benefited from the state veterinary health care workers / veterinary doctors, who live near the city/ town or the village which has veterinary hospital or dispensary. The results are supported by the findings of Rathore and Köhler-Rollefson (1997) and Ellen (2001) as reported that majority of livestock keepers in Pali district of Rajasthan resort to their own resources and experience and consult the local knowledgeable person for treatment of their sick animals.

5.2.5 `Common Health Care Problems in Cattle

The common health problems in cattle (Table 5.8) revealed through discussion with veterinarians working in the area, livestock health problems reported by farmers / herders and personal observation of cases.

Digestive system: Diarrhoea, impaction and tympany are common symptoms of digestive disorders found in cattle. In drought or scarcity period the incidences of these disorders are drastically raised, which might be due to the consumption of toxic substances found in the drought resistant grasses/ shrubs which are other wise very less palatable to the animals.

Respiratory system: Pneumonia and upper respiratory tract infection are the major respiratory disorders found in cattle, especially during the winter season.

Reproductive system: Anoestrus, repeat breeding, abortion and retained placenta are the key reproductive disorders sporadically found in cattle. Delayed puberty and anoestrus might be related to the nutrient deficiency, while abortion and retained placenta often resulted from the occurrence of brucellosis or other infectious agents.

Skin: The infestation of ecto-parasites as ticks, mites (caused mange), lice and maggots in breach of skin (larvae of warble flies) are frequently observed in the cattle population.

Metabolic or Deficiency diseases: Pica (depraved appetite) can be frequently observed in cattle throughout the area especially during drought, which might be due to deficiency of phosphorus in staple fodder, simultaneously exaggerated with salt deficiency. Night blindness is another important disease caused by deficiency of vitamin A and frequently observed during the recurrent drought period, which results from non availability of green fodder, the main source of vitamin A, during draughts. Earlier similar findings were reported by Gahlot (2005) that scarcity of monsoon herbage in arid region raised the incidence of metabolic disorders in lactating animals.

Infectious diseases: Mastitis, brucellosis, black quarters, hemorrhagic septicemia and actinobacillosis are the common bacterial diseases frequently observed by the veterinarians in the field, while in viral group ephemeral fever, foot-and-mouth disease and cow pox are sporadically observed in cattle. Actinomycosis is most important

fungal disease extensively observed in cattle population, while trypanosomiasis is infrequently observed in cattle.

Table 5.8 Common health problems in cattle encountered by the farmers

Nature of ailment	Common ailments/ symptoms
A. Systemic	
Digestive	Diarrhoea, impaction and tympany
Respiratory	Pneumonia and upper respiratory tract infection
Reproductive	Anoestrus, repeat breeding, abortion and retained placenta
Skin	Mange, tick infestation and lice infestation
Metabolic / deficiency	Pica and night blindness
B. Infectious	
Bacterial	Mastitis, brucellosis, black quarters, hemorrhagic septicemia and actinobacillosis
Viral	Foot-and-mouth disease, cow pox and ephemeral fever
Fungal	Actinomycosis
Protozoan	Trypanosomiasis

5.2.6 Ethnoveterinary Practices

Indigenous peoples discovered and developed medicinal uses of native plants for traditional healing system in human as well as animals. The knowledge of indigenous healing system in animals is termed as ethnoveterinary practice. The system was in the hand of few conservative and illiterate persons, who were not able to document the indigenous technical knowledge in a systemic manner, which is pre-requisite for propagation and dissemination of the knowledge.

This resulted in western medicinal system becoming dominant and destruction of the ancient heritage of technical knowledge. Still this system survived in interior locations where the modern veterinary facilities are not available. Some traditional healing practices either by use of indigenous substances or hot branding techniques adopted by the respondents are illustrated in Table 5.9.

Table 5.9 Indigenous technical knowledge of farmers for healthcare of livestock

SI No	ITK	Therapeutic use	Mode of application
A. Use of substances			
1	Jal (<i>Salvadora oleoides</i>)	Impaction in camel	Extract of green leaves (3-4 litres extract of Jal leaves have been reported to provide very good result)
2	Neem (<i>Azadirachta indica</i>)	Colic in horse	Ground seeds of Neem (~0.5kg) when fed orally provide relief from colic
3	Methi (Fenugreek)	Involution of uterus	To feed methi after parturition to animal for early involution of uterus
4	Alum	Deworming and pica	Grinded alum fed to calf/ adult cattle
5	Mustard oil in sulphur	Mange in camel	Clip the hairs, mix small amount of sulphur in mustard oil and thoroughly rub on skin
6	Ghee (butter oil)	Prepartum vaginal prolapse	Drenching 1-2 kg ghee over 2-3 days have been reported to suppress the prolapse
7	Bajra + gur	Expulsion of placenta	The luke warm gruel of bajra along with gur helps to expel the placenta and provide quick energy to recently parturated animal/s
8	Opium	Libido enhancer	About 10-20g opium fed with gur just before mating
9	Opium husk (<i>Doda</i>)	Diarrhoea	The extract of opium husk (10-20 g depending upon size and severity of symptom) drench orally
10	Ajamo (<i>Carum copticum</i>)	Indigestion and tympany	About 100-200 g crushed seeds given orally
11	Senia (<i>Crotalaria burhia</i>)	Expulsion of retained placenta	The root of Senia is boiled in water and this extract is drenched thrice a day.
B. Miscellaneous practices			
12	Hot brand	Abscess	Hot firing at specific location of abscess, causes early maturation
13	Hot iron object	Hernia	Diagonal hot branding at hernial ring
14	Hot iron object	Splenic fever or Anthrax	Hot branding at inter-coastal space of 6 th to 13 th ribs of upper left side of thorax has been reported to provide relief from anthrax or splenic fever

Table 5.9 contd.....

SI No	ITK	Therapeutic use	Mode of application
15	Ash	Lice	Ash applied on body of animal to control the lice
16	Cold water	Acute tympany	Cold water is poured on back of affected animal and it is then forced to run, it is reported to provide relief from tympany
17	Human urine	Acute tympany	Drench 250 ml (goat) or 1000 ml in cattle, some time provide good result due to buffering capacity

The hot branding is an old traditional method of treatment practiced by expert person/s, for every ailment has specific point. Hot brand is commonly practiced for identification purpose, every caste have specific designed symbol for hot brand

5.2.7 Constraints Faced by Respondents

Each livestock production system is facing various limitations, few of which are of social or personal origin which can be eliminated to some extent, while others are related to climatic and geographical factors which are largely beyond the control of the farmers.

The constraints in cattle production system (Table 5.10) revealed that scarcity of feeds and fodder especially in lean/ drought period, degraded grazing resources and non-availability of veterinary services were the major constraints encountered by the 80.00, 53.13 and 61.25 per cent respondents, respectively.

Table 5.10 Constraints of cattle management practices faced by respondents

Characteristics	Households (N = 160)	
	Number	Per cent
A. Major constraints (faced by more than 50% respondents)		
1. Scarcity of feeds and fodder	128	80.00
2. Degraded grazing resources	85	53.13
3. Non-availability of timely veterinary services	98	61.25
B. Minor constraints (faced by less than 50% respondents)		
1. Non-availability of pedigree bull	72	45.00
2. No marketing facilities for surplus milk	64	40.00
3. Drinking water scarcity for livestock	49	30.63
4. Poor market value of bullocks	45	28.13
5. No option to cull unproductive cattle	40	25.00
6. Heavy mortality in drought/ lean period	30	18.75

Non-availability of pedigree bull, no marketing facilities for surplus milk, drinking water scarcity for livestock especially in summer, poor market value of bullocks, lack of options to cull unproductive cattle and Heavy mortality in drought/lean period were the other constraints faced by the respondents of different locations in the proportion of 45.00, 40.00, 30.63, 28.13, 25.00 and 18.75 per cent, respectively. Almost similar findings were reported by Jangid and Rohilla (2004) in Pali district of western Rajasthan.

5.3 NUTRITIONAL STATUS OF THARPARKAR COWS

5.3.1 Feeding Practices

Feeding system

The feeding system of cattle whether grazing or stall fed entirely depends on the monsoon rainfall and seasons. During good rainfall plenty of grasses are available in rangelands as well as fallow lands for grazing by the animals. Animals are turned out for grazing between 7.00 a.m. to 6.00 p.m. every day with the break of 2-3 hours at afternoon for watering. The lactating cows are also offered some concentrate at the time of milking at morning and evening and the remaining animals are not offered any supplements during main grazing season. During the winter animals are let loose for grazing/ feeding on dry litter/ stubbles of grasses and some times given additional feed supplement at the stalls during evening to fulfill, at least partly, their additional nutrients requirements, while during summers rangelands are utterly deficit of grasses and stall feeding is the sole source for meeting the feed requirements of the animals. In case of deficit rainfall or drought, which is a recurrent problem in this area, grazing option gets shrunk to a limited period of 2-3 months and rest of time animals have to be fed their nutritional requirements from stall feeding.

Source of grazing

The region has plenty of fallow land as well as common rangeland for grazing by livestock. The common rangelands are accessed by all and therefore their productivity is very poor, hence the households with small or marginal landholding suffer more during the rainy season whenever the movement of animals is restricted. Customarily the landholdings of farmers are not fenced therefore during rainy season whenever crops are present in field, socially imposed rules restrict the movements of

own animals until harvesting is not completed. After the completion of harvesting, usually during the month of November animals are let loose and are allowed to graze anywhere including the agricultural fields.

Feeds and fodder

a) Fodder crops:

1. Bajra: Bajra grain is staple food for human as well as concentrate supplement for lactating cows, while bajra straw and bajra husk are most frequently used for feeding of cattle.
2. Guar: Guar seeds are occasionally used as protein supplement in the rations of lactating cows. Guar *phalagati*, the left over husk of the guar bean after removing the grains, is staple feed for camel, sheep and goat but is infrequently used for feeding cattle after mixing with bajra straw.
3. Moong: Moong straw is commonly used for feeding of camel and goat.
4. Moth: Moth straw is a delicious staple feed for camel, goat and cattle.

b) Grasses:

Dhaman (*Cenchrus ciliaris*), Bhurat (*Cenchrus biflorus*), Kuri (*Urochloa panicoides*), Sewan (*Lasiurus indicus*), kanti (*Tribulus terrestris*), Ganthia (*Dactyloctenium scindicum*), Gramna (*Panicum antidotale*) and Bekria (*Indigofera cordifolia*) are the main grass species preferred by the cattle. The grasses are available in green form only in rainy season, during rest of the period they are available in the form of hay, as stored surplus grasses in flush season and dried litter on grazing land.

c) Shrubs:

The leaves of Jhar-Beri (*Ziziphus nummularia*) locally named as 'pala' is highly palatable to cattle but farmers usually offer it as a sole feed to camel and goat but in cattle feeding a small quantity of the pala leaves are mixed with bajra straw to improve the nutritional value and raise the palatability of the straw.

d) Top feeds:

The leaves of Khejri (*Prosopis cineraria*) are the most common available top feed for animals but the farmers generally feed it to small ruminants and occasionally

supplement it in cattle ration as palatability enhancer and to improve the quality of straws.

e) Concentrate feed ingredients:

Bajra, guar, guar churi / *dala* (The extracted guar meal of guar gum industries along with locally available ingredients) and sesamum cake are commonly used as concentrate feeds for cattle.

