

**EFFECT OF FEEDING UREA-TREATED SUGARCANE  
TOPS ON PRODUCTION AND COMPOSITION OF  
MILK IN 'PHULE TRIVENI' CROSSBRED CATTLE**

*By*

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Reg. No. 05/237(II)

*A Thesis submitted to*

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(AGRICULTURAL UNIVERSITY),  
RAHURI - 413 722, DIST. AHMEDNAGAR,  
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*In partial fulfillment of the requirements for the degree  
of  
MASTER OF SCIENCE (AGRICULTURE)  
in  
ANIMAL SCIENCE*

**DEPARTMENT OF ANIMAL SCIENCE AND DAIRY SCIENCE  
POST GRADUATE INSTITUTE,  
MAHATMA PHULE KRISHI VIDYAPEETH,  
RAHURI - 413 722, DIST. AHMEDNAGAR,  
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2008

*Affectionately dedicated  
to my beloved parents*

**Alemayehu Tadesse**

## CANDIDATE'S DECLARATION

*I hereby declare that this thesis or part  
thereof has not been submitted  
by me or any other person  
to any other  
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for Degree or Diploma*

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This is to certify that the thesis entitled, "Effect of feeding urea-treated sugarcane tops on production and composition of milk in 'Phule-Triveni' crossbred cattle " submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India in partial fulfillment of the requirements for the degree of **"MASTER OF SCIENCE (AGRICULTURE) in ANIMAL SCIENCE**, embodies the results of a piece of bonafide research work carried out by **Mr. Alemayehu Tadesse**, under my guidance and supervision and that no part of the thesis has been submitted for any other University for Degree or Diploma or publication in other form.

The assistance and help received during the course of this investigation and source of references has been duly acknowledged.

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This is to certify that the thesis entitled, **"EFFECT OF FEEDING UREA-TREATED SUGARCANE TOPS ON PRODUCTION AND COMPOSITION OF MILK IN 'PHULE TRIVENI' CROSSBRED CATTLE"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India in partial fulfillment of the requirements for the degree of **"MASTER OF SCIENCE (AGRICULTURE) in ANIMAL SCIENCE**, embodies the result of piece of bonafide research work carried out by **Mr. Alemayehu Tadesse**, under the guidance and supervision of, **Dr. Y. G. Fulpagare**, Senior Scientist, RCDP and I/C Head, Department of Animal Science and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra (India) and that no part of the thesis has been submitted for any other University for Degree or Diploma or publication in other form.

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**Date: 24/3/2008**

  
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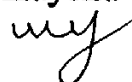
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*I am deeply obliged to the authors whose literature has been cited in this thesis.*

Place: MPKV, Rahuri

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# CONTENTS

Title	Page No.
<b>CANDIDATE'S DECLARATION.....</b>	<b>iv</b>
<b>CERTIFICATE</b>	
i) Research Guide .....	v
ii) Associate Dean (P. G. I) .....	vi
<b>ACKNOWLEDGMENTS .....</b>	<b>vii</b>
<b>CONTENTS .....</b>	<b>ix</b>
<b>LIST OF TABLES .....</b>	<b>xi</b>
<b>LIST OF FIGURES.....</b>	<b>xii</b>
<b>LIST OF PLATES.....</b>	<b>xiii</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>xiv</b>
<b>ABSTRACT .....</b>	<b>xvi</b>
<b>1. INTRODUCTION.....</b>	<b>1</b>
<b>2. REVIEW OF LITERERATURE .....</b>	<b>6</b>
2.1 Utilization of whole sugarcane/cane tops as cattle feed .....	6
2.2 Chemical composition and digestibility of sugarcane tops .....	8
2.3 Effect of urea treatment on chemical composition and digestibility of crop residues .....	10
2.4 Effect of feeding urea-treated crop residues on milk yield and composition .....	13
2.5 Nutritional factors affecting milk yield and milk constituents .....	15
2.6 Non- Nutritional factors affecting milk yield and milk constituents .....	19
2.7 Nutritional factors affecting blood biochemical constituents .....	19
<b>3. MATERIAL AND METHODS.....</b>	<b>22</b>
3.1 Location and climate of the study area.....	22
3.2 Methodology.....	22
3.2.1 Experimental feeds.....	22
3.2.2 Procedures for urea treatment of sugarcane tops.....	24
3.2.3 Chemical analysis of feed and faeces samples.....	25

3.2.4	Animals and management.....	26
3.2.5	Milk analysis.....	27
3.2.6	Blood analysis.....	27
3.3	Data collection.....	28
3.4	Experimental design and statistical analysis.....	28
3.5	Economic analysis.....	29
3.6	Experimental period.....	29
<b>4.</b>	<b>RESULTS and DISCUSSION.....</b>	<b>30</b>
4.1	Chemical composition of untreated and urea-treated sugarcane tops.....	30
4.2	Oxalic acid content of untreated and urea-treated sugarcane tops.....	34
4.3	Feed, fodder and nutrient intake of experimental cows.....	36
4.4	Milk yield and milk composition.....	39
4.5	Blood biochemical constituents.....	42
4.6	Digestibility coefficient of experimental diets.....	44
4.7	Economic analysis.....	49
<b>5.</b>	<b>SUMMARY AND CONCLUSIONS.....</b>	<b>51</b>
5.1	Summary.....	51
5.2	Conclusions.....	58
<b>6.</b>	<b>LITERATURE CITED.....</b>	<b>59</b>
<b>7.</b>	<b>APPENDICES.....</b>	<b>68</b>
<b>8.</b>	<b>VITA.....</b>	<b>73</b>

T-6267

## LIST OF TABLES

<b>Table No.</b>	<b>Title</b>	<b>Page No</b>
1	Chemical composition of feed and fodder (mean)	24
2	Proximate and cell wall constituents of untreated and urea-treated sugarcane tops	33
3	Oxalate content of untreated and urea-treated sugarcane tops	35
4	Daily feed, fodder and nutrient intake of experimental cows	38
5	Effect of experimental diets on milk yield and milk composition	41
6	Effect of experimental diets on blood urea nitrogen, calcium and phosphorous profile	43
7	Digestibility coefficient and nutritive value of experimental diets	48
8	Cost-benefit analysis of experimental diets	50

**LIST OF FIGURES**

<b>Fig.No.</b>	<b>Title</b>	<b>Between pages</b>
1	Effect of experimental diets on average monthly milk yield of cows	41-42
2	Effect of experimental diets on average milk yield and milk composition	41-42
3	Effect of experimental diets on average milk urea content	41-42
4	Digestibility coefficient of experimental diets	48-49

## LIST OF PLATES

Plate No.	Title	Between pages
1	Bunch of fresh sugarcane tops	25-26
2	Concrete trench silo pit, which was used for urea treatment of sugarcane tops	25-26
3	Uniform mixing of urea-treated sugarcane tops by using fork	25-26
4	Trampling of urea-treated sugarcane tops layer for proper compaction	25-26
5	Covering of the urea treated sugarcane top with plastic sheet for hermetic sealing	25-26
6	Covering of the ensiled sugarcane top with sorghum straw	25-26
7	Green colour of chopped sugarcane tops before urea treatment	25-26
8	Brown colour of chopped sugarcane tops after urea treatment	25-26
9	Experimental cows during feeding trial	26-27
10	VITROS DT60 II chemistry system instrument, which was used for analysis of blood urea nitrogen and blood phosphorous.	27-28
11	DTSCII module instrument, which was used for analysis of blood calcium.	27-28

## LIST OF ABBREVIATIONS

ADF	:	Acid detergent fibre
ADL	:	Acid detergent lignin
AOAC	:	Association of Analytical Chemists
BC	:	Benefit to cost
BUN	:	Blood urea nitrogen
Ca	:	Calcium
CF	:	Crude fibre
CP	:	Crude protein
DCF	:	Digestible crude fibre
DCP	:	Digestible crude protein
DDM	:	Digestible dry matter
DEE	:	Digestible ether extract
d	:	Days
dl	:	Deci litre
DM	:	Dry matter
DNFE	:	Digestible nitrogen free extract
EE	:	Ether extract
Fig	:	Figure
g	:	Gram
ISI	:	Indian Standard Institute
kg	:	Kilogram
l	:	Litre
LSD	:	Least significant difference
mg	:	Milligram
ml	:	Milliliter

**List of abbreviations Contd' ...**

MPKV	:	Mahatma Phule Krishi Vidyapeeth
N	:	Nitrogen
NaOH	:	Sodium hydroxide
NDF	:	Neutral detergent fibre
NFE	:	Nitrogen free extract
NH <sub>3</sub>	:	Ammonia
NR	:	Net return
NRC	:	National Research Council
OM	:	Organic matter
RCDP	:	Research Cum Development Project
Rs	:	Rupees
SAS	:	Statistical Analysis System
SCT	:	Sugarcane top
SCL	:	Sugarcane leaves
SE	:	Standard error
SNF	:	Solid not fat
T	:	Treatment
TDN	:	Total digestible nutrients
TS	:	Total solids
USCT	:	Untreated sugarcane tops
UTSCT	:	Urea-treated sugarcane tops
w/w	:	Weight by weight
w/v	:	Weight by volume
%	:	Per cent
°C	:	Degree celcius

## ABSTRACT

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### **EFFECT OF FEEDING UREA-TREATED SUGARCANE TOPS ON PRODUCTION AND COMPOSITION OF MILK IN 'PHULE TRIVENI' CROSSBRED CATTLE**

By

**ALEMAYEHU TADESSE**

A candidate for the degree of  
**M.Sc. in Animal Science**

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**Research guide : Dr. Y. G. Fulpagare**

**Department : Animal Science and Dairy Science**

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The experiment entitled “ Effect of feeding urea-treated sugarcane tops on production and composition of milk in ‘Phule Triveni’ crossbred cattle” was conducted at Research Cum Development Project (RCDP) on cattle to investigate the effect of feeding a diet containing urea-treated sugarcane top on dry matter intake, digestibility coefficient, milk yield, milk composition and blood profile of sixteen lactating ‘Phule Triveni’ crossbred cows, which were blocked according to their lactation days in milk, milk yield and age group in respective of their treatment groups by employing 4x4 Latin square design. Each treatment consisted of four cows as a replication. The daily dry matter requirement of experimental cows was given at 3% body weight of the animal and the diets used in the

experimental trial consisted of concentrate and roughage at a proportion of 1/3 and 2/3 part of the ration (DM basis), respectively. The concentrate portion of the diet was similar for all treatments. The roughage dry matter proportion of the treatments were T<sub>0</sub> (30% untreated sugarcane tops, 20 % green maize, 30 % green lucerne and 20% sorghum straw), T<sub>1</sub> (30 % from 4% urea-treated sugarcane tops, 20 % green maize, 30% green lucerne and 20% sorghum straw), T<sub>2</sub> (45% from 4% urea-treated sugarcane tops, 15% green maize, 20% green lucerne and 20% sorghum straw) and T<sub>3</sub> groups consisted of 60% from 4% urea-treated sugarcane tops , 20% green lucerne and 20% sorghum straw.

As a result of urea treatment, crude protein (CP), acid detergent fibre (ADF), cellulose and acid detergent lignin (ADL) content of sugarcane tops (SCT) increased by 127.72, 10.45, 10.75 and 29.25 per cent, respectively. Whereas neutral detergent fibre (NDF) and oxalate content of SCT was reduced by 6.78 and 52.28 per cent, respectively. There was significant difference ( $P < 0.05$ ) in DM, CP, Ash, oxalate, NDF, ADF, ADL and cellulose content of SCT after urea treatment. However, non significant variation ( $P > 0.05$ ) was observed in crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) content of SCT.

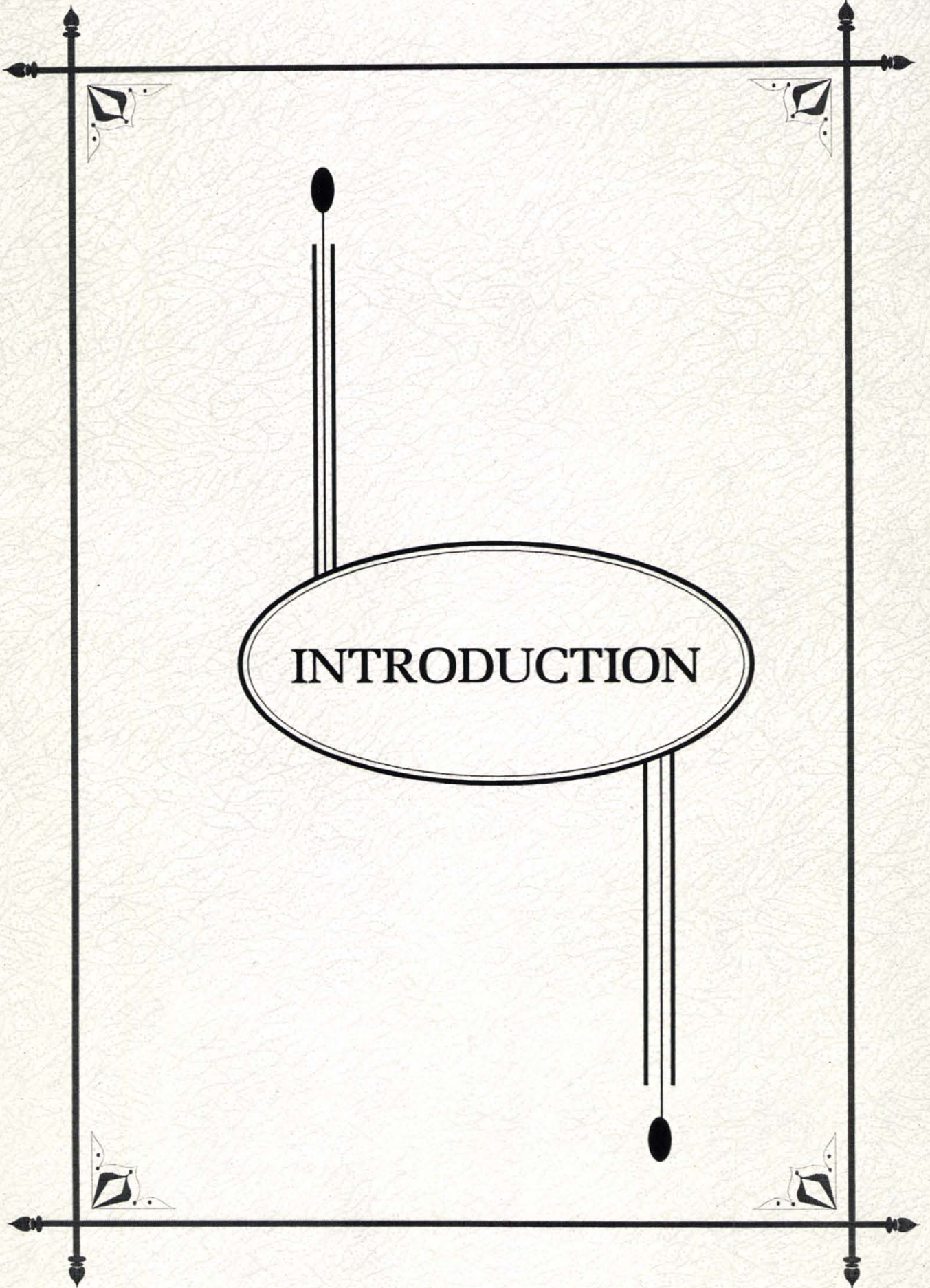
There was no significant difference ( $P > 0.05$ ) among treatments in respect of per cent dry matter intake, milk yield, milk constituents (protein, fat, TSS, SNF and calcium), BUN, blood calcium and phosphorous.

Whereas significant variation ( $P < 0.05$ ) was observed among treatments as regard to proximate digestibility coefficient (DM, CP, EE, CF, NFE and OM) and the intake of CP, CF and total dry matter.

The net income was higher in all of urea-treated sugarcane top based diets (Rs 46.80, 49.49 and 42.49/cow/day for treatment groups of  $T_1$ ,  $T_2$  and  $T_3$ , respectively) than the control ( $T_0$ ) treatment (Rs 38.25/cow/day).

A diet with 45% of urea-treated sugarcane top ( $T_2$ ) had highest dry matter intake, digestibility coefficient of proximate nutrients and nutritive value as compared to other treatments. The dry matter intake, digestibility coefficients of proximate nutrients tended to decrease with increasing urea-treated sugarcane top levels from 45 to 60% in the diet of cows. Therefore, it can be concluded that urea-treated sugarcane tops can be incorporated up to 45% of the roughage requirement in the diet of lactating cows for better milk production, feed utilization and profitability with out affecting the milk composition.

T-6267



INTRODUCTION

## **1. INTRODUCTION**

India is bestowed with a huge livestock population comprising 222 million cattle, 98 million buffaloes, 124 million goats, 61 million sheep and 489 million poultry. Animal Husbandry, Dairy and Fisheries sub-sectors generate supplementary incomes and gainful employment for rural households, particularly among landless, marginal or small farmers, as well as women. The products of these sub-sectors are also a source of valuable nutrients to millions of people in India (Anon, 2007a).

Dairying in India has emerged as an important sub-sector accounting for nearly two thirds of the total livestock contribution to GDP with an encouraging growth rate of 5 per cent. Agriculture and allied sectors account for about 24% of GDP, from this animal husbandry and dairy accounts for about 25%. More than 70 million rural families are engaged in milk production in India. Landless, small and marginal farmers with limited resources account for 65% of the total milk production in the country. Dairy cattle production is mostly based on crop residues such as straws, stovers and agro-industrial by-products (Anon, 2007a).

Crop residues are abundantly available in India and there is apparently no competition for these resources between other species and dairy animals. These fibrous crop residues have low protein and high crude fibre content, of approximately 3-4 and 35-48%, respectively.

Scarcity of feed resources is one of the major constraints for increasing milk production. The total potential availability of feed resources for the year 2005/06 was 47 million tones of concentrates, 495 million tones of crop residues and 511 million tones of green fodder. While the requirement

T-6267

of feed resources was 83 million tones of concentrates, 432 million tones of crop residues and 734 million tones of green fodder, indicating a huge shortage of concentrates and green fodder (Anon, 2007a).

