

**ASSESSMENT OF MULTI-NUTRIENT BLOCK
SUPPLEMENTATION AND RUBBER MAT ON THE
PRODUCTION PERFORMANCE OF DAIRY
ANIMALS UNDER FIELD CONDITION**



**THESIS SUBMITTED TO THE
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
MASTER OF VETERINARY SCIENCE
IN
LIVESTOCK PRODUCTION MANAGEMENT
BY
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KARNAL -132001 (HARYANA), INDIA**

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IN

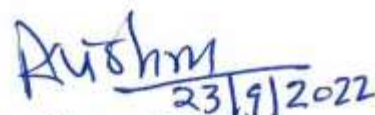
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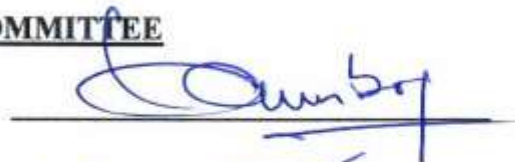


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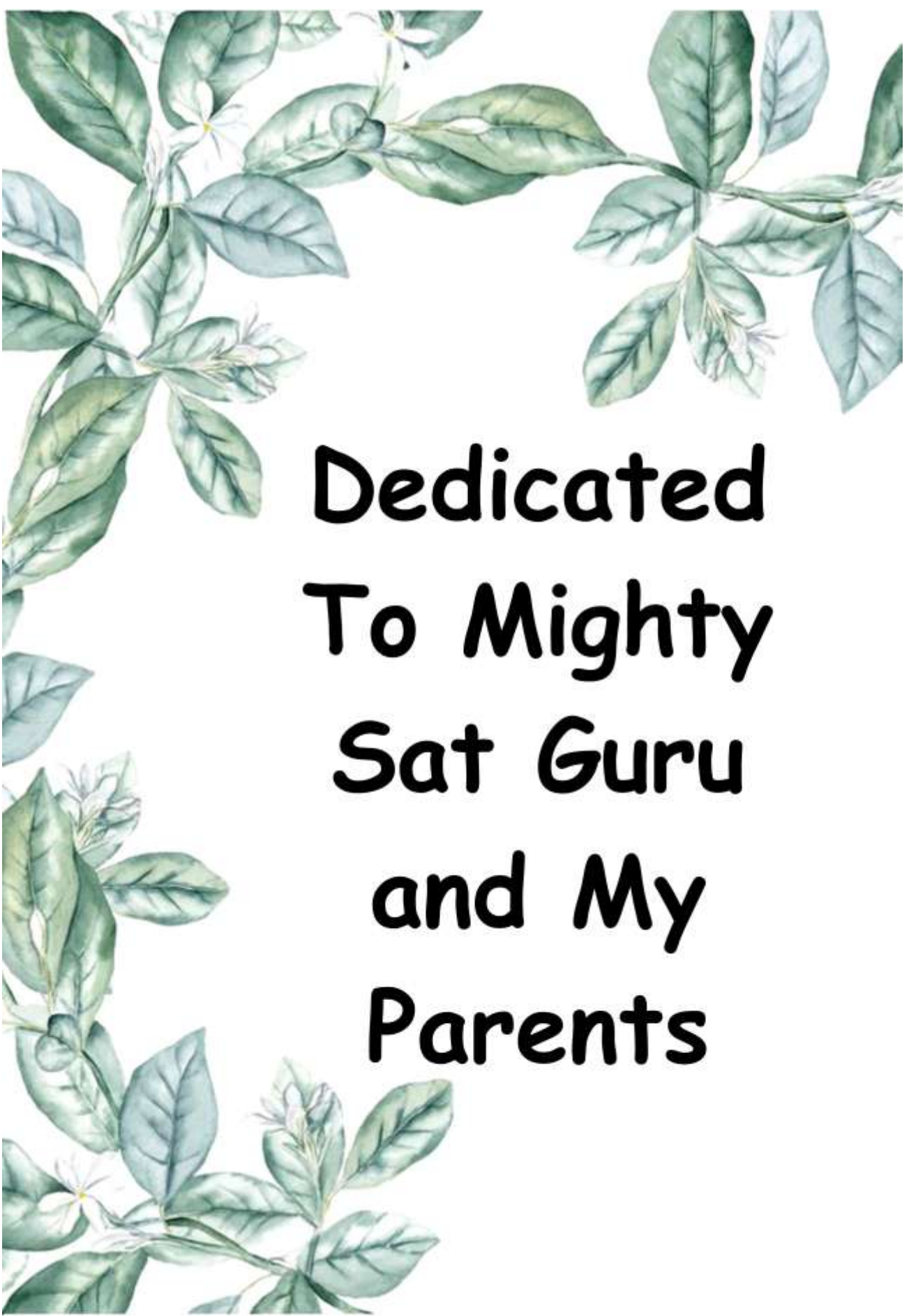
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**Dedicated
To Mighty
Sat Guru
and My
Parents**