Watering of animals

a) Source of drinking water:

The common water resources (ponds and tube wells) and personnel underground water tanks, which harvest rain water, are the customarily available watering resources in the region.

b) Frequency of watering:

Water is the limiting factor in the region, the frequency of watering cattle is 1-2 times a day in rainy season and during rest of the period animals move freely to common watering resource to get water wherever available, else water is generally offered once a day from the farmer's own harvested reserve.

Feeding management during summer

Animals are allowed to feed at cool hours of the day *viz.*, early in the morning and late in evening during the summer season to lessen the heat load and increase feed intake, simultaneously raising the watering frequency to 2-3 times a day if water is not a limiting factor in that area.

Feeding strategies during drought/ lean period

Step1. In flush season of good monsoon year

- a. Stock up of feeds and fodder in the form of hay

Step2. In case of lean period or single drought year

- a. Limited quantity of feed offered to animals
- b. Short distance migration of unproductive cattle
- c. Sale of surplus stock

Step3. In case of recurrence of drought

- a. Let loose the cattle on the mercy of God, especially unproductive stock
- b. Long distance migration of herd
- c. Purchase of fodder from other sources often beyond economical means.
- d. Rear animals at cattle relief camps, which are financially supported by state government under famine relief program (only for cattle).

5.3.2 Seasonal Variation in Nutrient Intake

The nutrient intake has been explained in the form of seasonal variation in dry matter (DM) and crude protein (CP) intake of lactating cows. As evident from the data (Table 5.11) mean dry matter intake in Tharparkar cows during summer, rainy and winter seasons was 9.34 ± 0.15 , 10.02 ± 0.38 and 9.35 ± 0.18 kg head⁻¹ day⁻¹ respectively. The overall mean dry matter intake was 9.48 ± 0.12 kg head⁻¹ day⁻¹ with the proportionate contributions from concentrate and roughages being 18.86 and 81.14 per cent respectively. Shortage of concentrates with the farmer households coupled with high cost of concentrate feed ingredients could be the reasons behind the adoption of low concentrate high roughage feeding system in the area.

The mean dry matter intake per 100 kg body weight (BW) was 2.89 ± 0.04 , 2.99 ± 0.11 and 2.80 ± 0.08 kg in summer, rainy and winter seasons respectively. The overall mean dry matter intake/100 kg BW was 2.88 ± 0.04 kg. Availability of good green grasses during rainy season might be the reason behind expectedly higher dry matter intake in cows; simultaneously the fact that the cows often walked around 9-10 km day⁻¹ while grazing which may also have raised their dry matter requirement and consequently the DM intake.

The mean crude protein intake was (Table 5.12) 902.81 ± 28.35 g cow⁻¹ day⁻¹, with the proportion accounted for by concentrate and roughages being 42.02 and 57.98 per cent respectively. There were marked seasonal variations in CP intake and the season wise intakes averaged 855.40 ± 39.49 , 1037.54 ± 42.83 and 882.85 ± 50.70 g cow⁻¹ day⁻¹ during summer, rainy and winter seasons respectively. The mean crude protein intake per 100 kg body weight was 273.88 ± 8.83 g. The higher CP intake in rainy period was due to higher CP contents in green grasses compared to crop residue of bajra, which is staple fodder for cattle during rest of the seasons.

Table 5.11 Mean (\pm SE) dry matter intake of the Tharparkar cows during different seasons**

Season	Observations (N)	Predicted BW (kg)	Dry Matter Intake (kg/d)			DMI/100 kg BW
			Concentrate	Roughage	Total	
Summer	20	324.10 \pm 6.10	1.93 \pm 1.78 (20.42)*	7.41 \pm 0.14 (79.58)	9.34 \pm 0.15 (100.00)	2.89 \pm 0.04
Rainy	10	335.00 \pm 9.12	1.97 \pm 0.19 (19.77)	8.03 \pm 0.36 (80.23)	10.02 \pm 0.38 (100.00)	2.99 \pm 0.11
Winter	20	335.60 \pm 5.43	1.62 \pm 0.26 (16.84)	7.73 \pm 0.22 (83.16)	9.35 \pm 0.18 (100.00)	2.80 \pm 0.08
Overall		330.88 \pm 3.75	1.82 \pm 0.13 (18.86)	7.66 \pm 0.13 (81.14)	9.48 \pm 0.12 (100.00)	2.88 \pm 0.04

* The values in bracket show the percentage

**These figures are for the lactating cows only and may not hold true for all the categories of Tharparkar animals.

Table 5.12 Mean (\pm SE) crude protein intake of the Tharparkar cows during different seasons

Season	Observations (N)	Predicted BW (kg)	CP intake (g/d)			CP intake (g/100kgBW)
			Concentrate	Roughage	Total	
Summer	20	324.10 \pm 6.10	440.61 \pm 41.41 (49.51)	414.79 \pm 10.56 (50.49)	855.40 \pm 39.49 (100.00)	263.71 \pm 11.05
Rainy	10	335.00 \pm 9.12	385.49 \pm 32.11 (36.89)	652.05 \pm 29.23 (63.11)	1037.54 \pm 42.83 (100.00)	311.66 \pm 15.32
Winter	20	335.60 \pm 5.43	372.36 \pm 58.06 (37.10)	510.49 \pm 18.18 (62.90)	882.85 \pm 50.70 (100.00)	265.16 \pm 16.68
Overall		330.88 \pm 3.75	402.29 \pm 29.11 (42.02)	500.52 \pm 15.95 (57.98)	902.81 \pm 28.35 (100.00)	273.88 \pm 8.83

The values in bracket indicate the percentage.

The comparison of dry matter and crude protein intake of lactating Tharparkar cows with NRC feeding standard is given in Table 5.13. It states that the overall dry matter and crude protein intake were deficit with 1.35 and 2.42 per cent, respectively. The mean dry matter and crude protein intake during summer were deficit as 3.51 and 6.75 per cent, respectively which might be due to the scarcity of feed. Moreover, the available feed ingredients are also poor in crude protein contents. The dry matter and crude protein intake could fulfill the intake requirements of cows during rainy season, as plenty of green grasses are usually available for feeding of cows and these grasses are rich in CP contents.

5.3.3 Concentration of Indicators in Feed and Dung Samples

The data (Table 5.14) indicated that the average concentration of acid insoluble ash (AIA) in feed samples of cows was 2.58 ± 0.12 per cent (2.11 - 3.31%). The AIA concentration in dung samples ranged from 7.30 to 10.96 per cent with the mean of 8.84 ± 0.42 per cent. The higher concentration of AIA in dung might be due to ingestion of silica content of soil during the grazing of short stumped grasses, which is the main fraction of acid insoluble ash.

The mean recovery of chromium in dung was 0.29 ± 0.01 g per cent with a range of 0.23 to 0.34 g per cent. Average predicted dry matter output in dung was 2.93 ± 0.12 kg day⁻¹ with a range of 2.41 to 3.57 kg day⁻¹. Based on the dry matter voided in dung and AIA concentration in feeds and dung samples, the dry matter intake was predicted and it ranged from 8.18 to 11.54 kg cow⁻¹ day⁻¹. The mean predicted dry matter intake was 10.02 ± 0.38 kg cow⁻¹ day⁻¹. The better than expected estimated dry matter intake might be attributed to a reasonably good availability of green grasses on the grazing land during grazing season.

5.3.4 Proximate Principles of Commonly Available Feeds and Fodder

The chemical composition of common grasses and crop residues of bajra, which was frequently consumed by the cattle, has been presented in Table 5.15. The data revealed that the CP content of grasses ranged from 8.49 per cent in *Aristida funiculata* to 19.00 per cent in *Trianthema portulacastrum* with the mean value of 11.83 ± 0.88 per cent for the grasses. An important grass of arid region *Lasiurus indicus* had 10.57 per cent crude protein on dry matter basis. The mean value of ether extract, crude fibre, nitrogen free extract (NFE) and total ash in grasses was 3.80 ± 0.56 , 25.28 ± 2.15 ,

Table 5.13 Comparison of plane of nutrition of Tharparkar cows with recommended feeding level **

Particular	Season			
	Summer	Rainy	Winter	Overall
<i>Dry matter</i>				
(a) DMI (kg/d)	9.34 ± 0.15	10.02 ± 0.38	9.35 ± 0.18	9.48 ± 0.12
(b) Requirement (kg/d) as per NRC*	9.68 ± 0.28	9.97 ± 0.35	9.37 ± 0.29	9.61 ± 0.18
Intake/Requirement %	96.49	100.30	99.79	98.65
Difference (%)	- 3.51	+ 0.30	- 0.21	- 1.35
<i>Crude protein</i>				
(a) CP intake (g/d)	855.40 ± 39.49	1037.54 ± 42.83	882.85 ± 50.70	902.81 ± 28.35
(b) Requirement (g/d) as per NRC	917.32 ± 43.04	1022.52 ± 51.26	884.47 ± 65.10	925.22 ± 33.07
Intake/Requirement %	93.25	101.47	99.82	97.58
Difference (%)	- 6.75	+ 1.47	- 0.18	- 2.42

* NRC, 2001

**These figures are for the lactating cows only and may not hold true for all the categories of Tharparkar animals.

Table 5.14 Mean (\pm SE) concentrations of indicators and predicted dry matter intake in Tharparkar cows during grazing in rainy season

Cow No	Internal indicator (AIA in %)		External indicator (Cr_2O_3)			Fecal DM output (kg/day)	DMI (kg/day)
	Fodder samples	Dung samples	Cr_2O_3 drenched (g/cow/day)	Chromium (Cr) concentration (g/cow/day)	Cr recovery in grabbed dung samples (g %)		
1	2.28	8.98	12.00	8.21	0.31	2.65	10.43
2	2.11	7.30	12.00	8.21	0.32	2.57	8.87
3	2.87	9.70	12.00	8.21	0.33	2.49	8.41
4	2.36	8.00	12.00	8.21	0.34	2.41	8.18
5	2.19	7.39	12.00	8.21	0.24	3.42	11.54
6	2.47	7.80	12.00	8.21	0.23	3.57	11.27
7	2.49	8.11	12.00	8.21	0.26	3.16	10.29
8	2.99	10.71	12.00	8.21	0.27	3.04	10.89
9	2.74	9.42	12.00	8.21	0.28	2.93	10.08
10	3.31	10.96	12.00	8.21	0.27	3.04	10.07
Mean	2.58 \pm 0.12	8.84 \pm 0.42	12.00 \pm 0.00	8.21 \pm 0.00	0.29 \pm 0.01	2.93 \pm 0.12	10.02 \pm 0.38
Range	2.11- 3.31	7.30 -10.96	-	-	0.23 - 0.34	2.41-3.57	8.18 -11.54

45.74 ± 1.64 and 13.35 ± 1.28 per cent, respectively. The crude protein in crop residues as estimated was found to be less in comparison with grasses and was 6.05 and 5.38 per cent in bajra straw and bajra husk, respectively.

The mean CP value of grasses was found to be higher in comparison to that of 7.4 per cent as reported by Singh and Saini (2002). This difference might be due to the stage in maturity of grasses. The samples of grasses were taken during young green stage in the month of August and September in rainy season and at this stage CP content is relatively high and decline subsequently as the grasses mature.