Sugarcane (*Saccharum Officinarum*) is one of the most important cash crop of India in general and particularly in Maharashtra state (Dhavan, 2002). The major by-products from sugar industry are sugarcane tops, molasses, bagasse and press mud. These products are available in a definite proportion. The sugarcane tops accounts 25 to 30 per cent of the total yield of sugar cane. The sugarcane bagasse which is left out after the juice is extracted from the cane is around 10 to 15 per cent of the cane crushed. The ratio however varies according to the season (Rangnekar, 1988a).

In India during the year 1999/2000 around 4.056 million hectare of land had been covered with sugarcane plant with annual production of 309.3 million tones. While in Maharashtra state about 5.9 lakh hectares had been covered with sugarcane plant with approximate production of 75 million tones/ annum (Dhavan, 2002).

The report from Natal, Hawali and Mauritius showed that the yield of sugarcane aerial biomass fractionated in to stalk, top and trash with the dry matter percentage of 56.2-62.4, 12.6-18.1 and 24.3-25.6, respectively (Naseeven, 1988).

Sugarcane top is a major by-product of the sugar industry which is often left in the field unutilized after harvest. The sugarcane top consists of 3 distinct parts: the green leaves (blades), the leaf sheath bundle and variable amount of immature cane. The yield of tops varies considerably with variety, age at harvest, growing condition and management practices (Naseeven, 1988; Nguyen Thi Mui et al 1997; Granzin, 2005).

In India, sugarcane tops are extensively fed to ruminants during the harvesting season and particularly during late winter and summer in view of its availability in large quantities. During the summer months, it is probably the only green material available to the animals. The bullocks and other livestock belonging to small farmers and landless peasants are maintained practically on sugarcane tops. This material needs to be supplemented in order to sustain production. In some parts of the country sugarcane tops are considered inferior and are used as fuel. Those who feed the top store the surplus after drying which further reduces its quality. In most cases, the sugarcane tops are not chaffed and are offered in the long form to animals, which resulting wastage and energy expenditure by animals during eating (Rangnekar, 1988a).

In Maharashtra state approximately 20 million tones of cane tops are available which is extensively used for animal feeding. In this state during the season of sugarcane crushing the livestock owners use sugarcane tops as a major source of feed. Village survey across different farmer categories in Maharashtra indicated that sugarcane tops constitutes between 20 to 70 per cent of the dry matter available to cattle during the dry season. In some parts it is common to strip leaves from sugarcane for feeding animals with out loss of cane yield (Dhavan, 2002).

Sugarcane tops are poor quality roughage, lacking in protein and minerals and the feed has low energy value (Leng and Preston, 1985). Sugarcane tops, however, acquire some importance in view of their availability at low cost during the period when other green fodders are not available. It is generally highly palatable and its voluntary consumption is good when they are chaffed and fed. The total digestible nutrients and

digestible crude protein content vary between 50 to 55 and 2.0 to 2.5 per cent, respectively (Rangnekar, 1988a).

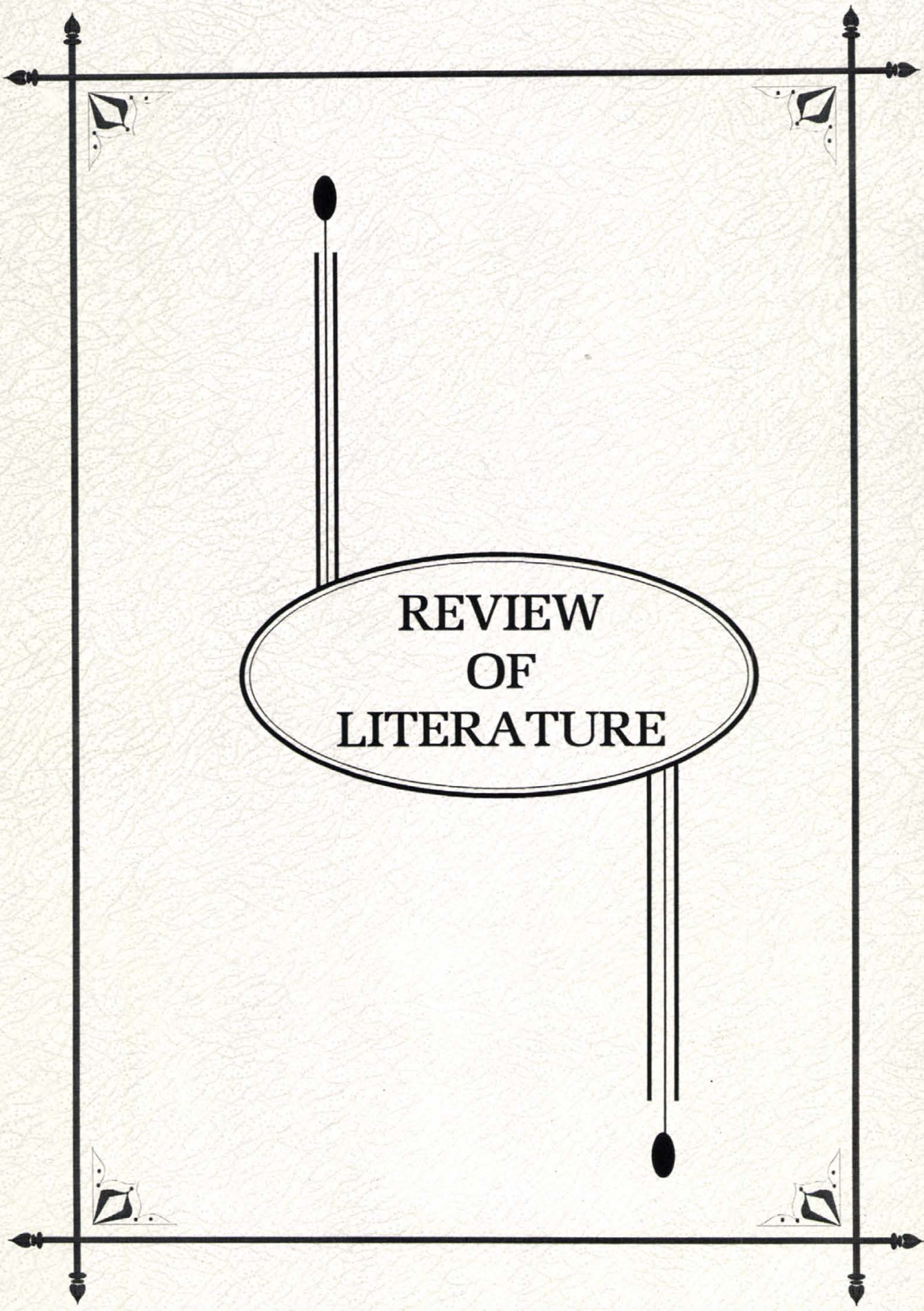
Use of urea and rice polish with cane tops-based rations supported a growth rate of 400 g/day in steers. Similarly, supplementation with rice bran, coconut meal, cotton seed meal or fish meal and *leucaena* also gave improved live weight gain (Pepito, 1969). In Mauritius, ruminants are fed exclusively on cane tops for most of the harvest season and it has been reported that sugarcane top based diets supported 2-4 litres of milk without supplementation (Sansoucy, 1972).

Sugarcane tops can be easily ensiled after supplementation with molasses- urea or after mixing with other crops. In western Maharashtra and south Gujrat, ensiling of cane tops has been well demonstrated to farmers who now adopt it. Treatment of sugarcane tops with alkalis like NaOH, NH<sub>3</sub> or urea has also been used to improve the digestibility (Naseevan, 1986). Rangnekar (1988b) reported that ensiling of sugarcane with urea produced encouraging results and good quality silage could be obtained. Pate *et al.* (2002) reported that due to the low crude protein content of sugarcane, diets based on cane forage require a large quantity of supplemental nitrogen. Natural protein feeds are expensive, particularly in regions where sugarcane would be fed. The economics of feeding sugarcane might be improved by using a less expensive source of crude protein, like urea. It was concluded that urea can supply all of the supplemental crude protein required in sugarcane based diets without causing harmful effects.

Thus, sugarcane top is extensively utilized as animal feed in Maharashtra state. However, there is dearth of information available on the influence of feeding urea-treated sugarcane top on production and

composition of milk in lactating cows. Therefore, this study was undertaken with the following objectives.

- 1) To study the effect of feeding urea-treated sugarcane top based diet on milk yield and its composition in crossbred cattle
- 2) To estimate the proximate composition, cell wall constituents and oxalic acid content of sugarcane tops before and after urea treatment
- 3) To study the dry matter intake of urea-treated sugarcane tops
- 4) To study the blood calcium, phosphorous and urea profile
- 5) To estimate the digestibility coefficient of experimental diets
- 6) To evaluate the cost-benefit analysis of experimental diets



REVIEW  
OF  
LITERATURE

## **2. REVIEW OF LITERATURE**

### **2.1 Utilization of whole sugarcane/cane tops as cattle feed**

Behera *et al.* (2005) indicated that a diet comprising sugarcane tops supplemented by leguminous fodder, dry fodder (e.g. rice or wheat straw) and concentrates at levels of 100, 200 and 300 g supplements/kg total diet DM proved to be the most balanced with a milk yield of 5.1, 6.7 and 9.0 kg/day, respectively.

Correa *et al.* (2003) reported that replacing of corn silage by sugarcane in diets with 200 grams of forage NDF per kg of dietary dry matter depressed intake (6.9%) and milk yield (7.3%) of cows yielding 34 kg of milk per day. Sugarcane seems to be an option to feed groups of Holstein cows during lactation stages in which nutrient demand is not at a maximum. Sugarcane was also considered adequate for dairy cattle producing 20 kg of milk per day, in diets formulated with about 50% of the dry matter from concentrate feedstuffs.

Pate *et al.* (2002) indicated that the quantity of sugarcane fed ranged from 20 to 77% of the diet dry matter (DM) with the remainder supplied by corn grain, citrus pulp and cottonseed meal for growing finishing steers. As the percentage of sugarcane in the diet increased, rate of gain, feed utilization, and carcass quality decreased. Steers fed on a moderate level of sugarcane (30-39%) had a rate of gain and feed efficiency somewhat similar to those fed 45% corn silage. Steers fed high sugarcane diets (77%) gained 30% slower and 30% less efficiently than those fed 75% corn silage diet. This comparison indicated that fresh-chopped sugarcane may be equivalent to corn silage as a roughage source in high-concentrate

diets, but has only 70% the value of corn silage when used as a major diet ingredient.

Boodoo *et al.* (1990) studied the feeding behaviour of cows offered sugarcane tops with the discarded parts of flowering head, mature and dry leaves. Cows began eating the cane top starting at the sheath bundle (which represented 48% by weight of the tops) and consumed only part of the green leaf blade, on either side of the midrib. The sheath bundle had less nitrogen (0.88%) and dry matter (19%) than the leaf blade (1.17% N and 31% DM).

Ferreiro and Preston (1977) studied the effect of feeding different proportion of sugarcane stalk and top (100:0, 75:25, 50:50, 25:75 and 0:100) which was supplemented with molasses/urea mixture on the consumption index and digestibility in Brown Swiss x Zebu steers. It was revealed that the daily DM intake was 1.68, 1.67, 2.0, 2.3 and 2.03 kg/100kg live weight, respectively, and the digestibility of DM was 70.7, 63.9, 62.9, 61, and 61.1 per cent, respectively. As the proportion of tops in the ration increased, digestibility first decreased and then increased in a curvilinear form; the opposite tendency was noted with respect to voluntary consumption index which increased with proportion of tops in the ration.

Alvarez *et al.* (1977) studied that growth rate of Zebu steers which fed on the rations based on fresh sugarcane, sugarcane ensiled without additives, and sugarcane ensiled with 2% solution of 67% molasses/33% aqueous ammonia (28%NH<sub>3</sub>). Each diet was made isonitrogenous by addition of urea and fed free choice with and without 0.5 kg/d of rice polishing. The daily live weight gain of each treatment in the presence of

rice polishing was 381, 327 and 446 g/day, respectively. However, the growth differences between silage treatments were not significant.

Ferreiro and Preston (1976) reported that bulls were fed on different proportion of sugarcane top and stalk on fresh basis (0:100, 20:80, 40:60, 80:20 and 100:0). These mixtures were supplemented with a solution of molasses/urea (283 g urea/litre of solution) at the rate of 50 ml/kg of fresh sugarcane. In addition all animals received 1 kg of rice polishing. During the 98 days experiment, there were significant positive relationships between the parameters voluntary consumption index, live weight gain and the treatment variable proportion of tops. Both intake and rate of gain in live weight increased as the proportion of tops in the sugar cane feed was increased. In contrast, feed conversion became worse as the proportion of tops in the ration increased.

## **2.2 Chemical composition and digestibility of sugarcane tops**

Gendley *et al.* (2003) found that the chemical composition of green sugarcane top had 4.91 %CP, 1.62% EE, 72.44% NDF, 41.2% ADF, 6.35% ADL, and 34.85% cellulose. Besides, they studied the effect of feeding three sugarcane top based dietary treatments ( In group 1 , animals were fed on ad lib SCT as a sole feed, while in group 2 and 3, were fed on chopped green SCT ad lib plus concentrate mixture and urea, respectively) on crossbred cattle bulls. During metabolism trial period the per cent DM, OM, CP and EE digestibility coefficient of groups 1, 2, and 3 were 55.25, 57.57 and 57.02; 58.18, 60.27 and 60.04; 43.49, 58.82 and 47.84; and 47.45, 61.01 and 49.40, respectively.

Patil *et al.* (1999) reported that fresh and dry sugarcane tops contained 42.6 and 88.72% DM, 6.43 and 5.96% CP, 30.92 and 40.34% CF, 0.38 and 0.43% EE, 50.24 and 46.84% NFE, 4.09 and 3.56% DCP, and 52.92 and 43.42% TDN, respectively. Moreover, they studied the effect of feeding fresh SCT and sun dried chopped sugarcane tops on performance of Surti buffalo calves. The nutrient digestibility coefficient of fresh and dry sugarcane top was 54.27 and 48.18% DM, 67.08 and 48.19% OM, 45.45 and 35.39% CF, 62.82 and 53.14% NFE, 63.62 and 59.72% CP, and 63.32 and 70.99% EE, respectively.

Naseeven (1988) found that sugarcane top has 5.90 % CP, 33.50% CF, 1.70% EE, 50.30% NFE, 8.50% Ash, 65.15% NDF, 40.40% ADF, 35.60% cellulose and 4.80 % ADL.

Rangnekar (1988b) indicated that the chemical composition of CO-740 variety of sugarcane top contained 6.20% CP, 30.90% CF, 1.50% EE, 8.50% Ash and 52.90% NFE.

Rangkuti and Djajanegara (1983) reported that sugarcane top has 6% CP, 37.40% CF, 41.90% NFE and 2.40% ether extract with a dry matter content of 29.3 per cent.

Montpellier and Preston (1977) studied the dry matter digestibility and consumption index of rations based on rind, tops, derinded stalk or whole sugar cane. DM digestibility was significantly higher with derinded stalk (71.3%) than with the chopped whole sugar cane (60.3%), rind (59.6%) or tops (61.5%). Voluntary consumption index, was highest for tops (2.78 kg/100 kg of live weight), followed by the whole cane (2.3) with lowest values for derinded stalk (1.98) and rind (1.86).

Salais *et al.* (1977) studied the digestibility of fineness of chopping of sugar cane tops when these were given with a molasses/urea diet or with chopped sugar cane stem, with or without a supplement of rice polishings. In all cases the digestibility of dry matter (DDM) of the diets was greater when the cane tops were given in the longer form (5-20 cm) with DDM of 75.9% than when finely chopped by machine with DDM of 71.6 per cent.

Sanchez-Nunez *et al.* (1974) studied the digestibility coefficient of DM, OM, CP, CF, EE and NFE of sugarcane tops by cattle was 53.9, 55.1, 41.1, 54.1, 56.2 and 57.8%, respectively.

### **2.3 Effect of urea treatment on chemical composition and digestibility of crop residues**

Anon (2007b) reported that treatment of sugarcane top by methods of alkali treatment or with ammonia/urea does not produce the same improvement in feed value as with cereal straws. Ensiling with urea has the benefit of increasing the nitrogen content and hence the rumen nitrogen balance for cattle.

Noroozy and Alemzadeh (2006) studied the chemical composition of untreated sugarcane top and sugarcane top silage which was treated with 1 per cent urea and 3 per cent molasses. They revealed that the CP content increased from 1.25 to 6.75%, the DM reduced from 30 to 28.5%, and the TDN increased from 46.8 to 48%, respectively for untreated and urea- treated sugarcane tops.

Emmambux and Driver (2002) reported a wilted sugarcane top (50% DM) was ensiled in the laboratory using a Semi Micro technique with

PVC silos. Treatments comprised graded levels of urea (4, 8, and 12%, respectively). The quality of the silages was assessed after 42 day storage. The SCT-urea silages were alkaline, with increasing pH, with increasing concentrations of urea levels. Urea treatments increased significantly ( $P<0.05$ ) the initial CP content of SCT and the CP content increasing with increases in the concentrations of urea. There was a significant decrease ( $P<0.05$ ) in the content of neutral detergent fibre (NDF) in SCT-urea silage.

Bui Van Chinh *et al.* (2000) found that the apparent digestibility of the organic matter (*in vivo*) was 49.30% for dry sugarcane leaves (SCL) and 53.10% for 4% urea-treated SCL, respectively. Feed intakes (kg DM/100kg live weight) by mature local cattle were 1.59 for dry SCL and 1.76 for urea-treated SCL. The chemical composition of dry SCL and 4% urea-treated SCL were indicated as follows; the CP content increased from 8.17 to 11%, EE increased from 1.89 to 2.47%, CF content reduced from 42.9 to 40.9%, NFE reduced from 39.2 to 36.8%, Ash content increased from 7.90 to 8.86%, respectively for dry SCL and 4% urea-treated SCL. The CP, EE, and Ash content of SCL was increased after urea treatment. In contrary to that the CF and NFE content of SCL reduced after urea treatment.