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Date:

(Pawan Kumar)

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ABBREVIATION

₹	Rupees
%	Percent
/	Per
@	At the rate
<	Less than
>	More than
A.I.	Artificial Insemination
ADF	Acid Detergent Fibre
AFC	Age at First Calving
B: C	Benefit Cost Ratio (BCR)
BCS	Body Condition Score
CAZRI	Central Arid Zone Research Institute
CCS	Cow Cleanliness Score
CP	Crude Protein
D.f.	Degree of freedom
DM	Dry Matter
E.E.	Ether Extract
e.g.	For example
et al.	Co-worker/ and other
Fig.	Figure
GoI	Government of India
Ha	Hectare
Hb	Haemoglobin
HF	Holstein Frisian
HIS	Hock and Knee Injury Score
i.e.	That is
ICAR	Indian Council of Agriculture Research
IVRI	Indian Veterinary Research Institute
Kg	Kilogram
Kg/h/d	Kilogram per head per day

CMT	California Mastitis Test
ml	Mili liter
MNB	Multi Nutrient Block
Mm	Mili meter
mg/dl	Milligram per deciliter
NDF	Neutral Detergent Fibre
NDRI	National Dairy Research Institute
No	Number
OM	Organic Matter
$P < 0.01$	1% Level of significance
$P < 0.05$	5% Level of significance
PCV	Packed Cell Volume
°C	Degree Centigrade
SAU	Standard Animal Units
SCC	Somatic Cell Count
SE	Standard Error
SLST	Sodium Lauryl Sulphate
SNF	Solid Not Fat
SPC	Service Per Conception
SPSS	Statistical Package Software System
TA	Total Ash
TLC	Total Leukocyte Count
Viz.	Namely
UMMB	Urea Molasses Mineral Block
USD	USA Dollar
Vs.	Versus