Table 5.15 Proximate principles (on dry matter basis) of common grasses and staple fodder of cattle in arid region

S.No	Local name of fodder	Botanical name of fodder	CP (%)	EE (%)	CF (%)	Ash (%)	NFE (%)
A. Grasses							
1	Dhaman	<i>Cenchrus ciliaris</i>	8.98	2.27	33.80	13.06	41.89
2	Sewan	<i>Lasiurus indicus</i>	10.57	4.78	35.40	12.27	36.98
3	Bhurat	<i>Cenchrus biflorus</i>	9.94	2.36	29.14	13.75	44.80
4	Kanti	<i>Tribulus terrestris</i>	11.76	2.18	22.29	12.82	50.95
5	Kuri	<i>Urochloa panicoides</i>	8.60	4.70	22.66	13.93	50.11
6	Bekario	<i>Indigofera cordifolia</i>	13.12	3.88	13.26	18.73	51.00
7	Hiranchabo	<i>Farsetia hamiltonii</i>	16.41	7.68	18.04	20.96	36.91
8	Satta	<i>Trianthema portulacastrum</i>	19.00	2.71	12.81	21.78	43.70
9	Sinter	-----	10.31	2.27	28.63	8.84	49.96
10	Ganthia	<i>Dactyloctenium scindicum</i>	9.67	6.70	34.57	9.79	39.27
11	Gramna	<i>Panicum antidotale</i>	14.00	6.18	26.65	9.85	43.32
12	Lampa	<i>Aristida funiculata</i>	8.49	2.15	31.40	6.62	51.34
13	Bui shrub	<i>Aerva tomentosa</i>	12.89	1.54	20.03	11.18	54.35
14	Mean		11.83 ±0.88	3.80 ±0.56	25.28 ±2.15	13.35 ±1.28	45.74 ±1.64
B. Crop residues							
1	Bajra straw	<i>Pennisetum typhoides</i>	6.05	1.40	36.18	11.39	44.98
2	Bajra husk	<i>Pennisetum typhoides</i>	5.38	0.61	33.98	6.84	53.20

Note: The samples of grasses taken in early bloom green-stage during months of August-September in rainy season

5.3.5 Phosphorus Contents in Feeds

Phosphorus is an important element for skeletal development as well as functioning of soft tissue. It is a key mineral in energy metabolism and an essential component of buffer system in blood and other body fluids. Thus phosphorus acquires importance in diet formulation for dairy cattle. The feed and fodders are the main source for this element, which reflect the amount of the phosphorus available for absorption. The mean phosphorus content in grasses of western arid region was 0.39 ± 0.03 per cent with a range of 0.16 to 0.52 per cent (Table 5.16). Most of the grasses were found to have phosphorus content above the recommended NRC standard of 0.28 per cent (NRC, 2001).

Phosphorus content in bajra straw was 0.16 per cent, which is below the level of NRC recommendation. In case of drought and lean period the availability of grasses becomes limited in the region and only the bajra straw is used as staple fodder for cattle ration, which has low level of phosphorus and a most probable reason for pica condition frequently observed in the cattle population of this region.

Table 5.16 Mean phosphorus concentration in grasses of arid region

Sl No.	Local name of fodder	Botanical name of fodder	P (%) on DM basis
1	Dhaman	<i>Cenchrus ciliaris</i>	0.33
2	Sewan	<i>Lasiurus indicus</i>	0.52
3	Bhurat	<i>Cenchrus biflorus</i>	0.42
4	Kanti	<i>Tribulus terrestris</i>	0.16
5	Kuri	<i>Urochloa panicoides</i>	0.42
6	Hiranchabo	<i>Farsetia hamiltonii</i>	0.48
7	Satta	<i>Trianthema portulacastrum</i>	0.39
8	Ganthia	<i>Dactyloctenium scindicum</i>	0.36
9	Gramna	<i>Panicum antidotale</i>	0.44
10	Lamp	<i>Aristida funiculata</i>	0.51
11	Bui shrub	<i>Aerva tomentosa</i>	0.32
12	Mean		0.39 ± 0.03
13	Range		0.16 – 0.52
14	Bajra straw	<i>Pennisetum typhoides</i>	0.16

5.3.6 Grazing Land Status

The grasses available in rainy season were grouped in three categories (Table 5.17) based on their comparative desirability of consumption by cattle viz., more-palatable, less palatable and un-palatable. The group of grasses most preferred by the cattle during grazing comes under the category of more-palatable, while the group of grasses which are unlikely to be eaten by cattle in the presence of earlier one was categorized under less-palatable class. The cattle are more sensitive for tastes as they usually refuse the grasses/ shrubs categorized under un-palatable group.

Table 5.17 Classification of rangeland grasses of arid region bases on their comparative palatability for cattle

Palatability Class	Characteristics	List of common grasses species
More palatable	More desirable grass species	Bhurat (<i>Cenchrus biflorus</i>), Dhaman (<i>Cenchrus ciliaris</i>), Moda dhaman (<i>Cenchrus setigerus</i>), Sewan (<i>Lasiurus indicus</i>), Murath (<i>Panicum turgidum</i>), Gramna (<i>Panicum antidotale</i>), Kuri (<i>Urochloa panicoides</i>), Tantia (<i>Dactyloctenium scindicum</i>), Sinter (---), Ganthel (<i>Ochthochloa compressa</i>), Karad (<i>Dichanthium annulatum</i>)
Less palatable	Less desirable grass species	Bekaria (<i>Indigofera cordifolia</i>), Lampro (<i>Aristida adscensionis</i>), Kanti (<i>Tribulus terrestris</i>), Satta (<i>Trianthema portulacastrum</i>), Dhakadi (<i>Tribulus pentandrus</i>) Bui (<i>Aerva pseudotomentosa</i>), Weeds; Lolaru (<i>Digera muricata</i>), Hiranchabo (<i>Farsetia hamiltonii</i>), Dutheli (<i>Euphorbia granulata</i>), Chinawari (<i>Boerhavia diffusa</i>), Hadarokhet (---), Tumba (<i>Citrullus colocynthis</i>)
Un-palatable	Undesirable grass species	Senia (<i>Crotalaria burhia</i>), Dhamaso (<i>Fagonia indica</i>), Unt-kantalo (<i>Blepharis indica</i>), Behunia (---), Rangatio-khar (<i>Mollugo nudicaulis</i>), Lunwo (<i>Zygophyllum simplex</i>)

Data obtained during this study (Table 5.18) revealed that the average number of seedlings per quadrat (1m x 1m) of grassland during rainy were 199.50 ± 22.91 , which was mainly composed by grass species of *Indigofera cordifolia*, *Cenchrus biflorus*, *Cenchrus ciliaris*, *Crotalaria burhia*, *Lasiurus indicus*, *Tribulus terrestris*, *Tribulus pentandrus*, *Fagonia indica* and *Blepharis indica*. The grassland was dominated by less palatable grass species for cattle with the proportion of 55.26 per cent (Table 5.21) followed by more-palatable and un-palatable grass species in the proportion of 29.70 and 15.04 per cent, respectively during the rainy season.

Table 5.18 Mean (\pm SE) floristic composition of the studied grasslands during rainy season

Name of grass		Mean numbers of seedlings/quadrat	Range	Proportion (%)
Local name	Botanical name			
Bekaria	<i>I. cordifolia</i>	64.90 \pm 7.62	19-60	32.53
Bhurat	<i>C. biflorus</i>	19.95 \pm 5.31	0-92	10.00
Dhaman	<i>C. ciliaris</i>	12.00 \pm 3.40	0-53	6.01
Senia	<i>C. burhia</i>	9.20 \pm 1.90	0-31	4.61
Dhakadi	<i>T. pentandrus</i>	9.05 \pm 2.42	0-40	4.31
Kanti	<i>T. terrestris</i>	8.55 \pm 2.28	0-44	4.29
Sewan	<i>L. indicus</i>	8.05 \pm 2.76	0-44	4.04
Unt-katelo	<i>B. sindica</i>	7.40 \pm 1.84	0-24	3.71
Dhamaso	<i>F. indica</i>	7.15 \pm 2.06	0-31	3.58
Sintar	-	6.90 \pm 1.60	0-20	3.46
Chinawadi	<i>B. diffusa</i>	6.90 \pm 1.47	0-17	3.46
Behunia	-	6.25 \pm 1.67	0-24	3.13
Lampro	<i>A. adscensionis</i>	6.20 \pm 2.01	0-31	3.11
Bui	<i>A. pseudotomentosa</i>	5.10 \pm 1.38	0-17	2.56
Hiranchabo	<i>F. hamiltonii</i>	4.80 \pm 1.30	0-19	2.41
Gramana	<i>P. antidotale</i>	4.15 \pm 1.33	0-22	2.08
Kuri	<i>U. panicoides</i>	3.60 \pm 1.06	0-13	1.80
Gantheh	<i>O. compressa</i>	3.40 \pm 2.11	0-17	1.70
Dudheli	<i>E. granulata</i>	2.25 \pm 1.06	0-15	1.13
Lolru	<i>D. muricata</i>	1.45 \pm 0.84	0-12	0.73
Tantia	<i>D. scindicum</i>	1.20 \pm 1.09	0-12	0.60
Sata	<i>B. diffusa</i>	1.05 \pm 0.47	0-7	0.53
Total numbers		199.50 \pm 22.91	93- 480	100.00

The average number of seedlings per quadrat in winter (Table 5.19) was 27.70 \pm 3.24 and it was mainly composed of grass species of *Fagonia indica*, *Aerva pseudotomentosa*, *Crotalaria burhia*, *Boerhavia diffusa* and *Blepharis sindica* and the proportion of un-palatable, less palatable and more-palatable grasses being 60.29, 30.32 and 9.39 per cent, respectively.

Table 5.19 Mean (\pm SE) floristic composition of the studied grasslands during winter season

Name of grass		Mean numbers of seedling/quadrates	Range	Proportion (%)
Local name	Botanical name			
Dhamaso	<i>F. indica</i>	6.35 \pm 1.28	0-26	22.92
Bui	<i>A. pseudotomentosa</i>	4.40 \pm 0.89	0-14	15.88
Senia	<i>C. burhia</i>	4.35 \pm 0.83	0-12	15.70
Unt-katelo	<i>B. sindica</i>	3.00 \pm 0.92	0-13	10.83
Behunia	-	3.00 \pm 0.98	0-18	10.83
Chinawadi	<i>B. diffusa</i>	2.35 \pm 0.49	0-6	8.48
Sewan	<i>L. indicus</i>	2.15 \pm 0.86	0-10	7.76
Dudheli	<i>E. granulata</i>	1.65 \pm 0.76	0-14	5.96
Gramana	<i>P. antidotale</i>	0.45 \pm 0.45	0-9	1.62
Total numbers		27.70 \pm 3.24	8-62	100.00

The average number of seedlings per quadrates in summer declined to 8.70 \pm 1.31; the main grasses/ shrubs were *Crotalaria burhia*, *Aerva pseudotomentosa* and *Fagonia indica*. The grass land was dominated by un-palatable grasses with a proportion of 85.63 per cent followed by less palatable ones in the proportion of 14.37 per cent.