Pholsen *et al.* (1996) reported that dry sugarcane tops, crop residues left in the field were collected and treated with 6% of urea in concrete tanks using three ratios of water to sugarcane tops (1:1, 1:1.5 & 2:1) and three treating periods (3, 4 & 5 weeks). After treating, the sugarcane tops become softened and crude protein content was increased from 4.2 to 8 per cent. There was slight change in fibre content with higher cellulose and lignin contents and lower hemicellulose content. Dry matter

digestibility measured by the nylon bag technique for 48 hours also increased from 39.2 to 54.4 per cent. Urea-treated sugarcane tops using water to sugarcane tops ratio of 1:1 for 3 weeks exhibited the best result. Increasing of water to sugarcane tops ratio resulted in lower protein content and higher moisture content lead to development of mould. Long periods of treating also lowered the quality of ensiled sugarcane tops due to mould growth and it also resulted in a slightly lower hemicellulose content and higher ash content.

Rangnekar (1988b) reported that the chemical composition and digestibility coefficient of sugarcane top silage treated with 0.5% of urea contained 30 and 48.40 % DM, 8.10 and 56.30% CP, 31.70 and 60% CF, 1.80 and 36.7% EE and 53.2 and 44.7% NFE, respectively.

Boodoo *et al.* (1977) reported that when sugar cane tops are ensiled without additives there is considerable conversion of the soluble sugars into volatile materials and that this can be prevented to a considerable extent by additives which have the properties of providing nitrogen and raising initial pH in the silos. The most encouraging results were obtained with ammoniated molasses.

Mesfin and Ledin (2004) indicated that 5% of urea treatment increased the CP content of *teff* and barley straw by 134 and 85%, respectively. With regard to cell wall constituents, NDF of *teff* and barley straw were reduced by 3.4 and 1%, respectively. On the other hand increases in ADF content of 9 and 11% and in lignin content of 57.5 and 29.5% for *teff* and barley straw, respectively were observed.

Datt and Singh (1996) studied the chemical composition of untreated wheat straw and 4% urea-treated wheat straw contained 90.68 and

88.03% OM, 3.59 and 7.45% CP, 1.23 and 1.16 % EE, 38.23 and 36.57% CF, 47.63 and 42.85% NFE, 9.32 and 11.97% total ash, 86.78 and 81.96 % NDF, 60.55 and 60.94 % ADF, 40.82 and 43.57% cellulose, respectively.

#### **2.4 Effect of feeding urea-treated crop residues on milk yield and composition**

Noroozy and Alemzadeh (2006) investigated the effect of different amounts of treated sugar cane top silage on milk production of buffaloes in the southern part of Iran. Sixteen milch buffaloes in their third lactation were used in a completely randomized design with four treatments and four replications. The treatments consisted different proportions of sugar cane top silage treated with 1 per cent urea and 3 per cent molasses (0, 33, 66 and 100 per cent) replacing maize silage. The effect of treatments on feed consumption was not significant ( $P>0.05$ ) and the average daily feed consumption was 13.00 kg. The results of milk yield and milk composition were similar to the control group. It is concluded that treated sugar cane top silage can replace up to 100% of maize silage in rations for milch buffaloes with out any effect on intake, milk production and composition.

Alamzadeh and Seraj (2003) studied the effect of using different levels of sugarcane tops silage on the productivity of dairy cattle. Sugarcane tops were treated with urea (0.5%) and molasses (3%) and ensiled. The forage portion of the dairy cattle diet was replaced by different amounts of sugarcane silage (25, 50 and 75%). The results were compared between the treatment and control groups. The contents of forage and concentrate in the cattle ration were obtained based on the weight and milk production. This ration was fed to the animals daily. Insignificant

differences were observed in milk production ( $p>0.05$ ) between the treatments. The average milk production values were 11.39, 11.21, 11.55 and 11.13 litres, respectively. The analysis of milk composition between the different treatments showed insignificant differences in milk fat, pH, total solid and protein. Sugarcane tops silage enriched with urea and molasses could be used in dairy cattle nutrition and replace up to 75% forage ration without any negative productivity effects instead of lucerne.

Mesfin and Ledin (2004) studied the effect of feeding three diets formulated from 5% urea-treated barley straw , 5% urea-treated *teff* straw and hay based diet on the milk yield and composition of 'Boran' x Friesian cross bred cows. All experimental cows were supplemented with concentrate and molasses. The results indicated insignificant variation in respect of milk yield, milk protein and milk fat among the experimental diets.

Sharma *et al.* (2004) studied the effect of feeding untreated and 4% urea-treated wheat/rice straw with a supplement of (parts/100: 10-12 parts of deoiled soybean cake and 88-90 parts of rice polishing) on the milk yield and composition of multiparous buffaloes during the late pregnancy stage of 8-12 weeks before calving. Buffaloes fed on urea-treated wheat/rice straw tended to consume 24% more straw as compared to their counterparts fed untreated straw. Buffaloes fed on urea-treated straw produced 57% more milk than those fed untreated straw, but there was no significant difference in milk total solids, SNF, CP, fat, ammonia nitrogen ( $\text{NH}_3\text{-N}$ ) and Ash content.

Srinivasulu *et al.* (1998) studied the effect of feeding *Gliricidia* leaves + untreated paddy straw (T1) and *Gliricidia* leaves + 4% urea-treated

paddy straw + concentrate (T2) on milk yield and composition of cross bred cows, it was observed that there was no significant difference on milk yield and composition between two treatments.

## **2.5 Nutritional factors affecting milk yield and milk constituents**

Groff and Wu (2005) reported the effect of feeding diets consisted of 50% forage and 50% of concentrate (dry matter basis) on the mid lactating Holstein cows. The analyzed protein content of the four experimental diets was 15.70, 16.90, 18 and 19.20%, respectively. Milk yield was similar among dietary protein levels ranging from 35.2 to 36.1 kg/day. While the changes in milk fat and protein due to the protein content of the diet were small and inconsistent.

Jenkins and McGuire (2005) mentioned that reducing the proportion of forage in the diet of cow increases both protein content and milk yield. Milk protein content can be increased by 0.40 percentage units or if forage proportion in the diet is reduced to 10% or less of the dietary DM. Fat supplement resulted a decline of 0.03% milk protein for each 100 g supplemental fat intake, or about 0.1 to 0.3 percentage units for most typical levels of fat feeding. Besides, they indicated that cereal grains are source of digestible energy needed for maintaining high levels of milk production; however, high grain intakes can also depress milk fat percentage and alter fatty acid composition.

According to Harris and Bachman (2003) nutrition of the cow has marked effect on milk composition, particularly the fat content of milk. The solid not fat component of milk, which consists of proteins, lactose and minerals, may also vary with changes in the diet but to a lesser degree than

the fat content. Forage quality and quantity may affect milk SNF. Increasing the intake of roughage such as grass and sorghum silage usually reduces SNF and milk production. Adding more roughage to the ration has little to no effect on SNF. However, a minimum amount of roughage is needed for normal milk fat per cent and healthy maintenance of the cow. Feeding protein over and above the NRC recommendations will not increase the SNF or protein content of milk, but underfeeding total digestible nutrients (TDN) or net energy will reduce milk yield, SNF and protein. Generally, a depressed SNF problem is caused by a lack of energy to the higher producing cows. This condition may result from the use of pasture and more hay with a reduction in grain consumption or the feeding of high-fiber low energy rations.

Frank and Swensson (2002) studied the effect of five treatments with two different protein supplements made of ingredients of Swedish origin were each fed at two protein levels (13.1 and 13.5% low level and 16.6 and 17 % high level) and a fifth imported commercial protein mix was fed at higher level of 17% CP were offered for Swedish Holstein cows which were in first month of lactation. The treatments with low protein levels (13.1 and 13.5%) had a significantly lower milk yield, however, no significant differences in milk yield were observed between high protein supplements of 16.6 and 17%, respectively. Moreover, milk fat was not significantly affected.

Ferguson (2000) reported that milk protein level increases with increased dietary protein level but the changes are usually quite small estimated at 0.02 percentage unit increase in milk protein for each percentage unit increase in dietary protein. Similarly, the milk protein increased from 2.85 to 3.27% as

protein content in the diet varied from 15.00 to 19.50% (Jenkins and McGuire, 2005).

Jones-Ensley *et al.* (1997) reported that the percentage of milk fat produced by grazing dairy cow was unaffected by crude protein in the supplement or by the amount of supplement offered.

Samuelsson (1996) mentioned that cows on a high plane of nutrition generally have a reduced fat content in the milk, whereas cows with low energy intake have an increased fat content.

Increased dietary protein levels often increase ration digestibility and feed intake, thus increasing a cow's energy status and milk yield, in this situation, protein yield may be increased through increased milk production while milk protein percentage may not be affected (Snowdon, 1992). Moreover, he reported that milk protein is less variable than milk fat and more difficult to influence with diet. A diet low in forage and high in energy will increase milk output. On the other hand, a low energy, high forage diet will tend to lower milk protein test and milk protein production. In addition a drop in protein production was observed from high forage diets even when compared to low forage diets of similar energy content.

Emery (1991) mentioned that increasing crude protein from 10 to about 18% of the diet in lactating dairy cows, milk fat percentage may decrease due to dilution by increased milk yield. However, Emery (1988) reported that the amount of protein have a little or no effect on content of milk fat.

Schmidit (1988) reported that the protein and SNF composition of milk can be changed only slightly, and the variation is considerably less than that of fat. Most of changes in SNF composition of milk resulted from

changes in protein content. Mineral and lactose contents are quite unchangeable. Underfeeding of dairy cows results in a 0.20% reduction in protein and non fat solids percentage and depression in milk yield. Increasing the plane of nutrition to 25% above normal standards result in an increase in nonfat solids and protein percentage. An increased plane of nutrition usually results an increase in milk production.

Bector *et al.* (1998) indicated that the natural urea content of cow milk ranges between 22.8 – 92.4 mg/dl and the average urea content of cow milk was  $53.36 \pm 6.75$  mg/dl.

Eicher *et al.* (1999) indicated that voluntary dry-matter intake and composition of the forages of the ration can be considered responsible for the base level of milk urea concentration.

Frank and Swensson (2002) mentioned that the amount of concentrate offered in dairy cattle are usually distributed according to the daily milk yield and are mostly responsible for the individual variation of milk urea. The milk urea content was significantly higher ( $p < 0.0001$ ) in treatments with 17% CP as compared to 13 % CP level in the diet.

Rodríguez and Yáñez (2002) reported that dairy cows fed on grazing of ryegrass-clover pasture were supplemented concentrate depending on the treatment assigned to the group. The treatments were: no supplementation, 14 per cent CP ration, 17 per cent CP ration and 20 per cent CP ration. Supplemented groups had significantly higher milk production as compared to no supplementation group. Milk urea values were 244, 295, 317 and 364 mg urea/kg for no supplementation, 14 per cent CP, 17 per cent CP and 20 per cent CP groups, respectively, and those values were significantly different. These results showed that using too high levels

of CP in grazing rations does not improve total production significantly, so CP is not used in an efficient way. The excess of CP in the ration implies higher urea content in milk.

The mineral content of milk is relatively stable and the content of major elements (calcium, phosphorous, potassium, chloride and sodium) can not be changed by altering the levels of these elements in the diet of cow (Schmidt, 1988; Banerjee, 2005).

## **2.6 Non-nutritional factors affecting milk yield and milk constituents**

The daily yield and composition of milk are affected by physiological and environmental factors (Schmidt, 1988). Under normal situations, milk production increases during the first six weeks of lactation and then gradually decreases. The actual amount and composition of milk produced during the lactation period is affected by several non-nutritional factors such as breed, age, parity, day to day variation, stage of lactation, pregnancy, season of calving, temperature and humidity, dry period and body condition of animal (Schmidt, 1988; Banerjee, 2005).

## **2.7 Nutritional factors affecting blood biochemical constituents**

Radotra *et al.* (2002) studied the effect of feeding five herbage mixtures of [hybrid sorghum + soybean (T1), setaria + soybean (T2), hybrid napier + soybean (T3), guinea grass + soybean (T4) and green panic grass + soybean (T5)] for 60 days on blood calcium and phosphorous content of crossbred heifers. The results revealed that the plasma calcium levels of T1, T2, T3, T4 and T5 groups before and after feeding trials was 9.58 and 9.63,

9.35 and 9.92, 9.40 and 9.76, 9.65 and 9.70 and 9.55 and 10.22 mg/dl, respectively. The increment of plasma calcium after feeding trial was a reflection of better calcium status of herbage mixtures. While the plasma phosphorous levels of T1, T2, T3, T4 and T5 groups before and after feeding trials was 5.38 and 5.25, 5.43 and 5.08, 5.25 and 5.48, 5.28 and 5.15 and 5.53 and 5.43 mg/dl, respectively. The calcium and phosphorous in the plasma of animal under different treatments were in normal range.

Mahanta *et al.* (1997) studied the effect of three different calcium supplements on blood parameters of male adult buffaloes. Animals were fed on isocaloric and isonitrogenous ration of wheat straw and concentrate mixture. Group A served as control and the experimental groups B, C and D received about 8.00 g calcium/animal/day from bone meal, dicalcium phosphate and calcium carbonate, respectively. Supplementation of these sources did not affect serum calcium and plasma inorganic phosphorous.

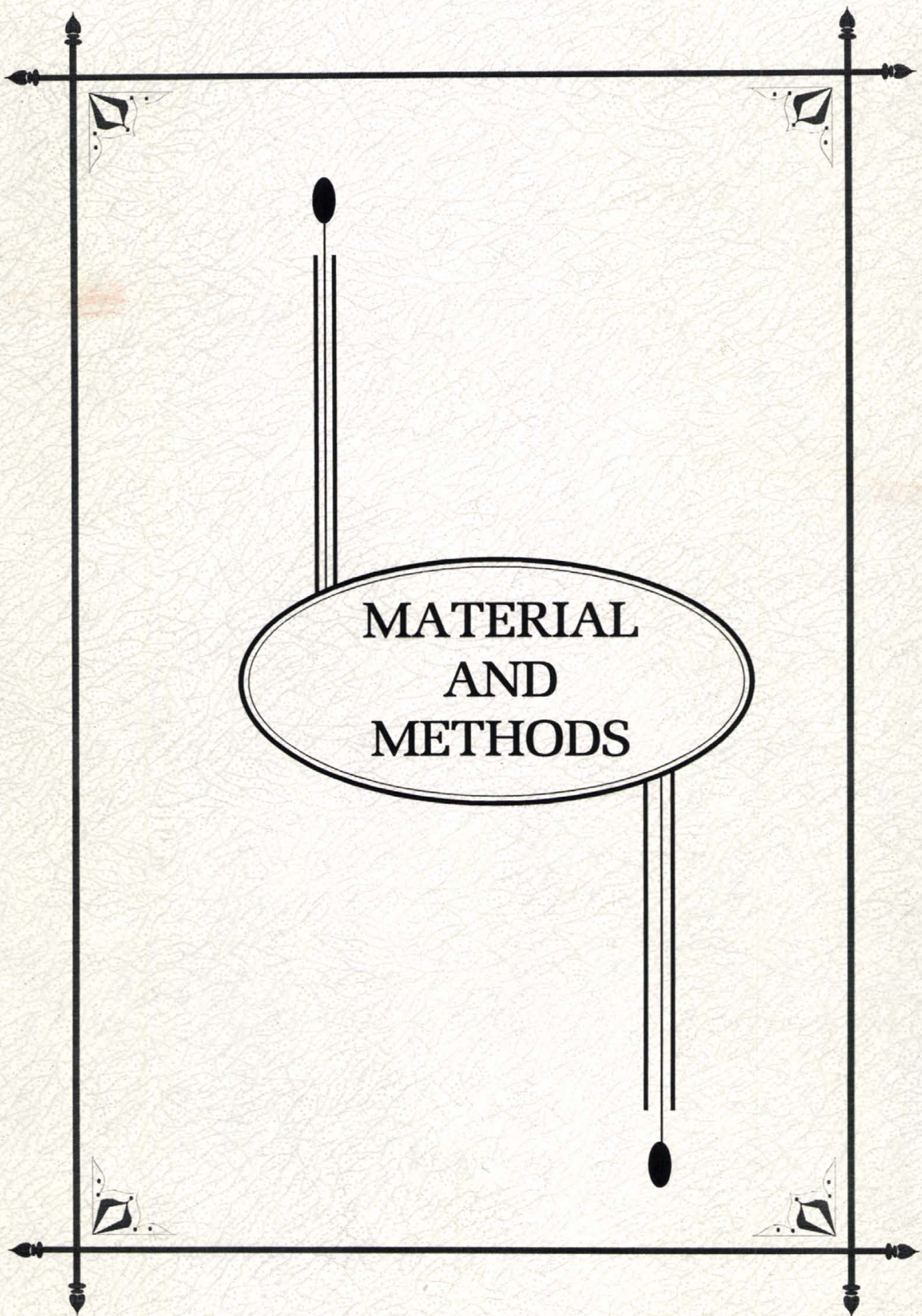
Sirohi and Rai (1994) studied the effect of feeding three diets: untreated wheat straw + concentrate, 4% urea ammoniated wheat straw + concentrate and urea with lime (3% + 4%, w/w) treated straw + concentrate on the serum calcium and urea concentration of growing buffalo bulls and the results of serum calcium concentration showed significant effect in different treatment groups, but not the serum urea. Serum calcium was 9.73, 10.30 and 11.06 mg/dl, respectively, while the serum urea was 24.87, 24.11 and 24.00 mg/dl, respectively among treatments.

According to Sastry *et al.* (1999) the normal range of blood calcium, phosphorous and blood urea nitrogen constituents of cattle were 9.4 to 12.2 mg/dl, 4.0 to 9.0 mg/dl and 6.0 to 27 mg/dl, respectively.

Varner (1998) reported that the average BUN for lactating cow is 13.4 mg/100ml with a range from 6.3 to 25.5mg/dl. BUN is most positively correlated to dietary protein intake but also correlated to degradable and undegradable protein level. The ratio of dietary protein to non-structural carbohydrate has a large influence on BUN, with a high ratio increasing BUN value at similar crude protein intakes. Degradability of starch source in isocaloric and isonitrogenous diets can also influence BUN, as higher BUN is observed in cows fed rolled barley versus rolled milo. Cows on pasture appear to have higher BUN levels which may be a result of elevated crude protein intake, increased rumen degradability of protein or low non-structural carbohydrate intact.