ABSTRACT

The present study was carried out in Yamunanagar district of Haryana and Sirmaur district of Himachal Pradesh to assess the effect of multi-nutrient block (MNB) supplementation and rubber mat bedding on the milk production, milk quality, reproduction, health and welfare of dairy animals. Thirty eight lactating crossbred cattle and 38 lactating buffaloes were selected for first objective (12 from Pinjori, 12 from Malimajra and 14 from Patlioni) whereas, for second objective, 24 crossbred cattle and 24 buffaloes (12 from Pinjori and 12 from Malimajra) were selected. The animals were divided into two groups as: control (T_0) and treatment (T_1) based on milk yield, body weight and parity of animals. In study area, majority of dairy farmers were marginal and small farmers with less than two hectares of land. The average herd size was in the range of 4 to 6.8. Result shows that MNB supplementation to post-partum dairy animals significantly ($P<0.05$) increased dry matter intake (T_0 : 12.46 ± 0.03 ; T_1 : 12.73 ± 0.04 kg/h/d), average daily milk yield (T_0 : 11.13 ± 1.35 ; T_1 : 12.47 ± 1.89 kg/h/d), fat percent (T_0 : 4.12 ± 0.14 ; T_1 : 4.31 ± 0.14) and SNF percent (T_0 : 8.60 ± 0.03 ; T_1 : 8.70 ± 0.02) in crossbred cattle, whereas, milk yield (T_0 : 9.67 ± 1.19 ; T_1 : 10.81 ± 0.99 kg/h/d) and fat percent (T_0 : 7.49 ± 0.05 ; T_1 : 7.59 ± 0.09) in buffaloes in the study area. Supplementation of MNB was significantly ($P<0.05$) reduce the days of first post partum estrus (T_0 : 94.76 ± 1.46 ; T_1 : 74.22 ± 3.62 days), service period (T_0 : 128.37 ± 2.16 ; T_1 : 103.85 ± 6.05 days), and number of service per successful conception (T_0 : 2.24 ± 0.06 ; T_1 : 1.35 ± 0.07) in crossbred cattle. Significant ($P<0.05$) reduction in service period (T_0 : 150.20 ± 9.31 ; T_1 : 115.83 ± 7.34 days) and number of service per successful conception (T_0 : 2.42 ± 0.08 ; T_1 : 1.58 ± 0.09) was recorded in buffaloes. The MNB supplementation significantly ($P<0.05$) increased blood urea (mg/dl) in crossbred cattle (T_0 : 10.86 ± 0.06 ; T_1 : 12.82 ± 0.03) and buffaloes (T_0 : 10.93 ± 0.34 ; T_1 : 13.21 ± 0.18). Non-significant ($P>0.05$) effect of MNB on reducing subclinical mastitis incidences (CMT and somatic cell count), body weight (kg), average DMI (percent body weight and total DMI) and hematological parameters were observed in crossbred cattle and buffaloes. Significant ($P<0.05$) increase in cow cleanliness score was observed due to rubber mat bedding in crossbred cattle (T_0 : 2.54 ± 0.01 ; T_1 : 3.22 ± 0.042) and buffaloes (T_0 : 2.59 ± 0.02 ; T_1 : 3.14 ± 0.01). Rubber mat bedding also significantly reduces the incidence of hock and knee injury in treatment group of crossbred cattle (T_0 : 2.19 ± 0.16 ; T_1 : 1.52 ± 0.06) and buffaloes (T_0 : 2.13 ± 0.09 ; T_1 : 1.50 ± 0.03). Similarly less subclinical mastitis incidences were recorded in treatment group of crossbred cattle and buffaloes as compared to control group. Rubber mat bedding had non-significant ($P>0.05$) effect on milk yield, milk fat, SNF, milk protein, body weight, BCS, reproductive performance and hematological parameters of crossbred cattle and buffaloes. It can be conclude that MNB supplementation improved the productive and reproductive performance of dairy animals and rubber mat bedding had improved the quality of milk and welfare of dairy animals.