The grass cover of rangeland steeply declined from moderate grazing value in rainy season to near zero grazing value in summer. The annual and perennial green grasses available during rainy season were accessible only as dried stubbles and litter in winter and summer.

Table 5.20 Mean (\pm SE) floristic composition of the studied grasslands during summer season

Name of grass		Mean numbers of seedling/quadrates	Range	Proportion (%)
Local name	Botanical name			
Dhamaso	<i>F. indica</i>	3.00 \pm 0.66	0-8	34.48
Senia	<i>C. burhia</i>	2.70 \pm 0.65	0-10	31.03
Behunia	-	1.75 \pm 1.27	0-8	20.11
Bui	<i>A. pseudotomentosa</i>	1.25 \pm 0.22	0-3	14.37
Total numbers		8.70 \pm 1.31	0-21	100.00

Table 5.21 Seasonal variations in floristic composition of the studied grasslands

Palatability class	Mean numbers of seedlings per quadrat (1m x 1m)		
	Rainy	Winter	Summer
More palatable	59.25 ± 11.24 (29.70)	2.60 ± 0.92 (9.39)	0.00 ± 0.00 (0.00)
Less palatable	110.25 ± 11.67 (55.26)	8.40 ± 1.32 (30.32)	1.25 ± 0.22 (14.37)
Un-palatable	30.00 ± 5.25 (15.04)	16.70 ± 2.54 (60.29)	7.45 ± 1.27 (85.63)
Total	199.50 ± 22.91 (100.00)	27.70 ± 3.24 (100.00)	8.70 ± 1.31 (100.00)

Value in parenthesis indicate percentage

Thus from the above findings it can be concluded that the common grasslands of the area are severely eroded evidently due to over exploitation of grazing resources by continuous over grazing and low and erratic rainfall. The common grazing lands are freely accessed by all communities. On the start of monsoon rain people allowed their animals for grazing, small ruminants start plucking the seedlings just 3 days after first rainfall, while large ruminants are also able to graze within one week. This grazing pressure continues till animals have option to get little bit of grasses; if the area received frequent and good rainfall then pasture will withstand the grazing pressure and grasses become mature and produce seeds for next generation. On the other hand, low and/ or long interval in rainfall, which frequently occurs in arid region, results in majority of seedlings dying in immature stage due to shortage of water with their remains being picked up by the animals causing a shortage of seeds for the next generation. If this situation gets repeated for few years in the same area then the soil become permanently deficient of seeds of grasses and whatever sparse grasses are available are un-palatable for animal consumption. These findings are supported by the report of Singh and Rathore (2005) that heavy grazing pressure on rangeland of arid region changes the botanical composition of natural grazing lands and selective grazing by the animals it results in domination of undesirable species in the grass lands.

5.4 MASTITIS AND MILK SOMATIC CELL COUNTS

5.4.1 Incidences of Mastitis

The mean incidence of mastitis in Tharparkar cows under existing field condition were found to be 5.78 per cent (Table 5.22) among all the cows screened for

mastitis. The lower incidence of mastitis in Tharparkar cows may be indicative of the better adaptability of Tharparkar animals to the prevailing dry agro-climatic conditions and higher degree of resistance against mastitis causing pathogens.

Table 5.22 Incidences of mastitis in Tharparkar cows under field condition of its breeding tract

Class	Season			Overall N = 346
	Summer N = 130	Rainy N = 115	Winter N = 101	
Infected	08 (6.15)	05 (4.35)	07 (6.93)	20 (5.78)
Non-infected	122 (93.85)	110 (95.65)	94 (93.07)	326 (94.22)

Figures in parenthesis indicate the per cent value

Although the number of studied cases (346 cows) was not very large yet the results obtained in the study are a fair representative of the population. These results are similar to the findings of Singh and Singh (1994) where they have reported that the average incidence of clinical mastitis in cows in India was 6.4 per cent under field conditions.

5.4.2 Milk Somatic Cell Counts

The overall mean for the somatic cell counts (SCC) in Tharparkar cows was 0.655 ± 0.01 . Data pertaining to the individual cow SCC was subjected to least squares analysis of variance (Table 5.23) to study the effect of parity, stage of lactation, season and level of production. The results of ANOVA revealed that parity, stage of lactation and season had highly significant ($P < 0.01$) effect on the milk somatic cell counts in Tharparkar cows, while the effect of level of production was non significant on SCC. The high R^2 value (81.8%) indicates towards very good prediction accuracy in used model of linear regression equation.

Table 5.23 Least squares ANOVA showing the effect of parity, stage of lactation, level of production and season on somatic cell counts in Tharparkar cows under field condition

Source of variation	d.f.	Mean sum of squares	R^2 (%)
Parity	4	4.762**	
Stage of lactation	2	1.008**	
Level of production	2	0.038 ^{NS}	81.8
Season	2	2.338**	
Error	315	0.212	

** Signifiant ($P < 0.01$) NS- Non Signifiant

The effect of SCC in between classes of parity is shown in Table 5.24. SCC increased significantly ($P < 0.01$) with ascending order of parity, which was found to be 0.361 ± 0.023 , 0.482 ± 0.019 , 0.623 ± 0.017 , 0.734 ± 0.019 and $1.077 \pm 0.020 \times 10^5$ SCC ml⁻¹ of milk in 1st, 2nd, 3rd, 4th and 5th and above parity, respectively.

Table 5.24 Least squares means (\pm SE) of somatic cell counts as influenced by parity, stage of lactation, level of production and season in Tharparkar cows under field condition

Factors	No. of observations	SCC/ml of milk in lakhs
Parity		
1 st	56	$0.361^a \pm 0.023$
2 nd	64	$0.482^b \pm 0.019$
3 rd	73	$0.623^c \pm 0.017$
4 th	63	$0.734^d \pm 0.019$
5 th and above	70	$1.077^e \pm 0.020$
Stage of lactation		
Early (0 -90 days)	131	$0.767^a \pm 0.018$
Mid (91-180 days)	132	$0.531^b \pm 0.019$
Late (181 to above days)	63	$0.669^c \pm 0.030$
Level of production		
Low (<2.84 kg)	77	$0.668^a \pm 0.025$
Medium (2.84 –7.08 kg)	177	$0.647^a \pm 0.017$
High (>7.08 kg)	72	$0.651^a \pm 0.028$
Season		
Summer	122	$0.620^a \pm 0.015$
Rainy	111	$0.821^b \pm 0.015$
Winter	93	$0.524^c \pm 0.016$
Overall	326	0.655 ± 0.010

Means with different superscripts differ significantly

The reason behind this might be that as parity increases the teat sphincters loosen owing to continuous milking pressure over the years thus widening the teat canal which in turn becomes prone to the entry of microorganisms resulting in higher rate of infection. Simultaneously increase in milk production capacity of cows causes more pressure on alveolar tissues of udder resulting in sloughing off of more epithelial cells into milk. These results are similar to that of Reneau (1986), Randy *et al.* (1988)

and Geneurova *et al.* (1993) who have reported that the somatic cell counts in milk rose with increase in the age and parity of cows.

The least squares means for somatic cell counts during the different stages of lactation *viz.*, early, mid and late were 0.767, 0.531 and 0.669 x 10⁵ SCC ml⁻¹, respectively and showed significant differences (P<0.01) among the three stages. The high value of SCC in early stage of lactation might be due to more udder pressure, due to udder edema associated with early lactation or peak milk production phase causing more sloughing off of epithelial cells. Additionally animals remain in stress either due to delayed involution of uterus or negative energy balance in earlier period of lactation phase. The results are similar to the findings of Kennedy *et al.* (1982) and Singh and Ludri (2001b) who also reported that the effect of stage of lactation on SCC was significant for all lactation age groups (≤ 2 to ≥ 6 lactations). Somatic cell counts were highest shortly after calving, declined rapidly between days 25 to 45 and then rose slowly throughout the remainder of lactation.

The milk SCC in cows of low, medium and high level of production were 0.668, 0.647 and 0.651 x 10⁵ SCC ml⁻¹, respectively and showed no significant difference between the levels of production.

The milk SCC in Tharparkar cows in summer, rainy and winter seasons were 0.620, 0.821 and 0.524 x 10⁵ SCC ml⁻¹, respectively and showed highly significant difference (P<0.01) in SCC between seasons. The rainy season generally considered being the most disease prone season in which animals suffer by the heavy parasitic load, pathogenic organisms get favourable environment for growing, menace of flies and other ecto-parasites and coupled with high humidity which in turn causes higher stress on the animals. These might be the reasons behind the higher SCC in rainy season compared to other seasons. In summers also, the animals feel relatively higher stress *vis a vis* winter resulting in higher SCC in summer as compared to winter season, which is considered as healthy season which is also confirmed by the lowest milk SCC. Similar findings were reported by Singh and Ludri (2001a) who opined that the hot humid season (rainy season) provides favourable environment for the growth of bacteria causing more stress on the udder of cow, resulting in raised level of SCC.

The mean basal value of milk SCC in Tharparkar cattle under field condition was found to be 0.655 x 10⁵ cells ml⁻¹. This SCC in Tharparkar cows in field was low

as compared to the average normal values of SCC in milk of Tharparkar cows under organized herd conditions of Karnal 1.26×10^5 cells ml^{-1} (Singh, 2002). The probable reason might be that the animals are better adapted in the generally dry climatic conditions of its breeding tract and thus suffer minimum stress due to environmental variations. Further, the factors such as the intensive husbandry practices like machine milking, stall feeding and group housing accompanied with better milk production under the organised herd management conditions may be responsible for this phenomenon.

5.5 BODY CONDITION SCORE AND PRODUCTION PERFORMANCE OF THARPARKAR COWS

5.5.1 Body Condition Score

Body condition score of animals directly reflects the nutritional status of animals. The least squares mean of body condition score of Tharparkar cattle in different categories (heifer, dry cow and lactating cow) and seasons (summer, rainy and winter) have been presented in Table 5.25. These results revealed that the mean body condition score of heifers, dry cows and lactating cows were 2.87 ± 0.02 , 2.97 ± 0.02 and 3.20 ± 0.02 , respectively, which differed significantly ($P < 0.01$) from each other.

Table 5.25 Least squares means (\pm SE) of body condition score of Tharparkar cattle in different categories and seasons

Factors	No. of observations	BCS
<i>Animal Category</i>		
Heifer	468	$2.87^a \pm 0.02$
Dry cow	433	$2.97^b \pm 0.02$
Lactating cow	410	$3.20^c \pm 0.02$
<i>Season</i>		
Summer	474	$2.81^a \pm 0.02$
Rainy	454	$3.10^b \pm 0.02$
Winter	383	$3.14^b \pm 0.02$
Overall	1311	3.02 ± 0.01

Means with different superscripts differ significantly ($P < 0.01$) from each other.