Harris (2003b) compared the effect of 13 and 20% protein ration on blood urea nitrogen content of lactating cows, the result indicated that the BUN content increased from 8.2 to 20.9 mg/dl. Similarly, Groff and Wu (2005) reported that the blood urea nitrogen concentration increased linearly ranging from 9.9 to 13.8 mg/dl, as the protein content of the experimental diets increased from 15.72 to 19.20 per cent.

According to Wustenberg (1999) blood urea nitrogen (BUN) indicates the level of protein currently being metabolized by the cow. Dry cows which possess high BUN more than 16mg/dl indicates that the diet contains excess protein or an imbalanced source of protein, while those contains low BUN which is less than 12 mg/dl indicating that protein in the ration is probably limited and the cows don't receive quite what they need. It is also important to note that normal or high BUN levels may not always indicate adequate ration protein. It can also indicate that the dry cow is using her own protein reserves to meet the needs of growing calf.



**MATERIAL  
AND  
METHODS**

## **3. MATERIAL AND METHODS**

The present investigation entitled “Effect of feeding urea-treated sugarcane tops on production and composition of milk in ‘Phule Triveni’ crossbred cattle” was conducted at Research Cum Development project (RCDP) on cattle, Department of Animal Science and Dairy Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri.

### **3.1 Location and Climate of the study area**

The RCDP farm unit is located 160 km North East of Pune city. The area lies at 569 m above sea level on the 18° 32’ north latitude and 73° 51’ at east longitude, also this area is categorized under semi-scarcity zone of Maharashtra state. The area has a bimodal pattern of rainfall and it receives an annual rainfall of 530.5 mm. The average maximum (39°C) and minimum (10.8°C) temperature was recorded in May and December month, respectively. The average minimum humidity of 39.55% and the maximum humidity of 73.99% were observed in the month of March and August, respectively. The study area has three main seasons: rainy season (June to October), winter season (November to February) and summer season extends from March to May month.

### **3.2 Methodology**

#### **3.2.1 Experimental Feeds**

The daily dry matter requirement of experimental cows was given at 3% body weight of the animal and the diets used in the

experimental trial consisted of concentrate and roughage at a proportion of 1/3 and 2/3 parts the ration (DM basis) as depicted in Banerjee (2005). The concentrate portion of the diet was similar for all treatments and consisted of (30 parts of deoiled rice bran, 15 parts of cotton seed cake, 10 parts of wheat bran, 10 parts of maize grain, 20 parts of sunflower cake, 12 parts of turchuri, 2 parts of mineral mixture and 1 part of common salt). The formulated concentrate was prepared to have 19% CP while the analyzed protein content of the experimental diets of T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 11.4, 12.0, 11.2 and 11.2, respectively. While the proportion of the total roughage dry matter was divided as per the treatment groups mentioned below. The average daily offered amount of feed and fodder of each treatment is presented in Appendix I. Untreated green sugarcane top, 4% urea-treated sugarcane top, green maize, green lucerne and sorghum straw were the roughage sources used in the trial. The green and dry fodder sources were chaffed by electrically operated chaff cutter to the particle size of 2-3 cm.

The four treatments consisted the following proportion of ration on DM basis:

T<sub>0</sub> (Control group): 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 30% DM from untreated sugarcane tops + 20 % DM from green maize + 30 % DM from green lucerne + 20% DM from sorghum straw)

T<sub>1</sub>: 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 30 % DM from 4% urea-treated sugarcane tops + 20 % DM from green maize + 30% DM from green lucerne + 20% DM from sorghum straw)

- T<sub>2</sub>: 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 45% DM from 4% urea-treated sugarcane tops + 15% DM from green maize + 20% DM from green lucerne + 20% DM from sorghum straw)
- T<sub>3</sub>: 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 60% DM from 4% urea-treated sugarcane tops + 20% DM from green lucerne + 20% DM from sorghum straw)

The chemical composition of feed and fodder sources is presented in Table 1.

Table 1. Chemical composition of feed and fodder (mean)

Feed and fodder samples	Proximate nutrients (%)					
	DM	CP	EE	CF	Ash	NFE
Untreated sugarcane tops	31.43	2.49	1.98	30.81	6.99	57.73
Urea-treated sugarcane tops	28.90	5.67	1.74	29.02	7.63	55.94
Sorghum straw	85.30	2.54	1.31	31.42	7.10	57.63
Green maize	27.50	6.11	1.72	28.03	8.09	56.06
Lucerne	22.40	17.45	2.44	22.69	10.07	47.35
Concentrate	92.50	18.66	2.35	8.85	8.68	61.47

### 3.2.2 Procedures for urea treatment of sugarcane top

The treatment was done in under-ground concrete silo pit. Four kg urea was dissolved in 50 litres of clean water for 100 kg sugarcane tops on dry matter basis. Green sugarcane tops of C0- 86032 variety which had

32% dry matter was chopped in to the size of 2-3 cm prior to ensiling process. Green Sugarcane top in batches of 25 kg was spread in the silo. Four litres of urea solution were sprinkled uniformly over 25 kg green sugarcane top by using a sprinkler. The treated sugarcane top was mixed using a fork. Further batches were treated following similar procedures. After treating one layer of sugarcane top, it was pressed by trampling before the next layer was placed. The silo pit was filled and the stack was covered tightly with a plastic sheet to exclude the entrance of oxygen and prevent ammonia from evaporating. The stack was loaded with sacks full of soil. The treated sugarcane top was ensiled for three weeks before opening for feeding trial.

### **3.2.3 Chemical analysis of feed and faeces samples**

Samples of urea-treated sugarcane top was aerated for 24 hours and pre-dried at 65°C for another 24 hours to allow evaporation of free water and loosely bound ammonia. The main purpose of the aeration and pre-drying was to help for detecting the amount of nitrogen which was chemically fixed to the sugarcane top structure after treatment. In addition, the fodder samples were also taken and pre-dried for parallel chemical analyses.

During the entire period of the experiment, samples of offered and refusals (left over) of feed and fodder were taken on weekly interval and bulked for the entire period of the experiment and were analyzed for dry matter (DM), Ash, crude protein (CP), ether extract (EE) and crude fibre (CF) content according to the methods of AOAC (1990). The neutral





**Plate 1. Bunch of fresh sugarcane tops.**



**Plate 2. Concrete trench silo pit, which was used for urea treatment of sugarcane tops.**



**Plate 3. Uniform mixing of urea-treated sugarcane tops by using fork.**



**Plate 4. Trampling of urea-treated sugarcane tops layer for proper compaction.**



**Plate 5. Covering of urea treated sugarcane tops with plastic sheet for hermetic sealing.**



**Plate 6. Covering of the ensiled sugarcane tops with sorghum straw.**



**Plate 7. Green colour of chopped sugarcane tops before urea treatment.**



**Plate 8. Brown colour of chopped sugarcane tops after urea treatment.**

detergent fibre (NDF) content of untreated and urea-treated sugarcane top samples was analyzed according to Goering and Van Soest (1970), while acid detergent fibre (ADF) and acid detergent lignin (ADL) contents were determined according to AOAC (1990). Oxalate content of untreated and urea-treated sugarcane top samples was determined according to Abeza *et al.* (1968). All the analyses were run in triplicates.

Daily collected faeces were weighed and mixed thoroughly and 1% sub sample of faeces was preserved for dry matter and 0.5% of sub-sampled faeces were preserved in 5% (w/v) sulfuric acid for nitrogen estimation according to the technique described by Prasad (1999). Faeces samples of seven days were bulked and determined for proximate analysis according to the methods of AOAC (1990).

#### **3.2.4 Animals and management**

Sixteen lactating 'Phule Tiveni' triple crossbred (50% Fiesian + 25% Jersey + 25% local *Gir*) cows were selected from Research Cum Development Project on cattle for the study. The experimental cows were in the age of  $4.6 \pm 0.7$  years. The cows had  $8.35 \pm 1.28$  litres and  $395.9 \pm 27.9$  kg of initial milk yield per day and body weight respectively. The experiment was started after the cows passed  $145 \pm 15$  days in lactation. The cows were dewormed for internal parasites with albendazole before the start of the experiment and the cows were fed individually in tie stalls. Green sugarcane top, urea-treated sugarcane top, green maize, sorghum straw and lucerne were offered in two equal parts for morning and afternoon feeding. The concentrate mixture was offered in equal portions at milking in the morning and in the evening. Drinking water was made available at 6, 12, 15 and 18



**Plate 9. Experimental cows during feeding trial.**

hour. The cows were let loose for exercise for one hour daily in morning and evening after milking. The cows were milked at 5:00 h in the morning and 16:00 h in the evening.

### **3.2.5 Milk analysis**

Fresh milk samples were collected at monthly interval from each experimental cow from morning and evening milking. Composite morning and evening milk samples were kept overnight in a refrigerator maintained below 4 °C before undertaking the required test for chemical composition. Milk fat analysis was run using the Gerber method (IS 1958). Protein content was determined by using the formaldehyde titration method according to the technique described by Pyne (1932). Total solids (TS) were determined by oven drying 5g of milk (Marth 1978). SNF was calculated by subtracting fat per cent from total solid. Milk calcium was analyzed according to the methods of ISI (1981). Milk urea was determined at 75<sup>th</sup> and 90<sup>th</sup> days of the experiment by using p-dimethyl amino benzaldehyde reagent as described by Bector *et al.* (1998).

### **3.2.6 Blood analysis**

Blood samples of experimental animals were collected at the start and at the end of the experimental trial, in the morning before offering of feed and water by puncturing jugular vein and analyzed for blood urea nitrogen and blood phosphorous by using VITROS DT60II chemistry system, while blood calcium was analyzed by using DTSCII module as depicted by Anon (2001).



**Plate 10. VITROS DT60 II chemistry system instrument, which was used for analysis of blood urea nitrogen and blood phosphorous.**



**Plate 11. DTSC II module instrument, which was used for analysis of blood calcium.**

### 3.3 Data collection

Milk yield of each cow and the quantity of offered and refused feed and fodder was recorded daily. At the end of the experiment a digestion trial was conducted for 7 days duration. The daily amount of offered and refused feed and fodder and the quantity of faeces excreted by each cow was recorded for seven days.

### 3.4 Experimental design and statistical analysis

Sixteen lactating 'Phule Triveni' crossbred cows were blocked according to their lactation days in milk, milk yield and age group in respective of their treatment groups by employing 4x4 Latin square design. Each treatment consisted of four cows as a replication.

Total dry matter intake, CP intake, CF intake, daily milk yield, milk fat, milk protein, SNF, total solids, milk calcium, milk urea, digestibility coefficients, blood Urea nitrogen, blood calcium, blood phosphorous were analyzed following the statistical procedures outlined by SAS system for Windows (1996).

$$Y_{ijk} = \mu + \alpha_i + \beta_j + T_k + e_{ijk}$$

Where,

- $Y_{ijk}$  is the dependent variable (dry matter intake, milk yield, milk protein, etc)
- $\mu$  = overall mean,
- $\alpha_i$  = effect of lactation stage (days in milk)

- $\beta_j$  = effect due to age of cows
- $T_k$  = effect of treatment (diet)
- $e_{ijk}$  = random error effect.

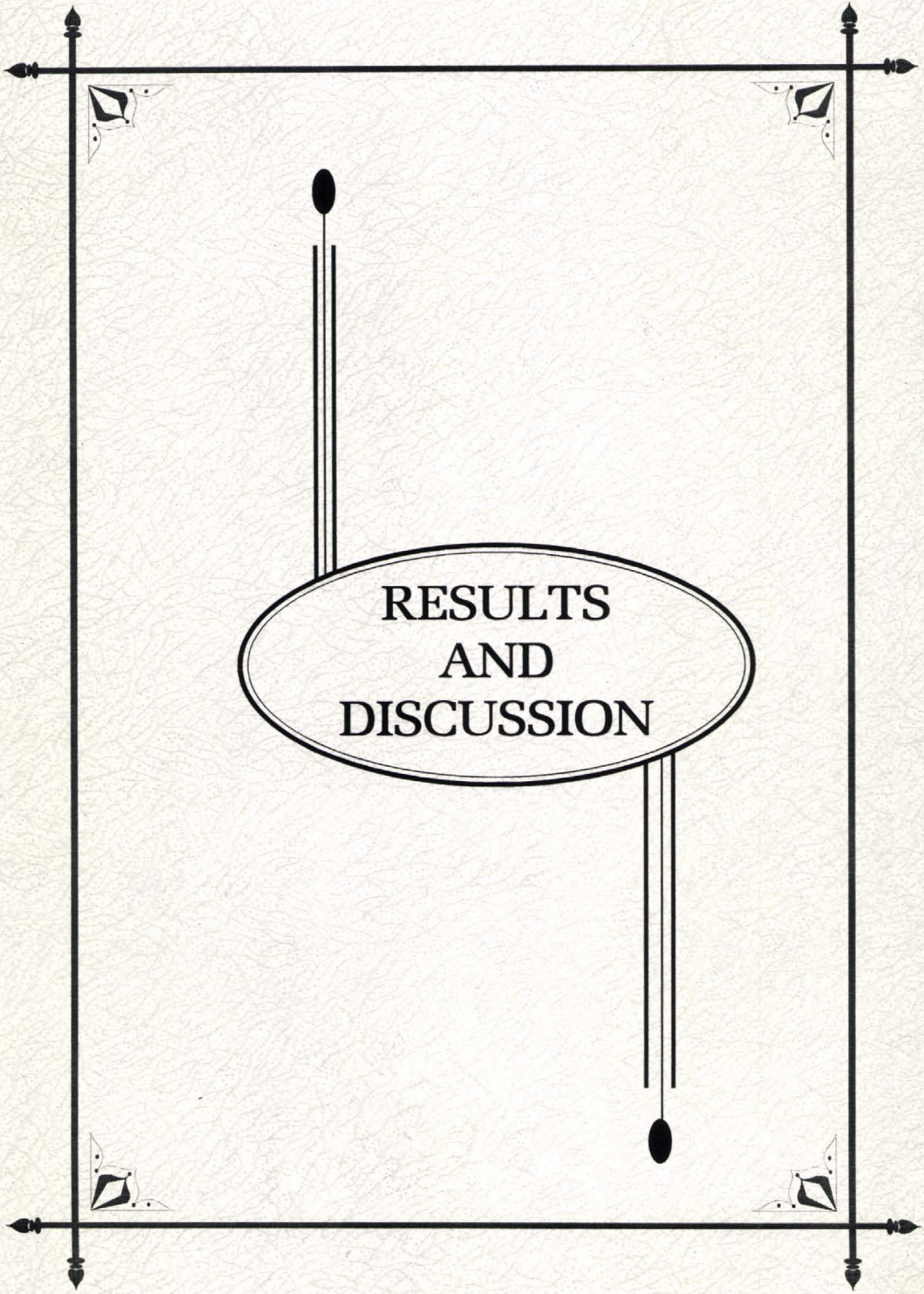
The statistical analysis regarding the proximate nutrients, cell wall constituents and oxalate content of untreated and urea-treated sugarcane top samples was analyzed by employing two sampled t-test.

### **3.5 Economic analysis**

The economic evaluation was based on computation of the total cost incurred for milk production and the amount of benefit gained from the sale of milk. The milk price was computed at Rs. 12/litre, which was the official price at RCDP. The detail production cost and calculation for economic analysis is indicated in Appendix II.

### **3.6 Experimental period**

The experiment was conducted for three months from January 18 to April 17, 2007, excluding 10 days of adaptation period and one week post experimental period of digestibility trial.



**RESULTS  
AND  
DISCUSSION**

## 4. RESULTS AND DISCUSSION

### 4.1 Chemical composition of untreated and urea-treated sugarcane tops

The results related to proximate composition and cell wall constituents of untreated and urea-treated sugarcane top in terms of per cent DM, CP, EE, CF, NFE, TA, NDF, ADF, ADL, Cellulose and cell contents are presented in Table 2.

The per cent DM, CP and Ash showed a significant variation ( $P < 0.05$ ) between untreated and urea-treated sugarcane top. Higher CP (5.67%) was observed in urea-treated sugarcane top and the CP increased by 127.72% after urea treatment. As a result of urea treatment of sugarcane top, a significant change in nutrient content was obtained. According to Noroozy and Alemzadeh (2006), the CP content of sugarcane top increased from 1.25 to 6.75 per cent after urea treatment. Similarly Rangnekar (1988b) found that sugarcane top silage treated with 0.5% urea contained 8.10% crude protein. Pholsen *et al.* (1996) also reported that treating of sugarcane top with 6% urea increased the CP content from 4.2 to 8 per cent. The CP content of urea-treated samples of the present finding was lower than the above reported findings. The per cent DM of urea-treated sugarcane top was in conformity with the result reported by Noroozy and Alemzadeh (2006). However, the per cent DM of untreated sugarcane top samples was lower by 11.17% than the results reported by Patil *et al.* (1999).

There was slight increment in EE and Ash content of urea-treated sugarcane tops samples. However, slight reduction was observed in DM, CF and NFE content after urea treatment. There was no significant

difference ( $p>0.05$ ) in respect of EE, NFE and CF contents between untreated and urea-treated sugarcane tops samples. The CF content of USCT sample was in conformity with the findings of Patil *et al.* (1999) and Rangnekar (1988b), however it was lower than the results of 37.40 and 33.50% reported by Rangkuti and Djajanegara (1983) and Naseeven (1988), respectively. The slight reduction in the CF content of UTSTCT samples was also in agreement with the findings of Pholsen *et al.* (1996). The Ash content of USCT was lower than the results of 8.50% reported by Rangnekar (1988) and Naseeven (1988). The NFE content of USCT was higher than the results of 50.30 and 52.96% reported by Naseeven (1988) and Patil *et al.* (1999), respectively. The present study was in agreement with the finding of Bui Van Chinh *et al.* (2000) who reported that the CF and NFE content of sugarcane leaves reduced after urea treatment, but the Ash and CP content increased after urea treatment.

With regard to cell wall constituents, the NDF content was reduced by 6.78% after urea treatment. Whereas after urea treatment cell contents, ADF, cellulose and ADL increased by 14.6, 10.45, 10.75 and 29.25%, respectively. Significant variation ( $P<0.05$ ) was observed between untreated and urea-treated sugarcane top samples in respect of the cell wall constituents of NDF, cell contents, ADF, cellulose and ADL. Treatment of SCT with urea had shown a significant effect on the cell wall constituents. The NDF content of USCT was lower than the finding of 72.44% reported by Gendley *et al.* (2003), but it was higher than the result of 65.15% reported by Naseeven (1988). Moreover, Mesfin and Ledin (2004) and Datt and Singh (1996) supported the reduction of NDF content after urea treatment.