सारांश

वर्तमान अध्ययन हरियाणा के यमुनानगर जिले एवं हिमाचल के सिरमोर जिले में मल्टी न्यूट्रियन्ट ब्लाक (MNB) एवं रबर मेट का दूध उत्पादन, दूध गुणवत्ता, पशुओं में प्रजनन, स्वास्थ्य, तथा पशु कल्याण पर प्रभाव ज्ञात करने के लिये किया गया। अध्ययन के प्रथम उद्देश्य (मल्टी न्यूट्रियन्ट ब्लाक) के लिए 38 संकर नस्ल की गायों एवं 38 भैंसों का चयन (12 पशु पिंजोरी से 12 पशु मालिमाजंरा से एवं 14 पशु पातलिया से) किया गया। जबकि द्वितीय उद्देश्य के लिये, 24 संकर नस्ल की गायों एवं 24 भैंसों का चयन (12 पशु पिंजोरी से 12 पशु मालिमाजंरा से) किया गया। प्रत्येक समूह को दूध उत्पादन, पशु का भार एवं ब्यात संख्या के आधार पर नियंत्रण (T_0) एवं उपचार (T_1) समूहों में विभक्त किया गया। अध्ययन के लिये चयनित किये गये सभी पशुपालक 4–6.8 हेक्टेर जमीन के साथ सीमांत एवं छोटे किसान थे। अध्ययन के परिणाम के आधार पर MNB संकर नस्ल की गायों में दैनिक शुष्क पदार्थ (T_0 : 11.13 ± 1.35 ; T_1 : 12.47 ± 1.89) (किलोग्राम/पशु/दिन), दूध उत्पादन (T_0 : 12.46 ± 0.03 ; T_1 : 12.73 ± 0.04) (किलोग्राम/पशु/दिन), दूध वसा प्रतिशत (T_0 : 4.12 ± 0.14 ; T_1 : 4.31 ± 0.14) तथा दूध SNF प्रतिशत (T_0 : 9.12 ± 0.02 ; T_1 : 9.20 ± 0.03) में वृद्धि देखी गयी। वही भैंसों में MNB के अनुपूरण से दूध उत्पादन (किलोग्राम/पशु/दिन) (T_0 : 9.67 ± 1.10 ; T_1 : 10.81 ± 0.94) एवं दूध वसा प्रतिशत (T_0 : 7.49 ± 0.05 ; T_1 : 7.59 ± 0.09) में वृद्धि, देखी गयी। संकर नस्ल की गायों को MNB के अनुपूरण से महत्वपूर्ण रूप से ब्यात के बाद प्रथम बार गर्मी में आने दिनों की संख्या (T_0 : 94.76 ± 1.46 ; T_1 : 74.22 ± 3.62) (दिन), सर्विस अवधि (T_0 : 128.37 ± 2.16 ; T_1 : 103.85 ± 6.05) (दिन) एवं प्रति गर्भधान सर्विस संख्या (T_0 : 128.37 ± 2.16 ; T_1 : 103.85 ± 6.05) में कमी देखी गयी। वही संकर भैंसों में MNB के अनुपूरण से सर्विस अवधि (T_0 : 150.20 ± 9.31 ; T_1 : 115.83 ± 7.34) (दिन) एवं प्रति गर्भधान सर्विस संख्या (T_0 : 2.42 ± 0.08 ; T_1 : 1.58 ± 0.09) में कमी देखी गयी। MNB के अनुपूरण से संकर नस्ल की गायों (T_0 : 10.86 ± 0.06 ; T_1 : 12.82 ± 0.03) (mg/dl) एवं भैंसों (T_0 : 10.93 ± 0.34 ; T_1 : 13.21 ± 0.18) (mg/dl) के खून में यूरिया (mg/dl) की मात्रा में वृद्धि देखी गयी। जबकि पशु का भार, उपनैदानिक थनैला तथा रुधिर मापदंडों पर कोई प्रभाव नहीं देखा गया। रबर मेट के प्रतिस्थापन से संकर नस्ल की गायों (T_0 : 2.54 ± 0.01 ; T_1 : 3.22 ± 0.042) एवं भैंसों (T_0 : 2.59 ± 0.02 ; T_1 : 3.14 ± 0.01) के गाय स्वच्छता अंक में वृद्धि, देखी गयी तथा संकर नस्ल की गायों (T_0 : 2.19 ± 0.16 ; T_1 : 1.52 ± 0.06) एवं भैंसों T_0 : 2.13 ± 0.09 ; T_1 : 1.50 ± 0.03) में हॉक एवं घुटना चोट में कमी दर्ज की गयी। साथ ही संकर नस्ल की गायों एवं भैंसों में उपनैदानिक थनैला (कायिक कोशिका संख्या एवं कोलिफोर्निया थनैला परिक्षण) में भी कमी देखी गयी। वही संकर नस्ल की गायों एवं भैंसों में रबर मेट के प्रतिस्थापन से दूध उत्पादन (किलोग्राम/पशु/दिन), दूध वसा प्रतिशत, दूध SNF प्रतिशत, दूध प्रोटीन प्रतिशत, प्रजनन एवं रुधिर मापदंडों पर कोई प्रभाव नहीं देखा गया। अतः MNB के अनुपूरण से संकर नस्ल की गायों एवं भैंसों के दूध उत्पादन एवं प्रजनन प्रदर्शन में सुधार देखा गया। वही रबर मेट के प्रतिस्थापन से संकर नस्ल की गायों एवं भैंसों के दूध गुणवत्ता, स्वास्थ्य, तथा पशु कल्याण पर सकारात्मक प्रभाव देखे गये।