The lactating cows maintained higher body condition score compared to dry cows and heifers; evidently due to the fact that farmers cared better for their lactating

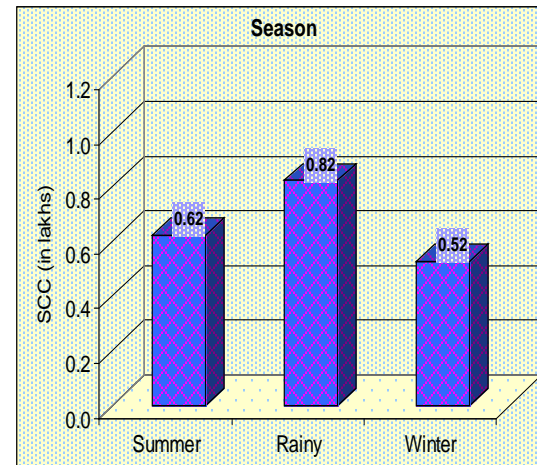
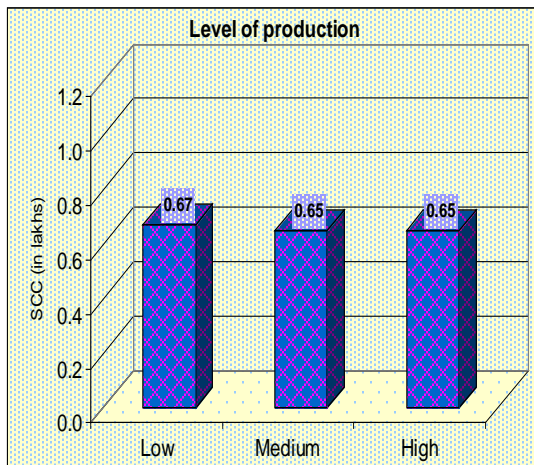
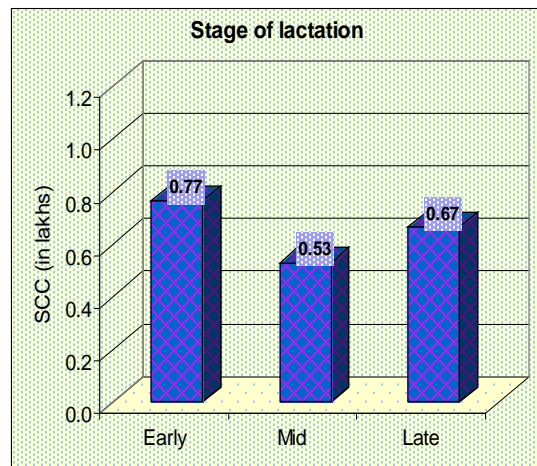
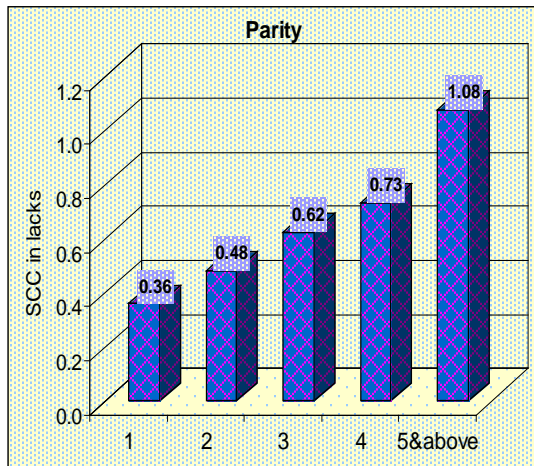


Figure: 2 Trends of milk somatic cell counts in Tharparkar cows

cows for nutritional requirement as compared to dry cows and heifers. Heifers were most neglected considering it as unproductive stock and therefore they suffered nutritional deficits with the resultant delay in attaining higher body weight, which is pre-requisite for early maturity.

Table 5.26 Least squares ANOVA showing the effect of season and animal's physiological category on body condition score under field condition

Source of variation	d.f.	Mean sum of squares
Animal category	2	12.256**
Season	2	14.198**
Error	1306	0.119

** *Signifiant (P<0.01)*

The mean body condition scores of cattle in summer, rainy and winter seasons were 2.81 ± 0.02 , 3.10 ± 0.02 and 3.14 ± 0.02 , respectively. The overall season effect was highly significant ($P<0.01$) with respect to the body condition score of animals. In between seasons the body condition score of cattle in rainy and winter was did non differ significantly from each other but body condition score of animals during the two seasons differed highly significantly ($P<0.01$) with reference to summer.

The reason might be that the cattle were better nourished during rainy and winter seasons compared to summer, later being a lean period in the western dry region and faces acute shortage of feeds and fodder. Body condition score being reflective of the overall nutritional status of animal, any improvement in BCS may require continuous supply of balanced nutrition for a long period of time which is not possible in summers as the frequent droughts and consequent scarcity of feed and fodder resources is widely experienced by the livestock keepers of the area. Following good nourishment during rainy season, owing to the spurt in the growing green grasses in the vast range lands, the body condition improves and the effect culminates during winter, a reason for the animals having better body condition score in winter as compared to rainy season. Additionally, during rainy season animals suffer heavy parasitic load, menace of flies and other pathogens which get suitable environment to proliferate and hamper the overall health status of animals. The overall body condition score of cattle was 3.02 ± 0.01 on six point scale of body condition score (scores; 0-6) applied in this study.

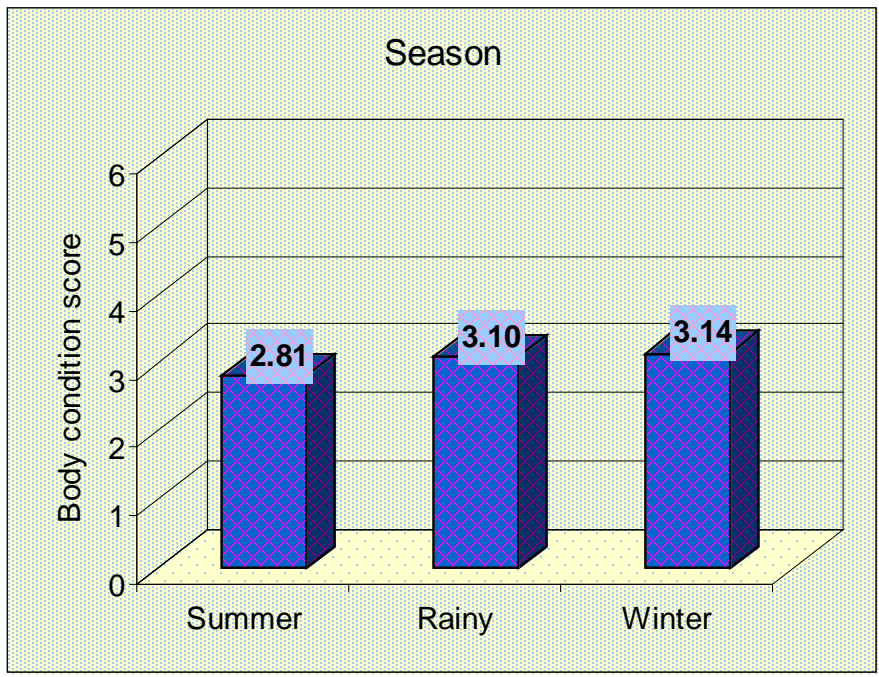
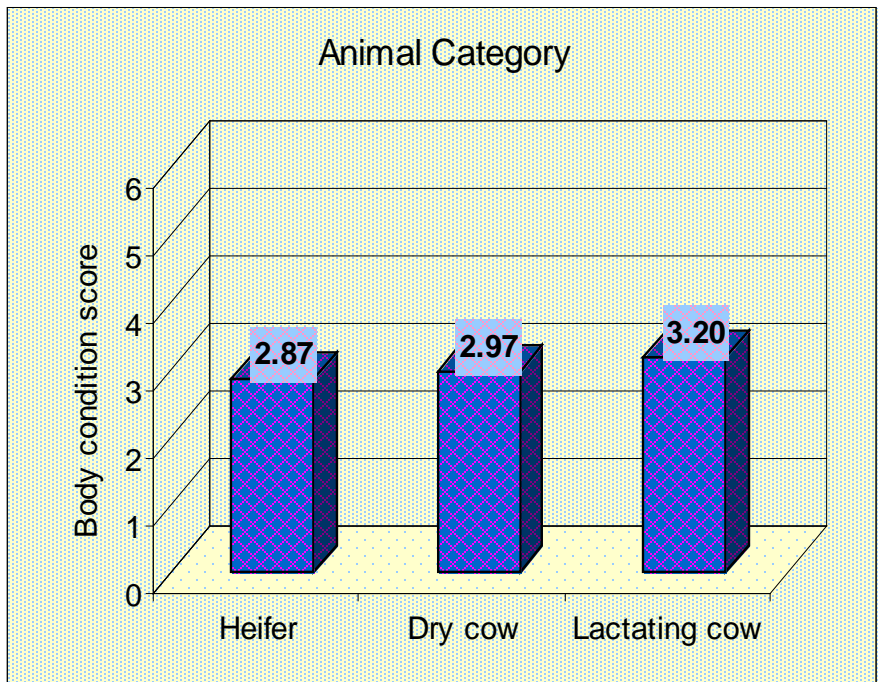


Figure: 3 Trends of body condition scores of Tharparkar cattle

5.5.2 Production Performance of Tharparkar Cows under Field.

5.5.2.1 Based on individual performance recording sheet

The information of production parameters of selected Tharparkar cows (N = 33) under existing field condition of its breeding tract were recorded by individual performance recording sheet (Table 5.27 and 5.28). The overall mean of monthly test day milk yield of Tharparkar cows was 5.65 ± 0.57 kg day⁻¹. Peak milk yield was observed in the second monthly test day recording. The mean value of peak milk yield was 9.59 ± 0.92 kg day⁻¹, with a range of 7.5 to 11.5 kg head⁻¹ day⁻¹.

Table 5.27 Mean (\pm SE) of monthly test day milk yield (kg) of Tharparkar cows in field

S. No.	Monthly Test Day MY (kg/d)	Mean	Range
1	I	7.46 ± 0.81	6.0 - 9.5
2	II	9.59 ± 0.92	7.5 -11.5
3	III	8.03 ± 0.93	6.5 – 10.2
4	IV	7.10 ± 0.74	5.8 – 8.5
5	V	6.48 ± 0.64	5.2 – 8.0
6	VI	5.93 ± 0.64	4.5 – 6.8
7	VII	5.18 ± 0.62	4.0 – 6.5
8	VIII	4.32 ± 0.68	3.0 – 5.5
9	IX	2.86 ± 0.77	1.5 – 4.5
10	X	0.92 ± 0.49	0.5 – 2.0
11	XI	0.61 ± 0.22	0.5 – 1.0
12	Average	5.65 ± 0.57	4.8 – 6.9
13	Estimated 305 days MY	1629.80 ± 176.11	1337.7 – 1951.0

The mean of estimated 305 days milk yield of selected Tharparkar cow was observed as 1629.80 ± 176.11 kg, and ranges from 1337.7 to 1951.0 kg. These findings of milk yield in the selected Tharparkar cows are at par or better than under many institutional farms maintaining Tharparkar cattle. This might be due to the fact that in the recording program of the study, purebred Tharparkar cows were only included for milk recording and simultaneously as these cows were being continuously monitored these animals also received good care and attention of the farmers.