The ADL content of USCT was lower than the finding of 6.35% reported by Gendley *et al.* (2003), but it was conformable with finding of Naseeven (1988). Mesfin and Ledin (2004) and Pholsen *et al.* (1996) reported ADL content increases after urea treatment. The ADF content of USCT was lower than the results of 41.2 and 40.48% reported by Gendley *et al.* (2003) and Naseeven (1988), respectively. The increment of ADF and cellulose content after urea treatment was supported by the findings of Mesfin and Ledin (2004) and Datt and Singh (1996). The increase in ADF and lignin is due to the fact that soluble nutrients like crude protein, nitrogen free extract, ether extract and soluble carbohydrates are dissolved and lost in solution, resulting in increased in cell wall constituents and ash contents in urea-treated samples (Musimba, 1988).

The variation in the nutrient content of untreated and urea-treated sugarcane top of the present study as compared with the findings of other researchers might be due to differences in variety, harvesting stage, fertilization practices, treatment period, urea level, quality of forage material, temperature, hermetic condition and ureolysis reaction.

**Table 2. Proximate and cell wall constituents of untreated and urea-treated sugarcane tops**

Parameters (%)	USCT	UTSCT	Overall mean	$t_{cal}$	Remark
DM	31.43	28.9	30.17	3.61	*
CP	2.49	5.67	4.08	3.55	*
EE	1.98	1.74	1.86	0.38	NS
CF	30.81	29.02	29.92	0.55	NS
Ash	6.99	7.63	7.31	3.30	*
NFE	57.73	55.94	56.84	0.60	NS
NDF	68.30	63.67	65.99	29.63	*
Cell contents	31.70	36.33	34.02	29.63	*
ADF	36.35	40.15	38.25	93.08	*
Cellulose	29.30	32.45	30.88	26.47	*
ADL	4.65	6.01	5.33	12.97	*

USCT = Untreated sugarcane tops

UTSCT = Urea-treated sugarcane tops

$t_{cal}$  = t-calculated

$t_{tab(0.05)}$  = t- tabulated = 2.78

\* =  $P < 0.05$

NS = Non-Significant

## 4.2 Oxalic acid content of untreated and urea-treated sugarcane top

The results obtained with regards to oxalate content of untreated and urea-treated sugarcane tops are presented in Table 3. The oxalate content was higher in untreated sugarcane top (3.94 g/kg) and lower in urea-treated sugarcane top (1.88 g/kg). After urea treatment, the oxalate content of sugarcane top was reduced by 52.28 per cent. The reduction of oxalate during ensiling might be due to the action of anaerobic microbes which degrades oxalates into carbonates and finally converted to carbon dioxide (Ahuja *et al.* 1998). Significant variation ( $P < 0.05$ ) was observed between untreated and urea-treated sugarcane top samples in respect of oxalate content.

The oxalate content of untreated sugarcane samples was in accordance with the finding reported by Anon (2003) in which the oxalate content of sugarcane top was in the range of 0.13 to 0.58 per cent. In the present study the reduction of oxalate content after ensiling with urea treatment was in agreement with the related findings of Ahuja *et al.* (1998) who reported ensiling of hybrid napier bajra variety of PBN-231 and PBN-83 was considerably reduced the oxalate content by 80 per cent. Similarly, Pham Sy Tiep (2006) reported that ensiling of *Alocasia macrorrhiza* leaves with 7% rice bran and 2% molasses reduced the calcium oxalate content by 78.8 per cent.

Table 3. Oxalate content of untreated and urea-treated sugarcane tops

Sample type	oxalate (g/kg)	Overall mean	$t_{cal}$	$t_{tab(0.05)}$	Remark
Untreated sugarcane top	3.94	2.91	4.18	2.78	*
Urea-treated sugarcane top	1.88				

$t_{cal}$  = t-calculated

$t_{tab(0.05)}$  = t- tabulated

\* =  $P < 0.05$

### 4.3 Feed, fodder and nutrient intake of experimental cows

The results pertaining to the average daily dry matter intake of feed, fodders and nutrient intake of experimental cows are presented in Table 4.

As indicated in Appendix I approximately 95.29, 95.81, 94.58 and 91.58 per cent of offered dry matter were consumed by T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> treatments, respectively. The highest daily total DM intake of the diet was observed in T<sub>2</sub> (11.35 kg/d) followed by T<sub>0</sub> (11.34 kg/d), T<sub>1</sub> (11.21 kg/d) and the lowest value was in T<sub>3</sub> (10.44 kg/d), respectively. The daily total dry matter intake (kg % body weight) in-group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 2.86, 2.92, 2.90 and 2.77, respectively. The per cent dry matter intake of all experimental treatments was in accordance with the finding of Banerjee (2006), who revealed that the total dry matter intake of crossbred cattle ranges between 2.5 – 3.0% of body weight. Moreover, the daily total dry matter intake per kg metabolic body size ( $\text{g/kg W}^{.75}$ ) in-group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 127.45, 129.39, 131.65 and 122.23, respectively. However, there was no significant variation among treatments as regards to dry matter intake per kg metabolic body size ( $\text{g/kg W}^{.75}$ ) and dry matter intake per 100 kg body weight, respectively. The dry matter intake of untreated sugarcane top was 2.19 kg/d, while the dry matter intake of urea-treated sugarcane top was higher in T<sub>3</sub> (3.75 kg/d) followed by T<sub>2</sub> (3.10 kg/d) and T<sub>1</sub> (2.05 kg/d), respectively. As indicated in appendix I, from the offered amount of urea-treated sugarcane tops about 89.13, 86.11 and 83.33% were consumed in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively. From the present findings the consumed proportion

of urea-treated sugarcane top tended to decrease with the increasing level of urea-treated sugarcane tops in the diet.

The highest CP intake was observed in T<sub>1</sub> (1381.75 g/d) followed by T<sub>0</sub> (1313.75 g/d), T<sub>2</sub> (1308.33 g/d) and T<sub>3</sub> (1244.78 g/d), respectively. Significant difference (P<0.05) was observed among experimental treatments in relation to CP intake. In the present findings the CP intake of all experimental treatments fulfills the daily CP requirements of dairy cows of 1.24 kg/d as depicted by Harris (2003a).

The highest CF intake was observed in T<sub>2</sub> (2514.28 g/d) followed by T<sub>1</sub> (2387.30 g/d), T<sub>0</sub> (2375.18 g/d) and T<sub>3</sub> (2272.5 g/d), respectively. Significant difference (P<0.05) was observed among experimental treatments as regards to the CF intake.

Table 4. Daily feed, fodder and nutrient intake of experimental cows

Feed and fodder intake (kg DM/d)	Treatments				Overall mean	SE±	LSD
	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>			
USCT	2.19	—	—	—	—	—	—
UTSCT	—	2.05	3.10	3.75	—	—	—
Sorghum straw	1.38	1.44	1.50	1.40	—	—	—
Green maize	1.57	1.56	1.18	—	—	—	—
Lucerne	2.31	2.29	1.57	1.49	—	—	—
Concentrate	3.89	3.87	4.00	3.80	—	—	—
Total DM intake (kg/d)	11.34 <sup>a</sup>	11.21 <sup>a</sup>	11.35 <sup>a</sup>	10.44 <sup>b</sup>	11.09	0.17	0.60
Total DM intake (kg % body weight)	2.86	2.92	2.90	2.77	2.86	0.09	NS
Total DM intake (g/kg W <sup>0.75</sup> )	127.45	129.39	131.65	122.23	127.68	3.17	NS
Total CP intake (g/d)	1313.75 <sup>b</sup>	1381.75 <sup>a</sup>	1308.33 <sup>b</sup>	1244.78 <sup>c</sup>	1312.15	12.14	42.03
Total CF intake (g/d)	2375.18 <sup>ab</sup>	2387.3 <sup>ab</sup>	2514.28 <sup>a</sup>	2272.5 <sup>b</sup>	2387.32	53.42	184.87

<sup>a,b,c</sup> = means in a row which having different superscripts are significantly different at P<0.05  
NS = Non-significant

#### 4.4. Milk yield and milk composition

The results obtained with regard to average daily milk yield and milk composition of experimental cows in respective to their treatment groups are presented in Table 5.

There was no significant difference ( $P>0.05$ ) in milk yield, milk protein, milk fat, TS and SNF among experimental treatments. The highest and lowest milk yield was observed in  $T_2$  (9.20 l/d) and  $T_0$  (8.10 l/d), respectively. As it can be seen in Fig 1, the milk yield of all experimental groups had shown increment up to 60 days of experimental period and then after it started to decline, which might be due to the fact as the lactation stage advanced, the milk yield started to reduce, moreover as indicated in appendix iv, it might have been coupled with the increase in temperature during the last 30 days of experimental period, which has affected the feed intake too. Therefore, this heat stress might have resulted in reduction of milk production in all experimental groups. Similarly, Sharma *et al.* (1988) and Armstrong (1994) reported that heat stress depressed milk yield and appetite of dairy cows.

The highest TS and SNF was observed in  $T_2$  (13.78 and 9.91%) respectively. While the lowest TS and SNF was observed in  $T_1$  (13.06 and 9.11%), respectively. The highest milk protein and milk fat was observed in  $T_0$  (3.60%) and  $T_1$  (3.98%), respectively, whereas the lowest milk protein and milk fat was observed in  $T_1$  (3.35%) and  $T_3$  (3.80%), respectively. However, the differences were non-significant in all milk constituents except milk urea. The present finding was in accordance with the result found by Alemezadeh and Seraj (2003) who reported feeding of different levels of

urea-treated sugarcane top silage had non-significant effect on milk production, milk fat, milk protein and TS. Similarly, it was in conformity with the findings of Noroozy and Alemzadeh (2006) who reported feeding of different amounts of urea-treated sugarcane top showed non-significant variation in buffalo milk production and milk composition. In related works Mesfin and Ledin (2004) reported that effect of feeding diets based on Hay, 5% urea-treated barley straw and 5% urea-treated *teff* straw didn't bring significant change in milk yield, milk protein and milk fat; Sharma *et al.* (2004) reported that non-significant variation was observed between the feeding of untreated and 4% urea-treated rice straw on buffalo milk in total solids, SNF, CP and fat per cent.

Non-significant variation was observed among the experimental treatments in terms of milk calcium content. The milk calcium was highest in T<sub>1</sub> (1224.23 mg/l) and lowest in T<sub>0</sub> (1105.49 mg/l). Goff (1995) reported that the normal range of cow milk calcium ranges from 1100 to 1300 mg/litre. The average values of milk calcium in the present study were within the range of those reported above. Besides insignificant variation in milk calcium of the present finding was supported by Schmidt (1988) and Banerjee (2005) who reported the mineral content of milk is stable and major elements like Ca can not be changed by altering the levels of this element in the diet of cow.

The milk urea had shown significant difference ( $P < 0.05$ ) among experimental diets. The highest and lowest milk urea was observed in T<sub>3</sub> (80.52 mg/dl) and T<sub>0</sub> (40.57 mg/dl), respectively. The average values of milk urea in the present study were within the normal range reported by Bector *et al.* (1998) which varies from 22.80 to 92.40 mg/dl.

Table 5. Effect of experimental diets on milk yield and milk composition

Parameters	Experimental diets (treatments)				Overall mean	SE±	LSD
	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>			
Milk yield (l/d)	8.10	8.88	9.20	8.43	8.65	1.29	NS
Milk composition							
Protein (%)	3.60	3.35	3.36	3.44	3.44	0.07	NS
Fat (%)	3.90	3.98	3.90	3.80	3.90	0.16	NS
TS (%)	13.37	13.06	13.78	13.43	13.41	0.32	NS
SNF (%)	9.48	9.11	9.91	9.63	9.53	0.33	NS
Ca (mg/l)	1105.49	1224.23	1155.74	1153.55	1159.75	42.01	NS
Urea (mg/dl)	40.57 <sup>c</sup>	66.79 <sup>b</sup>	73.8 <sup>ab</sup>	80.52 <sup>a</sup>	65.42	2.56	8.87

a, b, c = means in a row which having different superscripts are significantly different at P<0.05  
NS = Non-significant