CHAPTER –1

Introduction

INTRODUCTION

Dairy sector plays an important role in the national economy of India. Rearing of dairy animal is one of the most important livelihood activities in the rural areas, providing supplementary income to most of the families dependent on agriculture. Dairy animals are regular source of cash income and livelihood security under small holder production system (Misra *et al.*, 2006). In addition, this sector contributes in the reduction of rural poverty, inequality, and helps in the provision of nutrition to disadvantaged rural household. Dairying is the single largest agricultural commodity contributing 5 per cent of the country's economy. Dairy sector employs more than 8 crore farmers directly. It has been a consistent source of income, and contributing 15 per cent of average monthly income of agriculture households (GoI, 2022).

Small and marginal farmers together own about 8 per cent of livestock population, and they contribute approximately 80 per cent to the milk production in India (GoI, 2019). India ranks first in milk production i.e. 209.96 million tonnes in 2020-21 from 146.31 million tonnes in 2014-15 with annual growth of milk is 5.81 per cent. The per capita availability of milk is around 427 gram/day (2021-22) that is more than the world average of 321 grams per day in 2020 (DAHD, GoI, 2021-22; FAO, Food Outlook 2021).

The average cattle productivity in India is 1777 kg per animal per year during 2019-20 as compared to world average of 2966 kg per animal per year during 2019 (FAO, 2021). The major reason for low productivity is poor nutrition and management, as majority of dairy animals are maintained on low quality cereal crop residues such as wheat straw, stovers and dry grasses (Misra *et al.*, 2010). These feeds are deficient in crude protein, minerals, vitamins, whereas, high in crude fibre and lignin characteristics that restrict intake and digestibility and are insufficient to support satisfactory milk production (Duncan *et al.*, 2013). Feeding of low quality fodder often results in low milk yield, short lactation period (6-8 months) and long calving interval. Imbalanced feeding adversely impacts productivity, health and welfare of dairy animals, as well as the quality and safety of animal products (Choudhary *et al.*, 2018). Therefore, the increase in production needs to be achieved through adoption of efficient and sustainable farming practices (Anderson *et al.*, 2016).

Livestock rearing in Himachal Pradesh and Haryana state is an important aspect of the state economy and regular source of income for the majority of the population. According to livestock census 2019, the total livestock population the Haryana was 71.12 lacs, with a decrease of 20.96 per cent from previous livestock census, 2012. However, total cattle population has increased by 5.93 per cent in rural areas and by 12.44 per cent in urban areas. The total buffalo population in rural areas has decreased by 27.80 per cent and in urban area, the decrease was 27.42 per cent (DAHD, Livestock Census, 2019). The total livestock population of Himachal Pradesh was 44.13 lacs, with decrease of 8.91 per cent from previous livestock census, 2012 (GoI, 2019). The total number of cattle in the Himachal Pradesh was 18.28 lacs with decrease of 14.95 per cent over previous livestock census, 2012. (DAHD, GoI, 2021-22).

Strategic supplementation of critical nutrients can improve the utilization of poor-quality roughages. The use of urea molasses mineral blocks (UMMB) for supplementing crop residues based diet of livestock has been well documented in ruminants (Garg *et al.*, 1998; Singh and Singh 2003; Misra and Bipate, 2020) and has potential to improve the general, productive and reproductive performance of animals and to overcome the detrimental effect of deficiencies on animal performance (Singh and Singh 2003; Misra *et al.*, 2006) to enhance milk supplies and increase household income (Singh and Singh, 2003; Misra, 2017; Sankar *et al.*, 2020). UMMB can be fed throughout the year but are more beneficially utilized during dry season or when the animals are maintained on grazing and low quality fodders (Misra *et al.*, 2006).