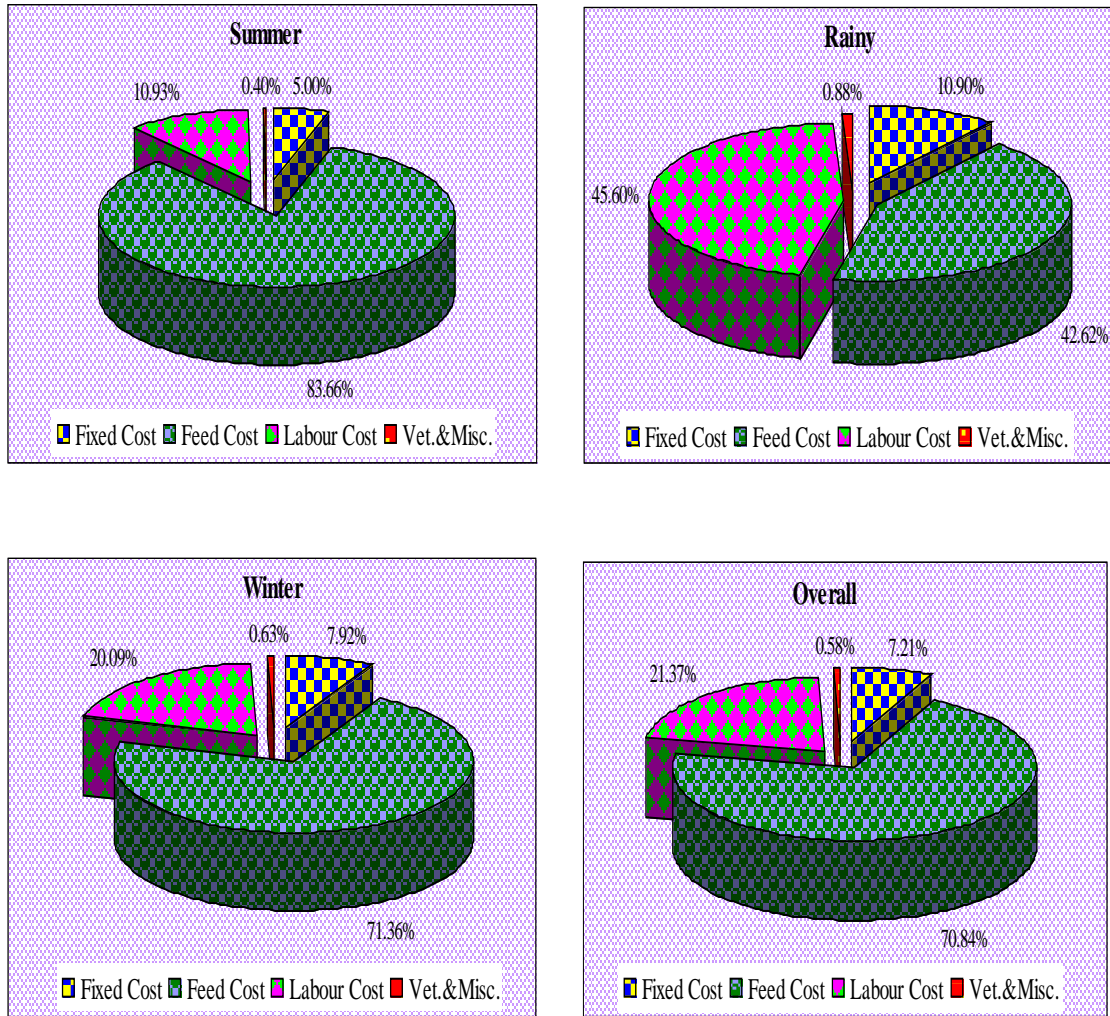


Figure 4: Seasonal variation in proportion of cost components of milk production

Table 5.28 Mean (\pm SE) of production parameters of Tharparkar cows under existing field conditions of its breeding tract (N = 33)

Sl. No.	Production parameters	Mean \pm SE	Range	S.D.
1	Service period (days)	184.55 \pm 11.39	57 - 298	65.45
2	Service/ conception	1.61 \pm 0.13	1 - 4	0.75
3	Lactation length (days)	318.76 \pm 3.14	295 - 365	18.06
4	Dry period (days)	144.12 \pm 9.99	35 - 242	57.39
5	Calving interval (days)	471.50 \pm 11.40	344 - 585	65.46
6	Lactation order	3.27 \pm 0.17	2 - 5	1.01

The mean service period was found to be 184.5 ± 11.39 days in selected Tharparkar cows and it ranged between 57 - 298 days. This service period was higher than that reported under institutional herd conditions (Singh and Chaudhury, 1961; Mahesh *et al.*, 1974; NDRI Annual report, 2003-04), and might be attributed to poor nutritional status of cows after freshening and/or timely non-availability of bull for service.

The mean services per conception recorded were 1.61 ± 0.13 , which ranged from 1 to 4 services required for the conception in selected cows under field condition. The mean dry period was estimated to be 144.12 ± 9.99 days, with a range of 35 to 242 days. These figures for services per conception are higher than most of farm studies except Mahesh *et al.* (1974) who has reported 153.0 ± 6.6 days, which might be due to difference in management practices as well as genetic and environmental factors.

The mean lactation length of Tharparkar cows was 318.76 ± 3.14 days, which ranged from 295 to 365 days in selected stock. The lactation length in this study was also very adequate and might be attributed to the incorporation of selected Tharparkar cows in the study, which were also fed and managed well by their owners. The mean calving interval observed was 471.50 ± 11.4 days, with a range of 344 to 585 days in studied Tharparkar cows.

5.5.2.2 Based on respondent's information

The information on production traits of Tharparkar cattle provided by the respondents are presented in Table 5.29. The data revealed that the mean age at first calving was 53.63 ± 0.30 months, which is higher than that reported under most of the farm studies and might be due to paucity of nutritional resources which often felt short

of nutritional requirement of the animals more so in case of the heifers making it difficult to attain early maturity.

Table 5.29 Mean (\pm SE) of production traits of Tharparkar cows based on the information of respondents (N = 254)

Sl No.	Production Trait	Mean + SE	Range	S.D.
1	Age at first calving (months)	53.63 \pm 0.30	39-66	4.86
2	Lactation length (days)	314.92 \pm 1.37	240-390	21.86
3	Service period (days)	186.37 \pm 2.65	102-309	42.18
4	Dry period (days)	153.77 \pm 2.55	51-285	40.61
5	Calving interval (days)	476.82 \pm 2.66	382-592	42.33

The mean service period and dry period were 186.37 \pm 2.65 and 153.77 \pm 2.55 days respectively, which are higher in comparison with the cows selected for the production performance through individual card approach. The reason might be due to individual variation in management practices of the animals and due to the fact that a large majority of the animals are not cared for well due to non availability of adequate grazing resources and poor economic conditions of the farmers restricting the supplemental feeding. The mean lactation length was found to be 314.92 \pm 1.37 days, while the mean calving interval was reported as 476.82 \pm 2.66 day in Tharparkar cattle.

5.6 ECONOMICS OF MILK PRODUCTION

The relevant costs of milk production of milch cows were categorized into variable and fixed costs across the seasons and have been presented in Table 5.30. The overall fixed cost was Rs 2.61 cow day⁻¹, which contributed only 7.21 per cent to gross cost (Figure 4). The lower contribution of fixed cost might be due the fact that the cost of shelter is negligible as very cheap animal shelters often using the locally available twigs, shrubs and grasses are raised by farmers. Further, the use of dairy equipments is also very limited.

The cost of feed is the major contributor in gross cost is 70.84 per cent, which considerably fluctuates with seasons as Rs 43.46, 10.17 and 23.69 cow⁻¹ day⁻¹ during summer, rainy and winter, respectively. The overall mean of feed cost was Rs 25.66 cow⁻¹ day⁻¹. The reason behind seasonality is that the feed and fodder availability are directly related to the monsoon rainfall and during rainy season, animals get enough to feed from grazing of rangeland with minimum recourse to the purchase of feed in rainy

season. During winter part of the requirements are fulfilled through grazing of dried litter/ stubs of grasses along with limited stall feeding, while in summer total dependence on the stall feeding occurs and during this period there is general scarcity of feeds and fodder the costs of fodder are also high, which often reach up to 3.5 to 4 Rs kg⁻¹.

The average labour cost was Rs 7.74 cow⁻¹ day⁻¹ which fluctuated to Rs 5.68, 10.88 and 6.67 cow⁻¹ day⁻¹ during summer, rainy and winter, respectively. The labour cost contributed 21.37 per cent to the gross cost of milk production. The comparatively higher labour charges in rainy season might be due to the fact that more labour is involved in taking care of animals during grazing when social rule is imposed to restrict the movement of animals to prevent the destruction of crops growing in the unfenced field.

In the miscellaneous expenditure, the main component is veterinary expenses which contributed 0.58 per cent in the gross cost of milk production with the value of Rs 0.21 cow⁻¹ day⁻¹. Thus the total variable cost contributed 92.79 per cent to the total gross cost incurred on milk production.

Cow dung is perhaps the main source of fuel for cooking food as well as for manuring of agricultural fields. Further, it is also used for construction work as well as for the renovation of kutcha human houses after mixing with clay. The approximate value of cow dung is around Rs 2.00 cow⁻¹ day⁻¹, during summer and winter, while in rainy season the day droppings of cows get lost during grazing, thus during grazing season the value of dung comes Rs 1.50 cow⁻¹ day⁻¹ approximately.

The average daily milk yield (herd average) was recorded as 4.03, 4.34 and 4.14 litres in summer, rainy and winter, respectively and the cost of milk production came to Rs 12.39, 5.15 and 7.54 litre⁻¹ during summer, rainy and winter, respectively with overall mean cost being Rs 8.33 litre⁻¹. On the other hand the average price of cow milk in the local market was Rs 12.50 litre⁻¹ in summer, which is considered as lean period for milk production, while in rainy and winter it was Rs 11.50 litre⁻¹.

The overall net returns from milk production were Rs 3.50 litre⁻¹ which fluctuated to Rs 0.11, 6.35 and 3.96 litre⁻¹ during summer, rainy and winter, respectively. Low net return in summer was attributed to higher cost incurred in

purchase of feed and fodder inputs during this season contrary to rainy season where net cost of milk production was lowest due to grazing and/ or cheaper availability of feeds and fodder.

Table 5.30 Cost and returns from milk production of Tharparkar cows across different seasons of the year (Rs./cow/day)

S.No.	Particulars	Season			Overall
		Summer (N=62)	Rainy (N=63)	Winter (N=65)	
A	Total fixed cost	2.60 (5.00)	2.60 (10.910)	2.63 (7.92)	2.61 (7.21)
A.1	Depreciation on fixed assets	0.93 (1.79)	0.94 (3.94)	0.95 (2.86)	0.94 (2.60)
A.2	Interest on fixed capital	1.67 (3.21)	1.66 (6.96)	1.68 (5.06)	1.67 (4.61)
B	Total variable cost	49.35 (95.00)	21.26 (89.10)	30.57 (92.08)	33.61 (92.79)
B.1	Feed cost	43.46 (83.66)	10.17 (42.62)	23.69 (71.36)	25.66 (70.84)
B.2	Labour cost (family labour)	5.68 (10.93)	10.88 (45.60)	6.67 (20.09)	7.74 (21.37)
B.3	Vet. & Misc. exp.	0.21 (0.40)	0.21 (0.88)	0.21 (0.63)	0.21 (0.58)
C	Gross cost (A + B)	51.95 (100.00)	23.86 (100.00)	33.20 (100.00)	36.22 (100.00)
D	Average milk yield (lit.)	4.03	4.34	4.14	4.17
E	Value of dung	2.00	1.50	2.00	1.83
F	Net cost of milk production per litre (C-E)/ D	12.39	5.15	7.54	8.33
G	Market price of milk (Rs. / lit.)	12.50	11.50	11.50	11.83
H	Net return Rs. per litre (G - F)	0.11	6.35	3.96	3.50
I	Value of milk (D x G)	50.38	49.91	47.61	49.28
J	Net profit margin (%) {(I + E - C) / I x 100}	0.85	55.20	34.47	30.37

Values in bracket show the percentage

The overall net profit margin was 30.37 per cent and it varied between seasons, with the profit margin being 0.85, 55.20 and 34.47 per cent during summer, rainy and winter seasons, respectively.