Fig 1. Effect of experimental diets on average monthly milk yield of cows

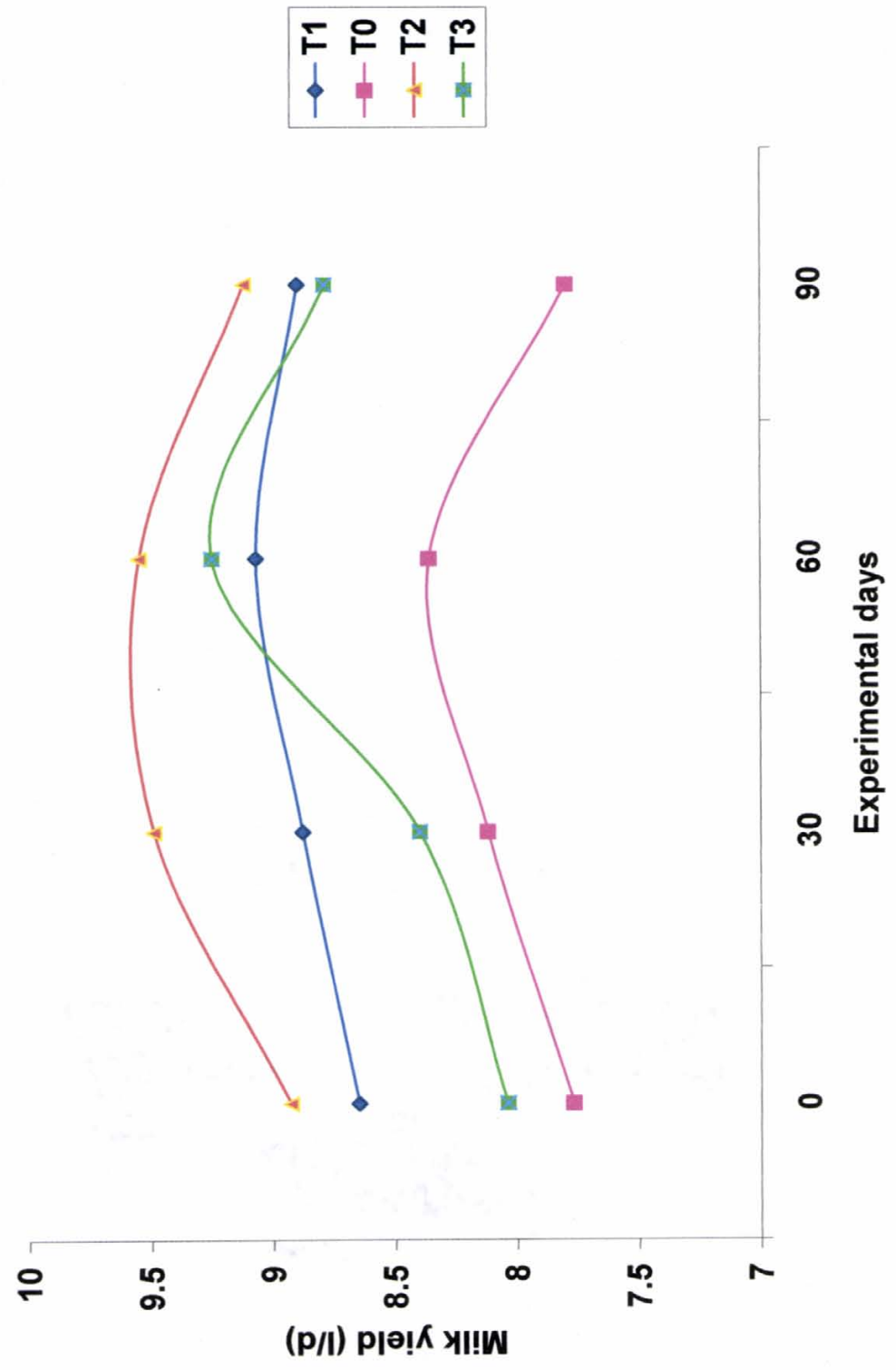


Fig 2. Effect of experimental diets on average milk yield and milk composition

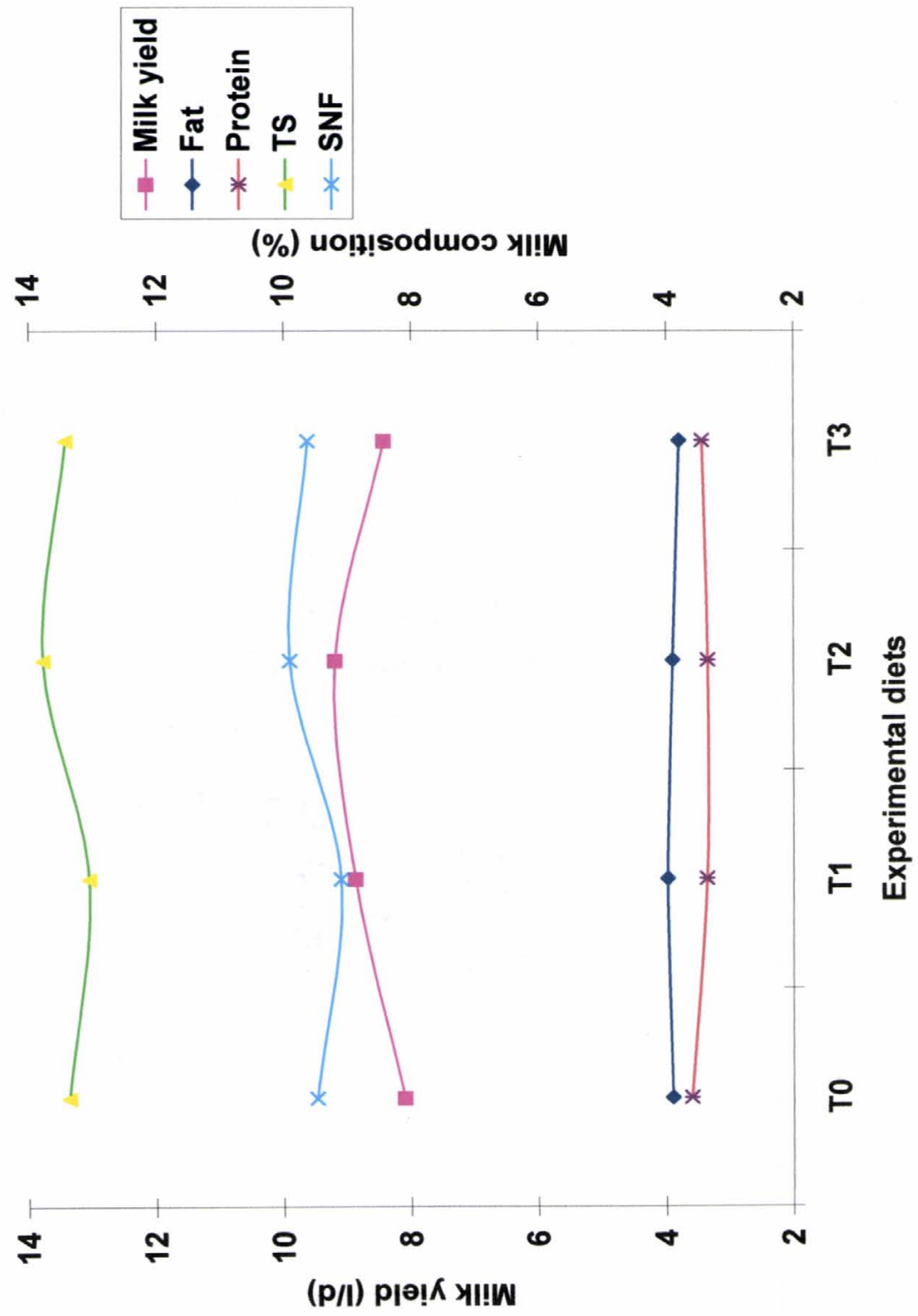
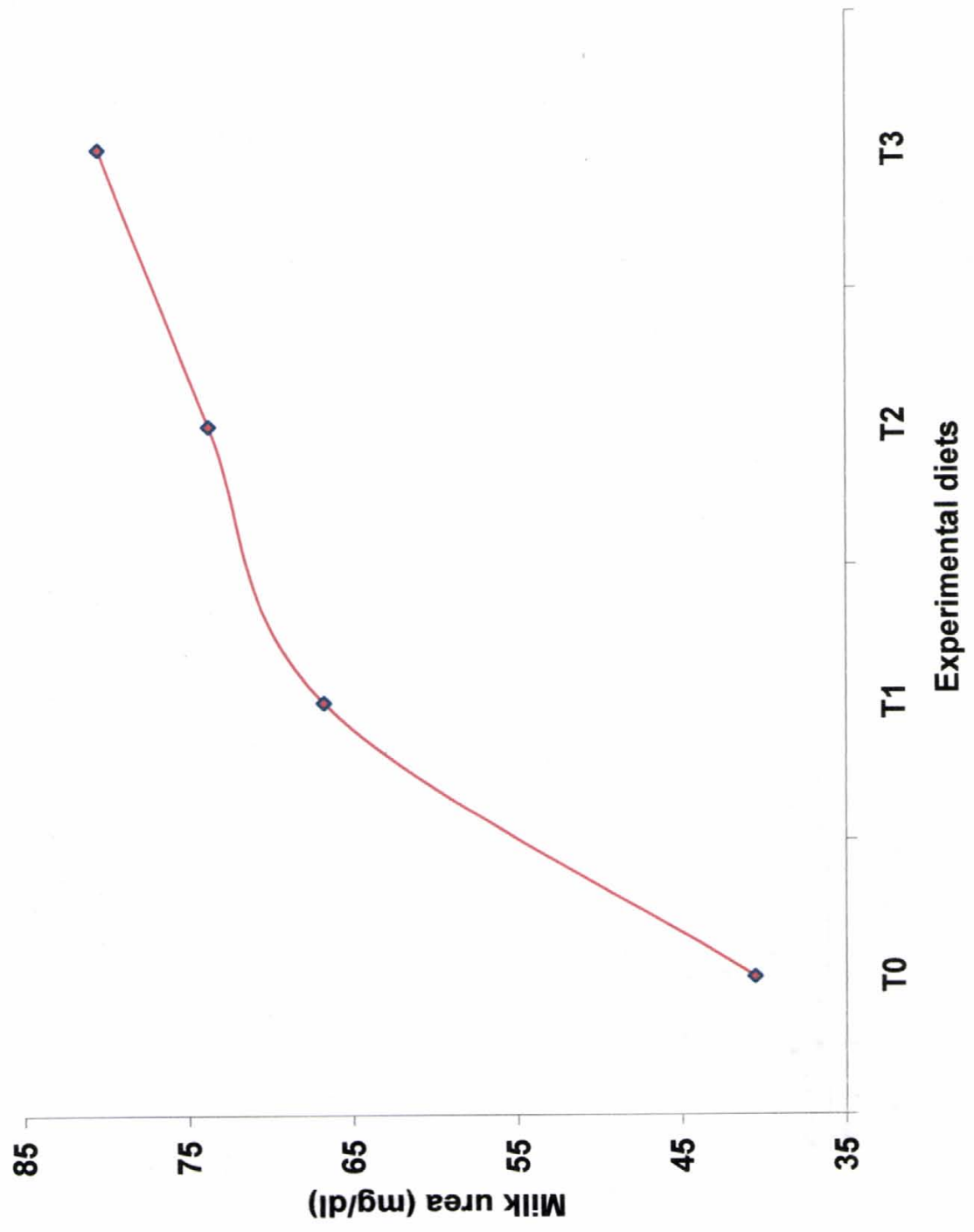


Fig 3. Effect of experimental diets on average milk urea content



#### 4.5 Blood biochemical constituents

The results obtained in respect of blood urea nitrogen, blood calcium and phosphorous of experimental cows are presented in Table 6.

Non-significant variation ( $P>0.05$ ) was observed among the experimental treatments in terms of BUN. The highest BUN was observed in T<sub>3</sub> (18.75 mg/dl) followed by T<sub>2</sub> (18.50 mg/dl), T<sub>1</sub> (18.15 mg/dl) and the lowest value in T<sub>0</sub> (16.60 mg/dl), respectively. Sastry *et al.* (1999) reported that the normal range of BUN of cows vary from 6.0 to 27 mg/dl and 6.30 to 25.50 mg/dl by Varner (1998). The average values of BUN in this study were in agreement within the range of those reported above.

Non-significant variation ( $P>0.05$ ) was observed in blood calcium content among the experimental treatments. The highest blood calcium was observed in T<sub>3</sub> (9.55 mg/dl) followed by T<sub>2</sub> (9.49 mg/dl), T<sub>1</sub> (9.42 mg/dl) and T<sub>0</sub> (8.63 mg/dl), respectively. In the present study the average values of blood calcium (T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub>) were in agreement within the range reported by Sastry *et al.* (1999) which vary from 9.40 to 12.20 mg/dl. However, the blood calcium of T<sub>0</sub>-group was lower than the normal range of those reported above, this might be due to intake of high oxalic acid which is present in untreated sugarcane top hampered the utilization of blood calcium.

Non-significant variation ( $P>0.05$ ) was observed in blood phosphorous content among the experimental treatments. The highest blood phosphorous was observed by T<sub>3</sub> (5.90 mg/dl) followed by T<sub>2</sub> (5.23 mg/dl), T<sub>1</sub> (4.93 mg/dl) and T<sub>0</sub> (4.43 mg/dl), respectively. The average values of

blood phosphorous in this study were in agreement within the ranges reported by Sastry *et al.* (1999), which varies from 4.0 to 9.0 mg/dl.

**Table 6. Effect of experimental diets on blood urea nitrogen, calcium and phosphorous profile**

Experimental diets (treatments)	Parameters		
	BUN (mg/dl)	Blood Calcium (mg/dl)	Blood Phosphorous (mg/dl)
T <sub>0</sub>	16.60	8.63	4.43
T <sub>1</sub>	18.15	9.42	4.93
T <sub>2</sub>	18.50	9.49	5.23
T <sub>3</sub>	18.75	9.55	5.90
Overall mean	18.00	9.27	5.12
SE±	1.30	0.38	0.68
LSD	NS	NS	NS

NS = Non-significant

#### 4.6 Digestibility coefficient of experimental diets

The results pertaining to the average apparent digestibility coefficient and nutritive value of the experimental diets are presented in Table 7.

Significant variation ( $P < 0.05$ ) was noticed among experimental treatments in terms of dry matter digestibility coefficient. The highest DM digestibility was observed in  $T_2$  (62.93%) followed by  $T_0$  (60.52%),  $T_1$  (58.80%) and lowest value in  $T_3$  (52.84%), respectively. It needs to be noted here that in  $T_3$  group per day dry matter intake was also less (Table 4). It is indicated that, inclusion of 4 % of urea-treated sugarcane top silage up to 60% of total roughage requirement had adverse effect on both i.e. dry matter intake and its digestibility too. This may be because of increased concentration of ammonia which may affect the intake and higher content of acid detergent fibre in UTSCCT (Table 2), which affected the digestibility. The DM digestibility coefficients of  $T_0$ ,  $T_1$  and  $T_2$  groups were higher than the findings of Gendley *et al.* (2003) who reported 57.57% for crossbred cattle fed on adlib sugarcane top plus concentrate mixture. Similarly, in the present finding the DM digestibility coefficients of all experimental groups were higher than the finding of Rangnekar (1988b) who reported 48.40% for sugarcane top silage treated with 0.5% of urea. However, Montpellier and Preston (1977) reported that a DM digestibility coefficient of sugarcane top based diet (61.5 %) was higher than the experimental groups of  $T_0$ ,  $T_1$  and  $T_3$  respectively.

Significant variation ( $P < 0.05$ ) was observed among experimental treatments in respect of crude protein digestibility coefficient.

The CP digestibility coefficients for treatment T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 66.18, 65.92, 71.18, and 67.20%, respectively. The CP digestibility coefficients in all of experimental groups were higher than the finding of Rangnekar (1988b) who reported 56.30% for sugarcane top silage treated with 0.5% of urea and Gendley *et al.* (2003) who reported 58.82% for crossbred cattle fed on adlib sugarcane top plus concentrate mixture.

The highest digestibility coefficient of ether extract was observed in T<sub>2</sub> (63.59%) followed by T<sub>1</sub> (61.53%), T<sub>0</sub> (52.41%) and the lowest value was in T<sub>3</sub> (50.16%). Significant variation ( $P < 0.05$ ) was noticed in EE digestibility coefficient among the experimental treatments. The EE digestibility coefficients of T<sub>0</sub> and T<sub>3</sub> groups were lower than the finding of Gendley *et al.* (2003) who reported 61.01% for crossbred cattle fed on adlib sugarcane top plus concentrate mixture. However, all treatments were higher than the finding of Rangnekar (1988b) who reported 36.70% for sugarcane top silage treated with 0.5% of urea.

The crude fibre digestibility coefficients for treatment T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 55.11, 56.78, 57.11, and 50.10%, respectively. Significant variation ( $P < 0.05$ ) was observed in CF digestibility coefficient among the treatments. The CF digestibility coefficients of all experimental groups were lower than the finding of Rangnekar (1988b) who reported 60% for sugarcane top silage treated with 0.5% of urea.

The highest digestibility coefficient of nitrogen free extract was observed in T<sub>2</sub> (69.15%) followed by T<sub>0</sub> (67.91%), T<sub>1</sub> (62.62%) and the lowest value was in T<sub>3</sub> (57.80%). Significant variation ( $P < 0.05$ ) was noticed in NFE digestibility coefficient among the experimental treatments. In

treatment (T<sub>3</sub>) the green maize was totally replaced by urea-treated sugarcane top silage which may be the reason for the reduction of NFE digestibility as the UTSCCT were having more fibre than maize. The NFE digestibility coefficients of all experimental groups were higher than the finding of Rangnekar (1988b) who reported 44.70% for sugarcane top silage treated with 0.5% of urea. Similarly, the NFE digestibility coefficients of T<sub>0</sub>, T<sub>1</sub>, and T<sub>2</sub> groups were higher than the findings of Sanchez Nunez *et al.* (1974) who reported the NFE digestibility coefficients of sugarcane top by cattle was 57.80%, but the NFE digestibility coefficient of T<sub>3</sub> group was in conformity with the above finding.

Significant variation ( $P < 0.05$ ) was observed in the organic matter digestibility coefficient among the experimental treatments. The highest organic matter digestibility coefficient was observed in T<sub>2</sub> (66.61%) followed by T<sub>0</sub> (64.09%), T<sub>1</sub> (61.92%) and lowest value in T<sub>3</sub> (57.28%). The less OM digestibility in T<sub>3</sub> groups may be because of similar reason as that for NFE digestibility. The OM digestibility coefficients of T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> groups were higher than the finding of Gendley *et al.* (2003) who reported the OM digestibility coefficient of 60.27% for crossbred cattle fed on adlib sugarcane top plus concentrate mixture. Similarly, the OM digestibility coefficients of all experimental groups were higher than the finding of Sanchez Nunez *et al.* (1974).

The highest digestible crude protein was observed in T<sub>2</sub> (8.60%) followed by T<sub>3</sub> (8.17%), T<sub>1</sub> (8.00%) and the lowest value in T<sub>0</sub> (7.56%), respectively. Significant variation ( $P < 0.05$ ) was noticed in DCP among the experimental treatments. In the present study the DCP of all

experimental groups was higher than the finding of Patil *et al.* (1999), who reported the DCP (4.09%) of male buffaloe calves fed on green sugarcane top as sole feed source.

Significant variation ( $P < 0.05$ ) was noticed in total digestible nutrients among the experimental treatments. The highest TDN was observed in T<sub>2</sub> (60.95%) followed by T<sub>0</sub> (59.67%), T<sub>1</sub> (57.59%) and the lowest value in T<sub>3</sub> (52.44%), respectively. The per day TDN made available for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 6.71, 6.46, 6.83 and 5.47 kg/d/cow, it is pertinent to mention here that the experimental rations prepared and offered to the cows could meet the TDN requirement depicted by Harris (2003a), except T<sub>3</sub> group. In the present study the TDN of T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> groups was higher than the finding of Patil *et al.* (1999) who revealed that the TDN (52.92%) of male buffaloe calves fed on green sugarcane top as sole feed source.

The digestibility coefficient of DM, EE, CF, NFE, OM and TDN content of T<sub>3</sub> group was lower as compared to the other experimental treatments and this might be due to the high content of lignin contained in T<sub>3</sub> diet. It indicates that, 60% of the roughage requirement provided through 4% UTSCCT silage along with concentrate was not able to fulfill the nutrient requirement of lactating cows.

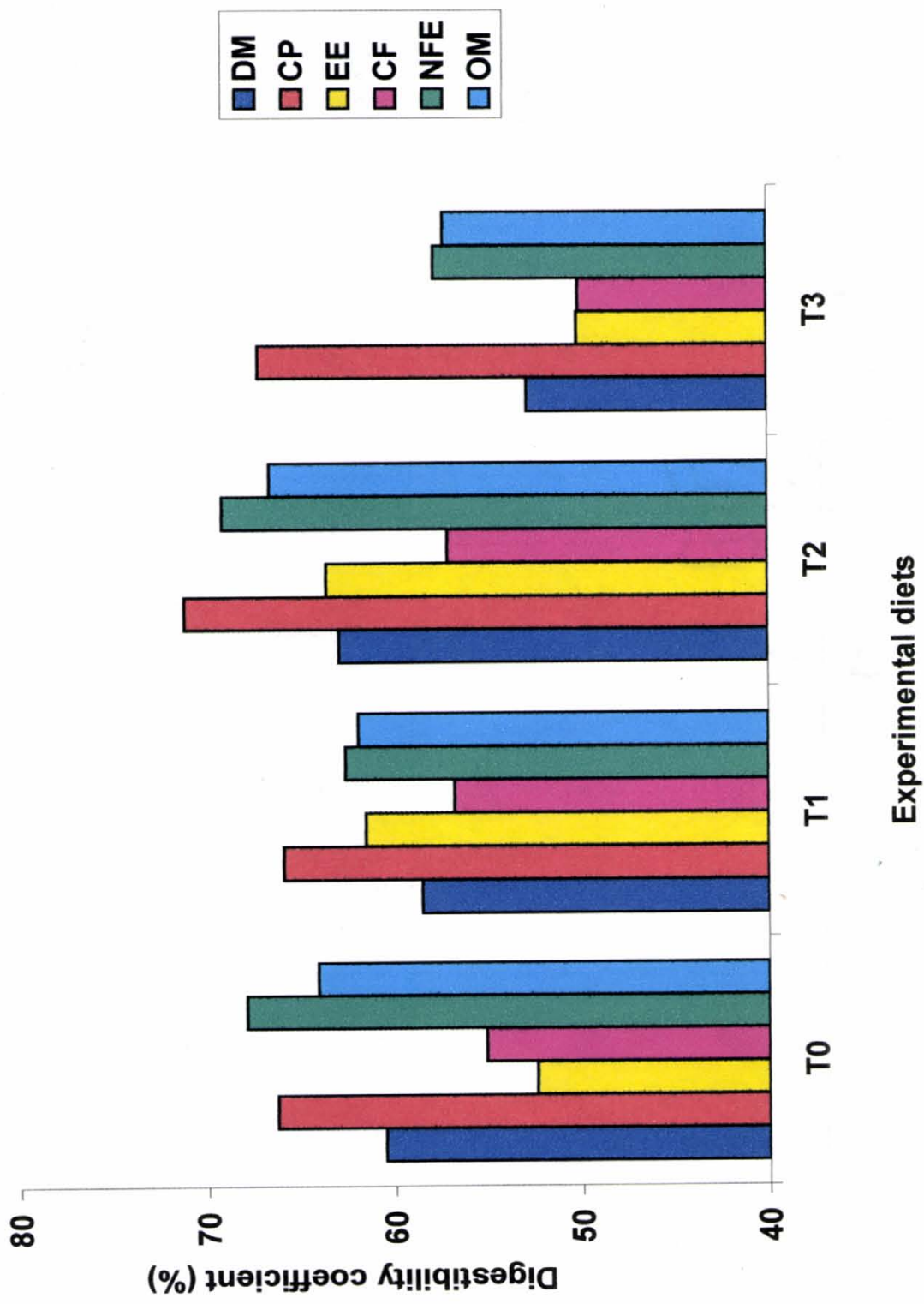
The variation in the digestibility coefficient of nutrients and the nutritive value of the present study as compared with the findings of other researcher might be due to the differences in the variety, ration composition, level of feeding, and nutrient content of the ration.