A series of on-station trials have been conducted in India on the animal response and economic benefits of using UMMB (Misra and Reddy 2004; Misra *et al.*, 2010). Results suggested that about 30 to 40 per cent concentrate allowance could be reduced by feeding UMMB without any loss of animal production (Singh and Singh 2003; Misra and Reddy 2004). However, most of the past work has been done at research stations under controlled conditions and very few attempts have been made to evaluate the response of UMMB supplementation in lactating dairy animals under field conditions of smallholder production system in the country.

Along with the production prospective, livestock welfare is another important aspect, not only for livestock comfort, but also because it directly or indirectly influences livestock production. In recent years, there has been a greater focus on the welfare of dairy cattle than ever before. Animal welfare is defined as an animal's ability to cope

with its physiochemical and social surroundings physically, behaviorally, cognitively, and emotionally, as well as the animal's subjective view of their situation. (Fraser and Duncan, 1998; Scott *et al.*, 2001). According to OIE (World Organization for Animal Health) animal welfare means how an animal is coping with the condition in which it lives. The good state of an animal's welfare is defined as healthy, comfortable, and well nourished, safe, able to express its innate behaviour, and not suffering from unpleasant states such as pain, fear, and distress.

According to farm animals' welfare council (FAWC) (1993) the freedom's that are required to ensure that animals are in good welfare includes: (i) Freedom from thirst and hunger – by having easy access to fresh water and a diet that promotes complete health and vigour, (ii) Freedom from discomfort – by providing a suitable atmosphere including shelter and a comfortable place to rest, (iii) Freedom from pain, injury, and disease – through means of prevention or early diagnosis and treatment, (iv) Freedom to express normal behaviour – by providing sufficient space, proper facilities and company of the animals of own kind and (v) Freedom from fear and distress – by ensuring that the conditions and treatment are such that mental suffering is avoided.

According to Fraser (2003) for a dairy farmer to be successful at producing quality milk, the welfare needs of dairy animals must be considered in their planning. In present time where dairy welfare has become part of milk quality, its monitoring is an additional guarantee for the consumers that the products they buy, are derived from healthy animals, breeds and kept according to good farming practices at farms (Hristov *et al.*, 2012). The welfare- productivity model shows that beyond a point, higher welfare standards involve some sacrifices in livestock productivity and hence an economic cost (McInerney, 2004)

Poorly built stalls and bedding facilities increase the risk of low productivity, reproduction, and lameness in dairy animals. Flooring of animal shelter is an important component affecting production, reproduction and welfare of animal (Madke *et al.*, 2010; Shrivastava *et al.*, 2020). Concrete flooring is popular amongst dairy farmers in India due to their durability and convenience in cleaning (Sadharakiya *et al.*, 2019), however, due to hard and solid consistency it cannot provide comfort required for standing, walking and lying (Phillips and Morris, 2001). Cows prefer softer bedding materials for lying and they spent longer time in lying down on soft surface as compared to hard surface (Tucker and Weary, 2004; Shrivastava *et al.*, 2020). The incidences of

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subclinical mastitis are reported about 10-50 in dairy cows with reduction of about 70 per cent in milk yield during mastitis (Sharma *et al.*, 2012). The application of rubber mat flooring may reduce the chances of mastitis as well as stress level (Shrivastava *et al.*, 2020).

Though the importance of demonstrating the benefits of dairy production technologies under farm conditions has been stressed in almost all the meetings/conferences/seminar, yet the numbers of studies reporting on-farm research and development are very few. Therefore, the present study was conducted to assess the effect of multi-nutrient block (MNB) supplementation and use of rubber mat on productive and reproductive performance of cattle and buffaloes at farmer's field in Yamunanagar and Sirmaur districts with the following objectives:

1. To assess the effect of multi-nutrient block supplementation on productive and reproductive performance of dairy animals.
2. To evaluate the effect of rubber mat bedding on production and welfare of dairy animals in the study.