The cows remained more profitable during rainy season, when they got most of their feed requirements met from grazing of rangeland with minimum involvement of purchased inputs in the form of concentrate supplement. Thus the monsoon rainfall is a coin of fate for the people if it falls in favour, it enriches the livelihood of millions of rural masses or else depressed naked eyes of the people are always looking towards the skies with hope of forthcoming monsoon.

The findings are at some variance with those reported by Dev Raj and Gupta (1994) who conducted study on the economic analysis of milk production in Churu district of arid region of Rajasthan and reported that the milk production from cows and buffaloes was not profitable enterprise. In their study the net returns across all the groups of households were negative even during rainy season. The reasons behind this might be the differences in geographical location as the study area have good milch stock of Tharparkar compared to the Churu district, where low producing cows of Nagori (draught purpose) breed and non-descript cattle predominate. Moreover, the breeding tract of Tharparkar animals also has plenty of open grazing resources for cattle, which reduce the feed cost.

CHAPTER – 6

Summary and Conclusions

6. SUMMARY AND CONCLUSIONS

Tharparkar is an important breed of cattle in western dry region providing livelihood sustenance to millions of rural households. The main objectives of present study on Tharparkar cattle in its breeding tract were to find out the status of the breed in terms of population and productivity parameters, management practices, availability of local feeds and fodder, status of grazing land and economics of milk production.

The present study was conducted in Jaisalmer, Barmer and Jodhpur districts of western Rajasthan, which together comprise the breeding tract of Tharparkar cattle in India. Multistage stratified sampling procedure was used to select the districts, tehsils, villages and respondents. The data generated from the study were analyzed through tabular and least squares analysis of variance by using suitable mathematical models.

Salient Findings

The salient findings of this study have been summarized as follows:

1. The estimated population of Tharparkar cattle based on quinquennial (1997-2003) and decadal (1992-2003) growth trends were 44,580 and 55,072, which accounted for 5.99 and 6.22 per cent, respectively in total cattle population of its breeding tract. The higher concentration of breed specimens was found in Jaisalmer, Pokaran, Fatehgarh and Shiv tehsils with the proportion of 13.37, 12.64, 12.60 and 7.12 per cent, while in Barmer, Chohtan, Phalodi and Shergarh tehsils the proportions were smaller which were, 2.76, 2.73, 1.93 and 1.99 per cent, respectively.
2. Natural mating system was the only option for breeding of the cattle, where indiscriminate breeding of cows dominated (67.50%) over planned mating (32.50%) with pedigree bull. Majority of respondents (55.00%) practiced castration in their male calves; on the contrary 45.00 per cent respondents were averse of castration practices owing to social and religious taboos which concurrently declined the animal's draught value in agriculture and transportation.
3. All the respondents followed loose housing system with stable (56.25%) or seasonally movable (43.75%) housing structure, where the location of cattle shelter inside or near human dwelling was 45.00 per cent and separate from

human dwelling was 55.00 per cent. Seasonal alterations in cattle shelter were practiced by respondents, especially in winter, thick wind breaking barrier was made towards northern to north-eastern side to protect the animals from cold wind, while provision of shadow in cattle shelter in summer was very infrequent and the farmers usually left their animals loose to seek shadow of trees to rest underneath it.

4. Feeding system of cattle entirely depends on the monsoon rainfall, during good rainfall grazing is the main source of nutrients intake with partial supplementation of nutrients during winter and summer whenever grazing land becomes deficit in fodder. In case of deficit rainfall or drought, which is a recurrent problem in this area, grazing option is skipped altogether (in case of severe drought) or shrunk for a limited period of 2-3 months and rest of the time animals get their requirements through stall feeding. Common grazing lands as well as personal fallow lands are the main source of grazing. Bajra straw and bajra husk are most frequently used roughage, while bajra grains, guar grain, guar churi/ *dala* and sesamum cake are commonly used as concentrate feeds for cattle.
5. Women accomplished the milking process in 97.50 per cent cases mainly following knuckling method for milking. During early stage of lactation, calf was allowed to suckle to ensure adequate let down of milk. During latter stage of lactation, however, the calf was usually replaced with concentrate feed for initiation of milk let down stimulus. Bulk of the milk produced by the household was being utilized as staple food at home for own consumption and only 31.87 per cent respondents sold their surplus milk remaining 68.13 per cent respondents processed and consumed milk at home as liquid milk, milk in tea, milk in form of curd and churning of curd into ghee and butter milk.
6. Majority of respondents (93.12%) were not adopting prophylactic measure against numerous prevalent diseases in cattle. Most of them (65.00%) instead relied on some conservative approaches based on their local knowledge for the treatment of sick animals and later on consult local knowledgeable person(s), who were expert to some extent in traditional methods of treatment either by use of indigenous substances or hot branding techniques. On the other hand

35.00 per cent respondents got benefit of veterinary services, who live near the city/ town or the village which has veterinary hospital or dispensary. Diarrhoea, impaction and tympany, anoestrus, pica, mastitis, actinobacillosis, actinomycosis, foot-and-mouth disease and ecto-parasitic menaces are the common health disorders frequently observed in the cattle population of study area.

7. Scarcity of feeds and fodder especially in lean/ drought period (80.00%), degraded grazing resources (53.13%) and non-availability of veterinary services (61.25%) were the major constraints encountered by the respondents.
8. The mean dry matter intake in Tharparkar cows during summer, rainy and winter seasons was 9.34 ± 0.15 , 10.02 ± 0.38 and 9.35 ± 0.18 kg head⁻¹ day⁻¹ respectively. The overall mean dry matter intake was 9.48 ± 0.12 kg head⁻¹ day⁻¹, with the proportion contributed by concentrate and roughages being 18.86 and 81.14 per cent, respectively. The overall mean dry matter intake/100 kg BW was 2.88 ± 0.04 kg.
9. The mean crude protein intake was 902.81 ± 28.35 g cow⁻¹ day⁻¹, with the proportion accounted for by concentrate and roughages being 42.02 and 57.98 per cent respectively. The season wise intakes of CP were 855.40 ± 39.49 , 1037.54 ± 42.83 and 882.85 ± 50.70 g cow⁻¹ day⁻¹ during summer, rainy and winter seasons respectively.
10. The average concentration of acid insoluble ash (AIA) in feed and dung samples of cows were 2.58 ± 0.12 (2.11 - 3.31%) and 8.84 ± 0.42 per cent (7.29 - 10.96), respectively. The mean recovery of chromium in dung was 0.29 ± 0.01 g per cent with a range of 0.23 to 0.34 g per cent, where as mean predicted dry matter intake was 10.02 ± 0.38 kg cow⁻¹ day⁻¹ (8.18 - 11.54 kg/ day).
11. The mean values of CP, EE, CF, NFE and TA in common grasses of arid region were estimated as 11.83 ± 0.88 , 3.80 ± 0.56 , 25.28 ± 2.15 , 45.74 ± 1.64 and 13.35 ± 1.28 per cent, respectively. The CP in crop residues of bajra straw and bajra husk was estimated as 6.05 and 5.38 per cent, respectively.
12. The mean phosphorus content in grasses of western arid region was 0.39 ± 0.03 per cent with a range of 0.16 to 0.52 per cent. Phosphorus content in bajra straw was 0.16 per cent.

13. The average number of seedlings per quadrat (1m x 1m) of grassland was 199.50 ± 22.91 , 27.70 ± 3.24 and 8.70 ± 1.31 in rainy, winter and summer seasons, respectively. The proportion of more palatable grasses steeply declined from 29.90 per cent in rainy to almost zero in summer season. On the other hand the proportion of un-palatable grasses increased from 15.04 per cent during rainy to 85.63 per cent in summer. The grass cover of rangeland steeply declined from moderate grazing value in rainy season to near zero grazing value in summer.
14. The mean incidences of mastitis in Tharparkar cows under existing field condition was 5.78 per cent among all mastitis screened animals.
15. Milk SCC significantly ($P < 0.01$) increased with ascending order of parity, and averaged to be 0.361 ± 0.023 , 0.482 ± 0.019 , 0.623 ± 0.017 , 0.734 ± 0.019 and $1.077 \pm 0.020 \times 10^5$ cells ml^{-1} of milk in 1st, 2nd, 3rd, 4th and 5th and above parity, respectively. The least squares mean for somatic cell counts during the different stages of lactation *viz.*, early, mid and late were 0.767 , 0.531 and 0.669×10^5 SCC ml^{-1} , respectively and showed significant difference ($P < 0.01$) between the stages. The milk SCC in cows having low, medium and high level of production averaged 0.668 , 0.647 and 0.651×10^5 cells ml^{-1} , respectively and showed no significant difference between the levels of production. The milk SCC in Tharparkar cows in summer, rainy and winter seasons averaged 0.620 , $0.82.1$ and 0.524×10^5 cells ml^{-1} , respectively and revealed highly significant difference ($P < 0.01$) in SCC between seasons. The mean basal value of milk SCC in Tharparkar cattle under field condition was found to be 0.655×10^5 cells ml^{-1} .
16. The mean body condition score of heifers, dry cows and lactating cows were 2.87 ± 0.02 , 2.97 ± 0.02 and 3.20 ± 0.02 , respectively, which differed significantly ($P < 0.01$) from each other. Similarly the mean body condition score of cattle in summer, rainy and winter seasons were 2.81 ± 0.02 , 3.10 ± 0.02 and 3.14 ± 0.02 , respectively, which again reveals highly significant ($P < 0.01$) difference in body condition score of animals across different seasons.
17. The mean estimated milk yield of selected Tharparkar cows was 1629.80 ± 176.11 kg 305 days⁻¹. The mean value of service period, dry period, lactation

length and calving interval were observed as 184.55 ± 11.39 , 144.12 ± 9.99 , 318.76 ± 3.14 and 471.50 ± 11.40 days, respectively. The mean of service per conception was found as 1.61 ± 0.13 .

18. The net cost of milk production was Rs. 12.39, 5.15 and 7.54 litre⁻¹ during summer, rainy and winter; respectively with overall mean for cost of milk production was Rs 8.33 litre⁻¹. The overall net profit margin was 30.37 per cent; which varied considerably with seasons and was 0.85, 55.20 and 34.47 per cent in summer, rainy and winter seasons, respectively.