Table 7. Digestibility coefficient and nutritive value of experimental diets

Parameters (%)	Experimental diets (treatments)				Overall mean	SE±	LSD
	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>			
Digestibility Coefficient							
DM	60.52 <sup>a</sup>	58.80 <sup>a</sup>	62.93 <sup>a</sup>	52.84 <sup>b</sup>	58.77	1.70	5.89
CP	66.18 <sup>b</sup>	65.92 <sup>b</sup>	71.18 <sup>a</sup>	67.20 <sup>ab</sup>	67.62	1.44	4.99
EE	52.41 <sup>b</sup>	61.53 <sup>a</sup>	63.59 <sup>a</sup>	50.16 <sup>b</sup>	56.92	1.70	5.89
CF	55.11 <sup>ab</sup>	56.78 <sup>a</sup>	57.11 <sup>a</sup>	50.10 <sup>b</sup>	54.78	1.90	6.58
NFE	67.91 <sup>a</sup>	62.62 <sup>bc</sup>	69.15 <sup>a</sup>	57.80 <sup>c</sup>	64.37	1.50	5.20
OM	64.09 <sup>a</sup>	61.92 <sup>ab</sup>	66.61 <sup>a</sup>	57.28 <sup>b</sup>	62.48	1.55	5.37
Nutritive value							
DCP	7.56 <sup>b</sup>	8.00 <sup>ab</sup>	8.60 <sup>a</sup>	8.17 <sup>ab</sup>	8.08	0.23	0.80
DEE	1.02 <sup>b</sup>	1.25 <sup>a</sup>	1.26 <sup>a</sup>	1.00 <sup>b</sup>	1.13	0.04	0.14
DCF	11.44 <sup>ab</sup>	11.95 <sup>a</sup>	11.25 <sup>ab</sup>	10.18 <sup>b</sup>	11.21	0.50	1.73
DNFE	38.37 <sup>a</sup>	34.83 <sup>b</sup>	38.26 <sup>a</sup>	31.84 <sup>b</sup>	35.83	0.89	3.08
TDN	59.67 <sup>a</sup>	57.59 <sup>ab</sup>	60.95 <sup>a</sup>	52.44 <sup>b</sup>	57.66	1.58	5.47

a, b, c = means in a row which having different superscripts are significantly different at P<0.05

Fig 4. Digestibility coefficient of experimental diets



#### **4.7 Economic analysis**

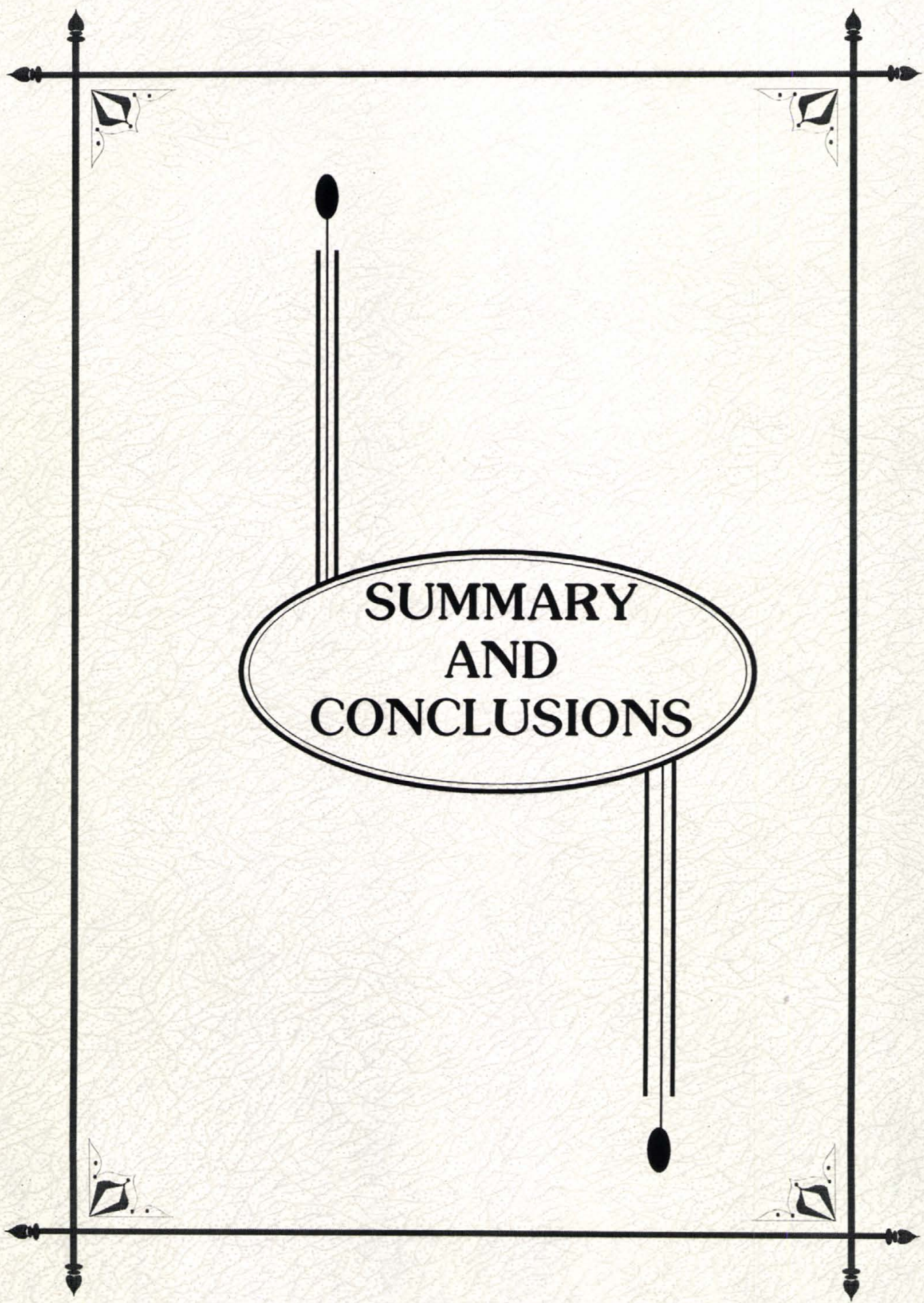
The results related to cost-benefit analysis of the experimental diets are presented in Table 8.

According to the cost-benefit analysis calculated for each diet, the highest and lowest cost of production was observed in T<sub>2</sub> (Rs. 60.91/cow/d) and T<sub>3</sub> (Rs. 58.31/cow/d), respectively. The net income from cows for treatment T<sub>2</sub> (diet with 45% UTSCCT) was highest as compared to other treatments and all of the urea-treated sugarcane top based diets were higher in net income (Rs. 46.80, 49.49, 42.49/cow/d for treatment groups of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively) than the control (T<sub>0</sub>) treatment (Rs. 38.20/cow/d). The highest and lowest value of benefit to cost ratio was noticed in T<sub>2</sub> (1.81) and T<sub>0</sub> (1.65), respectively. Diets with 45% UTSCCT (T<sub>2</sub>) and control group (T<sub>0</sub>) were the best and the least treatments, respectively in respect of economic profitability.

Table 8. Cost-benefit analysis of experimental diets

Parameters	Experimental diets (treatments)			
	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
Production cost (Indian Rs/cow/d)	59.00	60.00	60.91	58.31
Milk yield (l/cow/d)	8.10	8.90	9.20	8.40
Milk price (Indian Rs/l)	12.00	12.00	12.00	12.00
Gross return (Indian Rs/cow/d)	97.20	106.80	110.40	100.8
Net return (Indian Rs/cow/d)	38.20	46.80	49.49	42.49
Benefit to cost ratio	1.65	1.78	1.81	1.73

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**SUMMARY  
AND  
CONCLUSIONS**

## **5. SUMMARY AND CONCLUSION**

### **5.1 Summary**

The present investigation entitled “Effect of feeding urea-treated sugarcane tops on production and composition of milk in ‘Phule Triveni’ crossbred cattle” was conducted at Research Cum Development Project on cattle, Department of Animal Science and Dairy Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri with the objectives to:

- Study the effect of feeding urea-treated sugarcane top based diet on dry matter intake, milk yield, milk composition and blood constituents of lactating cows
- Estimate proximate composition, cell wall constituents and oxalic acid content of untreated and urea-treated sugarcane top
- Estimate the digestibility coefficient of experimental diets
- Evaluate the cost-benefit analysis of experimental diets.

The sixteen lactating ‘Phule Triveni’ cross-bred cows were blocked according to their lactation days in milk, milk yield and age group in respective of their treatment groups by using 4x4 Latin square design. Each treatment consisted of four cows as a replication. The experiment was carried out for three months with an adaptation period of 10 days. The treatment details were as follows:

- T<sub>0</sub> (Control group):** 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 30% DM from untreated sugarcane tops + 20 % DM from green maize + 30 % DM from green lucerne + 20% DM from sorghum straw)
- T<sub>1</sub>:** 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 30% DM from 4% urea-treated sugarcane tops + 20% DM from green maize + 30% DM from green lucerne + 20% DM from sorghum straw)
- T<sub>2</sub>:** 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 45% DM from 4% urea-treated sugarcane tops + 15% DM from green maize + 20% DM from green lucerne + 20% DM from sorghum straw)
- T<sub>3</sub>:** 1/3 DM from concentrate + 2/3 DM from roughage (i.e. 60% DM from 4% urea-treated sugarcane tops + 20% DM from green lucerne + 20% DM from sorghum straw)

Milk yield of each cow and the quantities of offered and refusal of feed and fodder was recorded on daily basis. At the end of the experiment, a digestion trial was conducted for 7 days. The daily offered and refused amount of feed and fodder and the quantity of faeces excreted by each cow was recorded for seven days. Samples of feed, fodder, refusal and faeces were analyzed for proximate composition. Samples of untreated and urea-treated sugarcane top were analyzed for oxalate, proximate composition and cell wall constituents. Fresh milk samples were analyzed for fat, protein, TS, calcium and urea contents.

The salient findings of the study are briefly given below

### **5.1.1 Chemical composition of untreated and urea-treated sugarcane tops**

Higher CP (5.67%) was observed in urea-treated sugarcane top, the CP% increased by 127.72% after urea treatment. DM, CP and Ash% showed a significant variation ( $P < 0.05$ ) between untreated and urea-treated sugarcane top samples. Non-significant variation ( $p > 0.05$ ) was observed in EE, NFE and CF contents between untreated and urea-treated sugarcane top.

With regard to cell wall constituents, the NDF content was reduced by 6.78% after urea treatment, whereas cell contents, ADF, cellulose and ADL increased by 14.6, 10.45, 10.75 and 29.25%, respectively after urea treatment. Significant variation ( $P < 0.05$ ) was observed in the cell wall constituents of NDF, cell contents, ADF, cellulose and ADL.

### **5.1.2 Oxalic acid content of untreated and urea-treated sugarcane tops**

The oxalate content was higher in untreated sugarcane top (3.94 g/kg) and lower in urea-treated sugarcane top (1.88 g/kg). After urea treatment, the oxalate content of sugarcane top was reduced by 52.28 per cent. Significant variation ( $P < 0.05$ ) was observed in oxalate content between untreated and urea-treated sugarcane top samples.

### **5.1.3 Feed, fodder and nutrient intake of experimental cows**

The highest daily total DM intake of the diet was observed by T<sub>2</sub> (11.35 kg/d) followed by T<sub>0</sub> (11.34 kg/d), T<sub>1</sub> (11.21 kg/d) and T<sub>3</sub> (10.44 kg/d). The daily total dry matter intake per 100 kg body weight in-group T<sub>0</sub>,

T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 2.86, 2.92, 2.90 and 2.77, respectively. Moreover, the daily total dry matter intake per kg metabolic body size in-group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> was 127.45, 129.39, 131.65 and 122.23, respectively. However non-significant variation ( $P>0.05$ ) was observed in dry matter intake per kg metabolic body size and dry matter intake on per cent body weight, respectively. The dry matter intake of untreated sugarcane top was 2.19 kg/d, while the dry matter intake of urea-treated sugarcane top was higher in T<sub>3</sub> (3.75 kg/d) followed by T<sub>2</sub> (3.10 kg/d) and T<sub>1</sub> (2.05 kg/d), respectively. The highest CP intake was observed in T<sub>1</sub> (1381.75 g/d) followed by T<sub>0</sub> (1313.75 g/d), T<sub>2</sub> (1308.33 g/d) and T<sub>3</sub> (1244.78 g/d), respectively. Significant variation ( $P<0.05$ ) was observed in CP intake among experimental treatments. The highest CF intake was observed in T<sub>2</sub> (2514.28 g/d) followed by T<sub>1</sub> (2387.30 g/d), T<sub>0</sub> (2375.18 g/d) and the lowest value was in T<sub>3</sub> (2272.5 g/d), respectively. Significant difference ( $P<0.05$ ) was noticed in CF intake among experimental treatments.

#### **5.1.4 Milk yield and milk composition**

There was no significant difference ( $P>0.05$ ) in milk yield, milk protein, milk fat, TS, and SNF among experimental treatments. The highest and lowest milk yield was observed in T<sub>2</sub> (9.20 l/d) and T<sub>0</sub> (8.10 l/d), respectively. The highest TS and SNF was observed in T<sub>2</sub> (13.78 and 9.91%), respectively. Whereas, the lowest TS and SNF was observed in T<sub>1</sub> (13.06 and 9.11%), respectively. The highest milk protein and milk fat was observed in T<sub>0</sub> (3.60%) and T<sub>1</sub> (3.98%), respectively, whereas the lowest

milk protein and milk fat was observed in T<sub>1</sub> (3.35%) and T<sub>3</sub> (3.80%), respectively. Non-significant variation ( $P>0.05$ ) was observed in milk calcium content among the experimental treatments. The highest and lowest milk calcium was observed in T<sub>1</sub> (1224.23 mg/l) and T<sub>0</sub> (1105.49 mg/l), respectively. The milk urea had shown significant difference ( $P<0.05$ ) among experimental diets. The highest and lowest milk urea was observed in T<sub>3</sub> (80.52 mg/dl) and T<sub>0</sub> (40.57 mg/dl), respectively. Milk urea tended to increase with the increasing level of urea-treated sugarcane tops in the diet.

#### **5.1.5 Blood biochemical constituents**

There was no significant difference ( $P>0.05$ ) in BUN, blood calcium and blood phosphorous content among the experimental treatments. The highest BUN were observed in T<sub>3</sub> (18.75 mg/dl) followed by T<sub>2</sub> (18.50 mg/dl), T<sub>1</sub> (18.15 mg/dl) and T<sub>0</sub> (16.60 mg/dl), respectively. The blood calcium of T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> group was 8.63, 9.42, 9.49 and 9.55 mg/dl, respectively. The highest blood phosphorous was observed by T<sub>3</sub> (5.90 mg/dl) followed by T<sub>2</sub> (5.23 mg/dl), T<sub>1</sub> (4.93 mg/dl) and T<sub>0</sub> (4.43 mg/dl), respectively.

#### **5.1.6 Digestibility coefficient of experimental diet**

The highest dry matter digestibility coefficient was observed in T<sub>2</sub> (62.93%) followed by T<sub>0</sub> (60.52%), T<sub>1</sub> (58.80%) and lowest value in T<sub>3</sub> (52.84%), respectively. Significant variation ( $P<0.05$ ) was noticed in the dry matter digestibility coefficient among the experimental treatments.

The CP digestibility coefficients for treatment T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 66.18, 65.92, 71.18, and 67.20%, respectively. There was significant difference (P<0.05) in respect of CP digestibility coefficient among the experimental treatments.

The highest digestibility coefficient of ether extract was observed in T<sub>2</sub> (63.59%) followed by T<sub>1</sub> (61.53%), T<sub>0</sub> (52.41%) and the lowest value in T<sub>3</sub> (50.16%), respectively. Significant variation (P<0.05) was noticed in EE digestibility coefficient among the experimental treatments.

The crude fibre digestibility coefficients for treatment T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were 55.11, 56.78, 57.11, and 50.10%, respectively. Significant variation (P<0.05) was observed in respect of CF digestibility coefficient among treatments.

The highest digestibility coefficient of nitrogen free extract was observed in T<sub>2</sub> (69.15%) followed by T<sub>0</sub> (67.91%), T<sub>1</sub> (62.62%) and the lowest value in T<sub>3</sub> (57.80%), respectively. The variation was significant (P<0.05) among the experimental treatments.

Significant variation (P<0.05) was observed in the organic matter digestibility coefficient among the experimental treatments. The highest organic matter digestibility was observed in T<sub>2</sub> (66.61%) followed by T<sub>0</sub> (64.09%), T<sub>1</sub> (61.92%) and the lowest value in T<sub>3</sub> (57.28%), respectively.

The highest digestible CP was observed in T<sub>2</sub> (8.60%) followed by T<sub>3</sub> (8.17%), T<sub>1</sub> (8.00%) and the lowest value in T<sub>0</sub> (7.56%), respectively.

The DCP was significantly different ( $P < 0.05$ ) among the experimental treatments.

The highest TDN was observed in  $T_2$  (60.95%) followed by  $T_0$  (59.67%),  $T_1$  (57.59%) and the lowest value in  $T_3$  (52.44%). There was significant difference ( $P < 0.05$ ) in TDN among the experimental treatments.