CHAPTER -2

Review of Literature

REVIEW OF LITERATURE

The aim of the present research work was to assess the supplementation of multi-nutrient block on productivity of animals and effect of rubber mat flooring on productivity and welfare of lactating cattle and buffaloes at farmer's field in Yamunanagar (Haryana) and Sirmour (Himachal Pradesh). The literatures available on supplementation of multi-nutrient blocks and use of rubber mat as bedding on the productive and reproductive performance of dairy animals are reviewed and presented in this chapter under following heads:

2.1 Definition of rural dairy farm

In Indian scenario the small holder production system is an important component of agriculture and is well integrated with crop production. It is considered as an instrument to socio-economic change to improved income and quality of life with equity (Rangnekar, 2006; Misra *et al.*, 2010).

Indian dairy sector comprises of millions of small and marginal farmer who own two to three animals and produce an average of five litre of milk per day which is far below as compared to the productivity level of dairy animals in developed nations (Mooventhana *et al.*, 2016; Misra and Singh, 2019). The majority of small and marginal farmers follow extensive grazing and low input cost based feed supplement (Misra and Bipate, 2020).

The price of the milk is based on two factors; one whether it is cow milk or buffalo milk, and the second determining factor is the fat and SNF (solid non-fat) per cent in milk. In the study area (Himachal Pradesh and Haryana), milk price is determined by fat per cent especially sale in local dairy, and sale at local market or public is based on the cow buffalo milk. The farmer sells buffalo milk generally at a higher price than the cow's milk in the local market, while SNF per cent does not have price determining factor.

2.2 Dairy farming practices

Agriculture is primary income source for farmer's livelihood security. Singh and Vaidya (2002) found that the most favourable scenario for farmers was the direct sale of milk to consumers at the Sirmour district. Marketing through traders is an alternative in

study area, but overall milk production and sales are lower. Chakravarty *et al.* (2021) conducted study in Karnal, Yamunanagar and Sirsa districts of Haryana and reported that the most of the dairy farmers were middle income earners (43.33 per cent).

2.2.1 Feeding practices

Biradar *et al.* (2010) conducted study in Karnataka and reported that crop residues such as sorghum stover, wheat straw and hay were the primary source of roughage for large ruminants. The horse gram, red gram, and green gram were used as concentrate and mixed with powdered paddy husk/hull. After soaking for 6 to 8 hours, all of these grains were administered to animals as powders. Maradal *et al.* (2004) conducted study in Faridabad district of Haryana and found that wheat straw was the most prevalent dry fodder, followed by sorghum stover, whereas berseem was the main green fodder for dairy animals.

Kumar *et al.* (2005) observed that 50-73 percent of dairy animals were fed dry fodder, 22-30 per cent green fodder and 4-25 per cent concentrate feed. Malik *et al.* (2005) conducted study in Uttar Pradesh and reported that crossbred cows were always stall-fed with a dry fodder, green fodder and concentrate feed, even though they were typically let out for grazing.

Kumar *et al.* (2006) reported that majority of dairy farmers in Punjab were offered concentrate to lactating Sahiwal cattle during milking time. About 57.14 per cent of farmers fed 1-2 kg of concentrate to lactating animals and did not practice any special feeding during the advanced stages of pregnancy. Singh *et al.* (2007) conducted study in Tonk and Jhunjhunu district of Rajasthan and reported 65.50 per cent of the respondent fed concentrate mixture only to milch animals.

Gupta and Mann (2011) conducted study in Rajasthan on lactating animals and reported that animals were fed concentration, mineral mixture, and common salt on individual basis and 43 per cent farmers were supplemented the feed with concentrate during late pregnancy. Sinha *et al.* (2009) conducted study in Bareilly district of Uttar Pradesh and reported that 97.8 per cent of farmers in the urban region fed concentrate feed round the year, however, only 66.7 and 75.6 per cent of farmers in rural and semi-urban areas did the same. Sabapara *et al.* (2010) reported that only 30.5 per cent of farmers in tribal area of south Gujarat fed mineral supplements to their dairy cows and 91 per cent of farmers fed concentrate to the animals after milking. About 75 per cent

farmers of study area grew fodder crops as green fodder resources while none of the farmers practiced silage making.