CONCLUSIONS

1. Based on estimated population of Tharparkar cattle in its breeding tract in the country the breed is fast approaching the insecure stage in India. The migration across the breeding tract and natural uncontrolled breeding system commonly prevalent in the area might be the major cause of genetic erosion of Tharparkar population.
2. Tharparkar cows in milk were being taken care of well especially with respect to the intake of DM and CP even during lean season even though the availability and palatability of grass cover steeply declined from moderate grazing value in rainy season to near zero grazing value in summer.
3. Milk productivity of Tharparkar cows in their breeding tract was moderate and the milk production from cows was found to be profitable enterprise on the year round basis with maximum profitability during rainy season followed by winter season, during summers; however, it hardly managed to cross break even point.
4. The incidence (5.78%) of mastitis was low in Tharparkar cows in their breeding tract most probably due to the prevalent dry conditions and dry and sandy soil to rest on. The mean basal value of milk SCC in Tharparkar cattle under field condition was fairly low (0.655×10^5 cells ml⁻¹). Parity, stage of lactation and season effect were significant for milk SCC.

SUGGESTIONS/ RECOMMENDATIONS

On the basis of this study, a few recommendations can be made which are given below:

A. Strategy for genetic improvement

1. There is an urgent need for effective implementation the castration practices to sterilize scrub bulls from the area or to shift them to nearby *gaushalas* or *pinjrapols* so they do not further dilute the genetic make up of Tharparkar population. Creation of awareness among farmers is also required for adoption of planned breeding in cows with pedigree Tharparkar bull(s) instead of indiscriminate breeding with scrub bull/s. State extension agencies and NGO's operational in the area have crucial role to play in this process.
2. Adoption of selective breeding practices among cattle in the concentrated pockets of Tharparkar breed in Jaisalmer and Shiv tehsil of Barmer district and grading-up with Tharparkar pedigree bulls in rest of breeding tract may be followed. NGO's or Governmental institutions may step up efforts to fulfill the existing gap in the demand of pedigreed bulls of Tharparkar breed through development of bull mother farms in the area. AI network may also be created/ strengthened in the area.
3. Charitable institutions (*gaushalas/ pinjrapols*) engaged in conservation of the breed in the western dry region may also be assisted in the development and implementation of suitable breeding plan. In each *gaushala* of the area, a Tharparkar unit may be established through segregating the animals based on breed characteristics and selective breeding may be adopted for purification of Tharparkar blood.

B. Strategy for marketing of surplus milk

1. Co-operative milk marketing infrastructure may be developed in the nucleated villages well connected by all weather road facilities. The concept of milk collection routes incorporating groups of concentrated villages or hamlets/ settlements attached to all weather roads may be feasible and practicable.
2. Co-operative network may also be developed for the procurement and marketing of ghee or butter oil from the dispersed settled villages of the area.

Ghee is less perishable and can be procured at weekly or fortnightly interval. Remuneration should be paid on the basis of quality and purity of the product.

C. Suggestions for effective housing/ watering of cattle to ameliorate climatic stress

1. Location: Summer being the hottest and most stressful season in the desert area, the sheds/ structures should be planned and constructed to take advantage of shady trees so as to modify the micro-climate of animal house.
2. Orientation: The housing structure should be orientated from north-west to south-east direction, which will effectively protect the animal from the heat waves blowing from south-west direction in summer and cold waves blowing from north-east direction in winter season.
3. Roof: Thatched roof is more suitable and cost effective and may be either made up of thorny bushes (*Ziziphus nummularia*) or shrubs (*Crotolaria burhuia*). Wherever feasible, stone slab roofs with earthen layer on top may also prove effective and durable.
4. Floor: As the sandy soil widely prevalent in the region soaks urine and keeps the shed dry, hence there is no need for pucca floors. However, to keep the floors tidy, dung should be removed daily and top soil may be removed and replaced by fresh sand frequently to prevent the growth of soil borne ecto-parasites.
5. Wall: Housing structure should be walled on two sides (south-west and north-east) or on single side to be modified seasonally towards south-west direction in summer and north-east direction in winter. Barrier/wall could be made of dung + mud plaster, stone posts as well as by using thorny bushes or shrubs depending upon availability cost effectiveness of the material.
6. Manger: Manger may be either kutchra or pucca but it should be ensured that it provides sufficient feeding space to each animal. The animals with vicious temperament may require separate feeding troughs though the docile animals can be accommodated in a single manger.
7. In summer, animals need plenty of drinking water and 3-4 watering frequencies in a day may be recommended along with restricting the movements of animals

in peak hours of day. Adequate watering arrangements with rainwater harvesting may be necessitated to ensure adequate water availability. Simultaneously, animals should be fed during cool hours of the day and the amount of concentrate fed to the animals may also be suitably increased to lessen the heat burden on the animal.

8. Creation of permanent drinking water facilities through effectively utilizing under ground water resources, harvesting of rain water and branching lift canals from Indira Gandhi canal system to supply drinking water to most deprived areas may be necessary.

D. Strategy for feed security

1. At individual household level

- Store the surplus fodder (grasses as well as crops by products) available during the rainy season in the form of hay.
- Strategically reduce the herd strength including fewer but more productive animals and essential replacements to overcome the pressure of feed shortage in lean period and/ or drought period.
- Individual land holdings may also be improved by planting strips of the perennial grasses as well as fodder crops on the crop fields.

2. Community level

- To rejuvenate the production potentiality of common grazing lands in favour of common interest through restricted and rotational grazing practices and simultaneously reseeding of worst affected range lands.
- To ensure adequate productivity of common grazing land, these lands should be fenced and reseeded with perennial grasses and protected from uncontrolled grazing. The matured grasses should be harvested and supplied to the concerned village habitats in lean period at nominal charges.
- Uneven and spatial distribution of rainfall in the area often causes fodder scarcity at one place while adequate availability at another place so the concept of co-operative fodder bank may be mooted at village level or cluster of villages to assure the fodder availability in the area.

E. Strategy to ensure effective health care and welfare of livestock

1. Keeping the view of long distance between the village settlements, routes of mobile veterinary services should be fixed and implemented strictly to assure the timely veterinary services to the isolated villages.
2. Prophylactic measures should also be implemented periodically through vaccination campaign with the participation of Govt. agencies/ NGO's operational in the area.
3. Keeping in view the occurrence of heavy mortality during drought or lean periods, it is suggested to gear up the welfare measures as well as organize veterinary treatment camps in the remote and most deprived areas at frequent interval.
4. Establishment of permanent sites for cattle camp at water shed pockets in drought prone areas may be necessary. This will help in preventing large scale migration of livestock in search of feed and fodder during drought, as well as will help to reduce the mortality and spread of communicable diseases.

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ANNEXURE-I

Ph.D. Project: "Production system analysis of Tharparkar cattle in its breeding tract".

1. Study area:
2. District:
3. Tehsil:
4. Cluster/ village:

VILLAGE PROFILE:

I Socio-economic aspects:

1. Geographical area:
 2. No. of households:
 3. Main occupation:
 4. Population distribution pattern: Dispersed type/ concentrate type/ mixed
 5. Availability of common grazing lands: Yes/ no
(If yes then specify the area and other characteristics)
-

II Cattle population:

Year	Cattle population figure		
	Tharparkar	Others	Total
Livestock census (2003)*			
Survey during 2006†			

2. Numbers of household having Tharparkar type cattle: -----

* Cattle population figure collected from the village record maintained at *Patwar* office

† Cattle population figure collected through surveying of selected villages

ANNEXURE-II

SOCIO-ECONOMIC VARIABLES OF RESPONDENT

District: Tehsil: Village:

1. Name of respondent:
2. Caste:
3. Family type: Joint/ nuclear
4. Family size:

Adults	Children	Total

5. Size of landholding:
Total: -----acres
Cultivable: -----acres

6. Family occupation
(i) Main: -----
(ii) Subsidiary: -----

7. Details of livestock:

Cattle	Buffalo	Sheep	Goat	Camel	Equine	Total

8. Herd strength:
(i) Cow in milk:
(ii) Dry cow:
(iii) Heifer:
(iv) Young stock:
(v) Breeding bull:
(vi) Bullock:
(vii) Total:

ANNEXURE-III

CATTLE MANAGEMENT PRACTICES

(A) Breeding practices:

1. Method of service: Natural/ AI
2. System of mating: Controlled/ uncontrolled
3. Castration of male calves: Yes/ no
4. If yes then method of castration: Open traditional/ burdizzo
5. Age of castration: Less than 1 year/ 1 – 2 years/ > 2 years
6. Information on production traits of Tharparkar cows:

S. No.	AFC (months)	ALL (days)	SP (days)	DP (days)	CI (Months)

(B) Housing practices:

1. Housing Type: Close/ semi-loose/ loose or open
2. Structure: Stable or fixed/ seasonally movable
3. Location: Inside/ near dwelling or separate from dwelling
4. Manger: Kutcha/ pucca/ wooden
5. Roof: Thatched/ open
6. Confinement of animals: Only for day/ only for night/ both day and night
7. Any special protection measures during:
 - (i) Summer season
 - (ii) Rainy season
 - (iii) Winter season

(C) Milking practices:

1. Gender of milker: Man/ woman
2. Method of milking: Knuckling/ full hand/ stripping
3. Hygiene measures during milking: Satisfactory/ unsatisfactory
4. Milk let stimulus: Calf suckling/ use of concentrate/ other
5. Milk disposable pattern:

Home consumption only/ home consumption + sale ghee /home consumption + sale milk

Formatted: Bullets and Numbering

(D) Health care practices:

1. Vaccination: Practiced/ not practiced

Disease(s)	Vaccination practiced			Vaccination schedule
	Always	Seldom	Never	

2. Deworming practices in cattle:

Category	Deworming practiced		
	Always	Seldom	Never
Calf			
Adult			

3. Deworming practices in other animals (sheep/goat): Yes/ no

4. Treatment of sick animals:

Source of health care	tick \checkmark if yes
Self medication with local materials	
Consult to local knowledgeable person	
Consult to veterinary staff	

5. Common ailments/ diseases in cattle:

Sl No.	Diseases		Remarks
	Local name	Scientific name	

6. Prevalence of ethno veterinary practices:

Sl No.	Disease / condition	Materials and methods of treatment	Remark

(E) Feeding practices:

1. Feeding system:

Feeding system	Season		
	Rainy	Winter	Summer
Grazing			
Stall feeding			
Grazing+ stall feeding			

2. Source of grazing land: Own fallow land/ common land/ both

3. Type of feeds and fodder

Feed category	Season		
	Rainy	Winter	Summer
Dry fodder			
Green fodder			
Concentrate			

4. Watering of animals

4.1 Source of drinking water

.....

4.2. Frequency of watering

Summer.....Rainy.....Winter.....

5. Feeding strategies during drought:

1.

2.

3.

(F) Common constraints of cattle production system:

1.

2.

3.

4.

ANNEXURE-IV

INDIVIDUAL PERFORMANCE RECORD SHEET

1. Name of farmer: 2. Village:
3. Tehsil: 4. District:
5. Breed of cattle: 6. Animal identification mark:
7. Date of calving: 8. Lactation order:
9. Date of 1st service after calving: 10. Date of conception:
11. No. of services/ conception (NS/AI): 12. Date of drying:
13. Schedule of monthly test day milk recording

Sr. No.	Date of milk recording	Milk yield (kg)			Remarks
		Morning milking	Evening milking	Total	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

14. Total lactation yield:
15. Lactation length:
16. Calving interval (service period + gestation length):
17. Dry period (calving interval – lactation length):