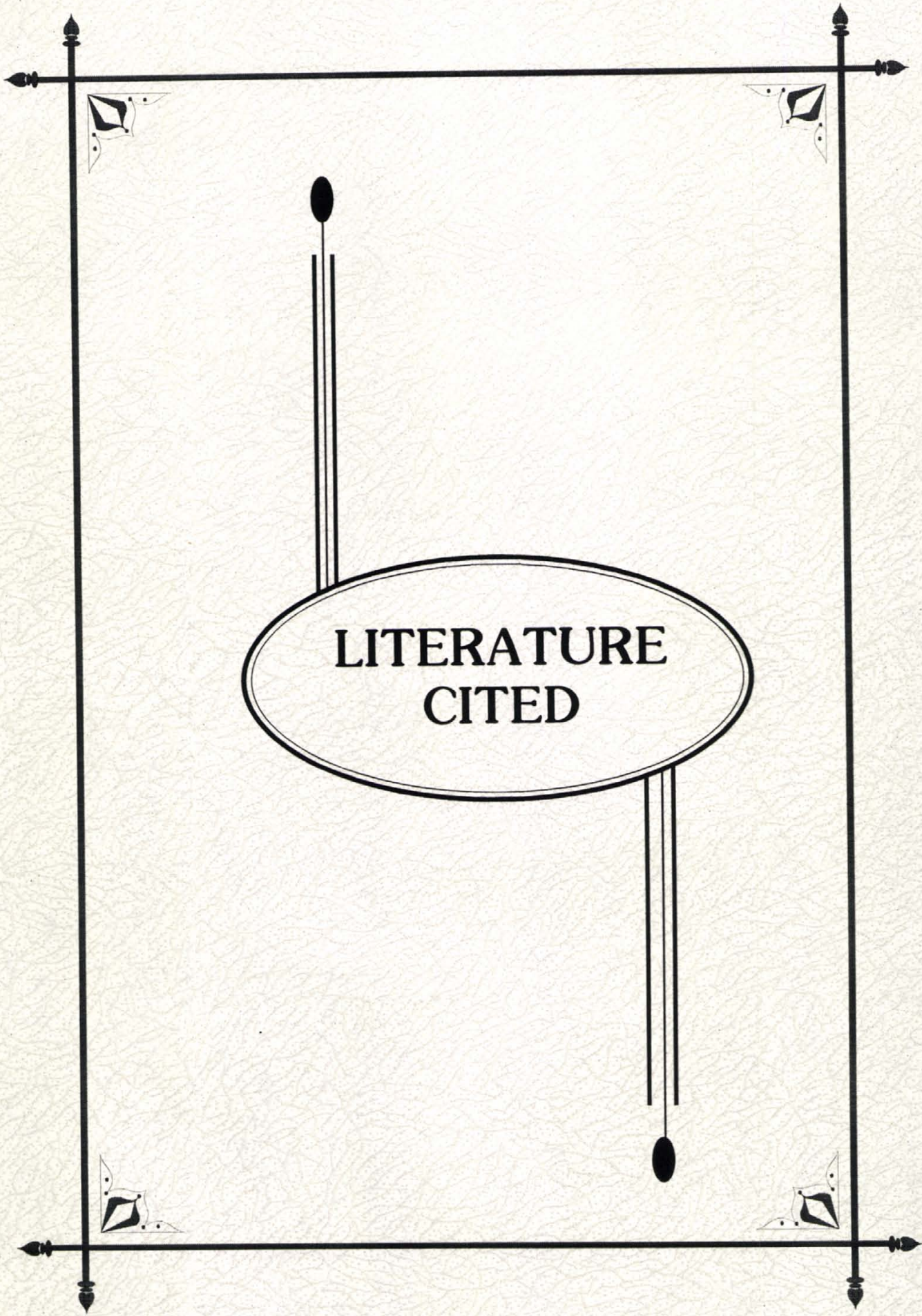
#### **5.1.7 Economic analysis**

The highest and lowest cost of production was observed in  $T_2$  (Rs. 60.91/cow/d) and  $T_3$  (Rs. 58.31/cow/d), respectively. However, the net income from cows for treatment  $T_2$  (diet with 45% UTSCT) was highest as compared to other treatments and all of the urea-treated sugarcane top based diets were higher in net income (Rs 46.80, 49.49, 42.49/cow/d for treatment groups of  $T_1$ ,  $T_2$  and  $T_3$ , respectively) than the control ( $T_0$ ) treatment (Rs 38.20/cow/d). The highest and lowest values of benefit to cost ratio was noticed in  $T_2$  (1.81) and  $T_0$  (1.65), respectively.

## 5.2. Conclusions

- Urea treatment can considerably reduce the oxalate content of sugarcane top. Besides, it resulted significant improvement in proximate nutrients and cell wall constituents of sugarcane top after urea treatment.
- A diet with 45% urea-treated sugarcane tops silage (T<sub>2</sub>) had highest dry matter intake and digestibility coefficient of proximate nutrients and nutritive value as compared to other treatments. The dry matter intake, digestibility coefficients of proximate nutrients tended to decrease with increasing urea-treated sugarcane top silage levels from 45% to 60% in the diet with out significant effect on milk yield and its composition.
- Similarly, higher net income was observed in all urea-treated sugarcane top based diets than the control diet. The diet with 45% urea-treated sugarcane top (T<sub>2</sub>) was the most economically profitable. Based on the above result, it can be concluded that urea-treated sugarcane top silage can be incorporated up to 45% of the roughage requirement in diet of lactating cows for better milk production, feed utilization and profitability with out affecting the milk composition of cow.

Further researches related to feeding of urea-treated sugar cane tops based diets should be conducted at on farm as well as at research station level.



LITERATURE  
CITED

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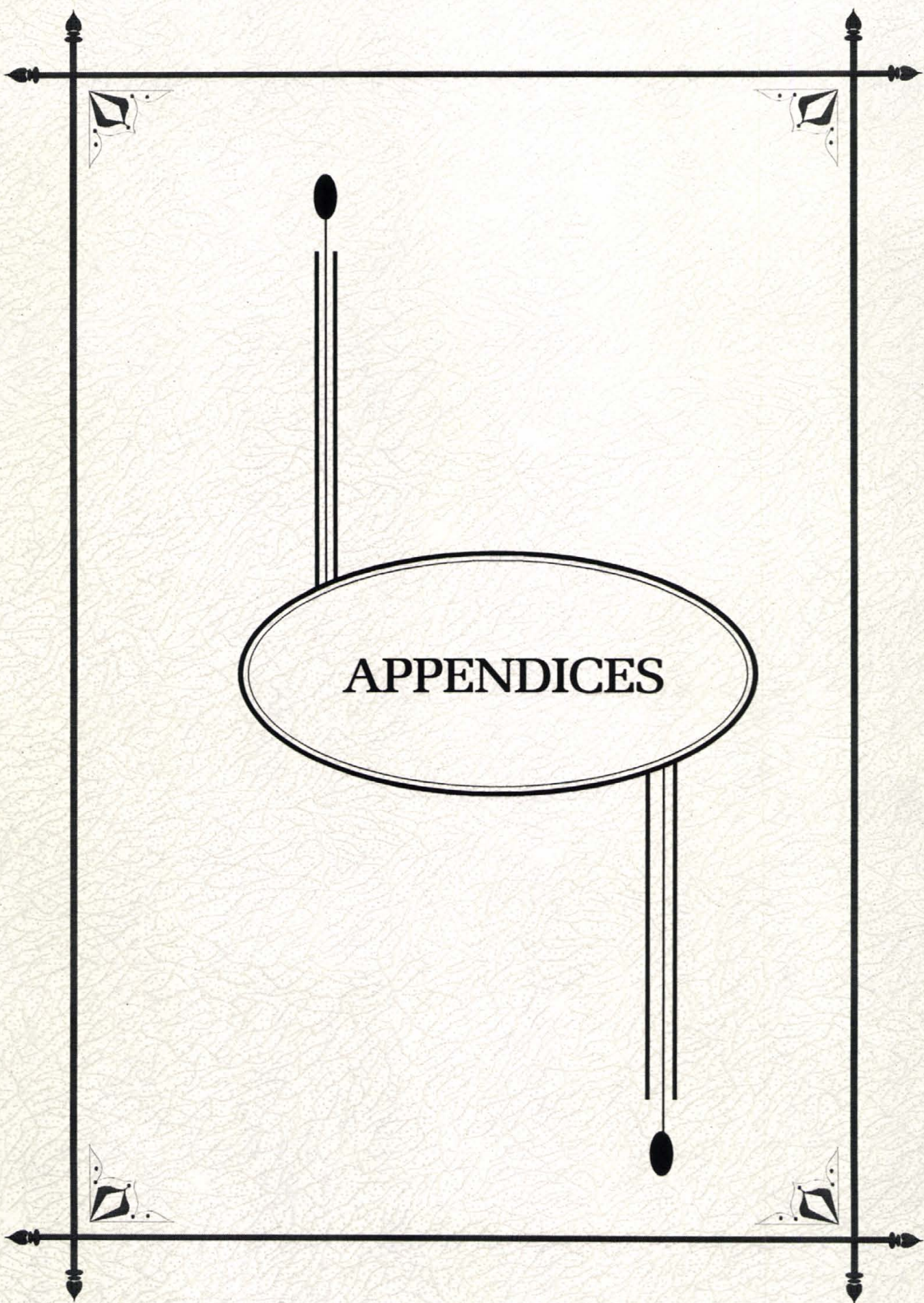
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**APPENDICES**

## 7. APPENDICES

**Appendix I. Offered amount of feed and fodder and consumed per cent of dry matter in the experimental trial**

Offered feed and fodder (kg DM/d)	Treatments			
	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
USCT	2.40	-	-	-
UTSCT	-	2.30	3.60	4.50
Green maize	1.60	1.60	1.20	-
Green lucerne	2.40	2.30	1.60	1.50
Sorghum straw	1.60	1.60	1.70	1.60
Concentrate	4.00	3.90	4.00	3.80
Total DM offered (kg/d)	11.90	11.70	12.00	11.40
Total CP offered (g/d)	1351	1404	1339	1272
Offered CP (%)	11.40	12.00	11.20	11.20
Total CF offered (g/d)	2631.96	2485.68	2632.26	2485.27
Offered CF (%)	22.10	21.20	21.90	21.80
Total EE offered (g/d)	248.56	236.27	238.59	225.16
Offered EE (%)	2.09	2.02	1.99	1.98
Total Ash offered (g/d)	999.68	988.66	1000.78	937.84
Offered Ash (%)	8.40	8.45	8.34	8.23
Total NFE offered (g/d)	6799.76	6592.04	6882.67	6485.49
Offered NFE (%)	57.14	56.34	57.36	56.89
Total DM intake (kg/d)	11.34	11.21	11.35	10.44
Consumed per cent of DM	95.29	95.81	94.58	91.58
Intake of UTSCT (kg/d)	-	2.05	3.10	3.75
Consumed per cent of SCT	-	89.13	86.11	83.33

## Appendix II. Economic analysis of experimental diets

Costs and benefits associated with feeding of different experimental diets on milk yield of cows are presented below.

### A) Costs

#### 1) Feed cost

List of ingredients used in the experiment and their prices

SN	List of ingredients	Price of ingredients/kg (Indian Rs) on as-fed basis
1	Untreated sugarcane top	1.10
2	Urea-treated sugarcane top	1.24
3	Sorghum straw	1.50
4	Green lucerne	1.10
5	Green maize	0.80
6	Concentrate	6.40

Costs incurred for preparation of urea-treated sugarcane top are indicated below.

#### i) Labor cost

For preparation of 15 metric tones of urea-treated sugarcane tops four labors for four days with a payment of Rs. 100/labor/day is required. Four labors \* 4 days \* Rs. 100/d = Rs. 1600

#### ii) For purchasing of untreated sugarcane top

One kg sugarcane top is purchased with a price of Rs. 1.10. The total cost incurred for purchasing of 15,000 kg of sugarcane top is Rs. 16500.

#### iii) For purchasing of urea fertilizer

One kg of urea fertilizer was purchased at a price of Rs 2.50. For preparation of 15,000 kg of urea-treated sugarcane top a total of 190 kg

of urea is required. Total cost expended for purchase of urea fertilizer was about Rs. 475.

Therefore, for preparation of 15,000 kg of urea-treated sugarcane tops a total of 18,575 rupees is required. Based on this computation for the preparation of one kg of urea-treated sugarcane top on as fed basis it costs around Rs. 1.24.

## 2) Labor cost

For feeding and management of 16 lactating cows, two labors per day with a payment of Rs. 50/labor/day is required. A total of Rs. 100/day is required for feeding and management of 16 lactating cows. Therefore, for feeding and management of one lactating cow it requires Rs. 6.25/day.

## B) Benefits

The income is generated from the sale of milk. The official price of milk at RCDP is Rs. 12/litre.

### Calculation for Economic Analysis

#### i) Net Return (NR)

$$NR = \text{Gross Return (GR)} - \text{Total cost (TC)}$$

#### ii) Benefit to cost ratio (BC ratio)

$$BC \text{ ratio} = \frac{\text{Gross return}}{\text{Total cost}} = \frac{GR}{TC}$$

### Appendix III. Nutrient requirement of dairy cattle

Harris (2003a) depicted the NRC (1988) daily maintenance and milk production nutrient requirements for dairy cattle are indicated below in section A and B, respectively.

#### A) Daily nutrient requirements for maintenance of mature lactating cows

S.N	Body weight (lb)	Crude protein (lb)	TDN (lb)
1	1000	0.98	7.58
2	1200	1.18	8.70
3	1400	1.37	9.76

#### B) Milk production – nutrients per pound of milk of different fat percentages

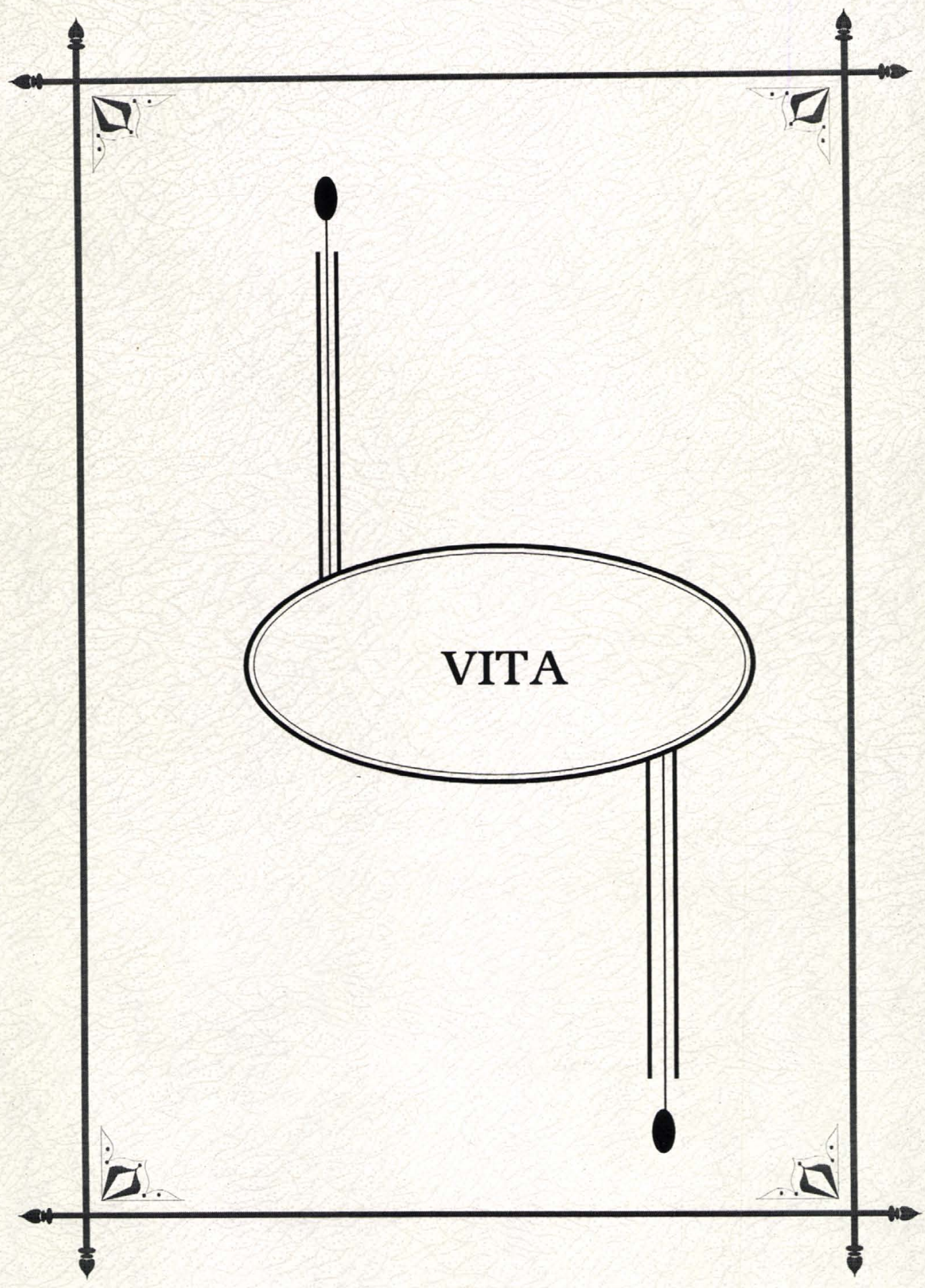
S.N	Fat (%)	Crude protein (lb)	TDN (lb)
1	3.0	0.073	0.280
2	3.5	0.079	0.301
3	4.0	0.086	0.322
4	4.5	0.092	0.343
5	5.0	0.100	0.364
6	5.5	0.105	0.385

- i) Based on the above section A and B , the daily CP and TDN requirement of 400 kg of lactating cow, which provides an average daily milk yield of 9.2 liter and 4% fat is computed as follows:

Purpose	Nutrient requirement (lb/day)	
	CP (lb/day)	TDN( lb/day)
Maintenance	0.98	7.58
Production	1.75	6.55
Total (lb/day)	2.73	14.13
Total (kg/day)	1.24	6.39

**Appendix IV. Average monthly temperature and dry matter intake of cows during the entire experimental period**

S.N	Date	Temperature (°C)		Dry matter intake (kg/day)			
		Max	Min	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
1	Jan 18 – Feb 16, 2007	30.90	12.88	11.11	11.06	11.08	10.23
2	Feb 17 – March 18, 2007	32.95	13.73	11.75	11.36	11.80	10.76
3	March 19 – April 17, 2007	37.63	18.3	11.16	11.22	11.17	10.33



VITA

## 8. VITA

### Alemayehu Tadesse Tassew

A candidate for the degree  
of

Master of Science (Agriculture) in Animal Science

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**Title of thesis** : Effect of feeding urea-treated sugarcane tops on production and composition of milk in 'Phule Triveni' crossbred cattle

**Major Field** : Animal Science

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