Rathore *et al.* (2010) conducted a study in the Churu district of Rajasthan and found that 60.50 per cent of farmers were offered homemade concentrate mixture with water soaking. The 68.75 per cent of farmers practice stall feeding and 62.25 per cent grazing in harvested fields. Manohar (2012) reported that 71.87 per cent farmers practiced stall feeding and 87.50 per cent farmers grew green fodder on own field to feed their animals in Jaipur district of Rajasthan. Tanwar (2012) reported that 65 dairy co-operative members in Jaipur district of Rajasthan were adopted concentrate feeding to dairy animals before soaking whereas, 61.67 per cent non dairy co-operative member practiced soaking of concentrate before feeding.

Jadav *et al.* (2014) reported that 64 per cent respondents provided mineral mixture to dairy animals in peri-urban area of Surat district of Gujarat. Rathod *et al.* (2014) observed that 46.5 per cent of dairy farmers in Bidar district of Karnataka adopted balanced feeding. Patil *et al.* (2014) reported that 20.5 per cent of dairy farmers were offer a balanced ration at regular intervals, 4 per cent of dairy farmers offer mineral mixture and 22.5 per cent of dairy farmers practiced 1 to 1.5 kg concentrate mixture feeding to pregnant buffalo in Ramtek Tehsil of Nagpur. Prajapati (2015) studied housing and feeding management of dairy production in Navsari district of Gujarat and reported that 58 per cent of respondent followed stall feeding and 43 farmers offered concentrate feed after milking.

Malsawmdawngliana and Rahman (2016) conducted study in Aizawl and Kolasib district of Mizorum and reported that 95 per cent of farmers practiced green fodder with concentrate feed and remaining 5 per cent farmers offered concentrate, green and dry fodder to their dairy animals. Fifty three per cent farmers fed 3-5 kg and 45 per cent farmers were offered 2-3 kg concentrate per day to dairy animals. Eighty two per cent of dairy farmers offered three times feed in a day to dairy animals.

Chaudhary *et al.* (2016) conducted study at Patan district of Guajrat and reported that 37.50 per cent farmers fed dried fodder and hay as alternate feed to dairy animals. All most all farmers were feed concentrates after soaking along with mineral mixture and chaffed fodder. Another study conducted in Surat district of Gujarat by Savale *et al.* (2017) observed that 84 per cent farmers fed concentrate on the basis of milk production.

All farmers of study area fed green roughage and only 4 per cent of farmers fed homemade concentrate to dairy animals.

Sahu *et al.* (2018) conducted study in Vidarbha region of Maharashtra and found that 46.43 per cent farmers grew green fodder regular and 32.14 per cent rarely grew green fodder for their dairy animals. Twelve per cent of dairy farmers regularly fed concentration mixture based on milk production, 24.29 per cent of dairy farmers sometime fed concentrate and 63.57 per cent farmers never followed any practice. Singh *et al.* (2018) conducted study in Haryana and reported that 70.83 per cent dairy farmers offered green fodder to dairy animals and 70 per cent dairy farmers fed concentrate mixture to dairy animals on the basis of milk production, whereas, in case of advanced pregnant animals, only 43.33 per cent livestock owners fed extra concentrate.

Divekar and Trivedi (2020) conducted study in Kheda district of Gujarat and reported that 86, 85 and 65 per cent farmers offered green fodder, mineral mixture and chaffed fodder to dairy animals, respectively. Seventy five per cent farmers fed balanced concentrate mixture on the basis of milk production, whereas, 74 per cent farmers follow pregnancy allowance to advance pregnant animals. Kumar *et al.* (2020) found that 18 per cent of dairy farmers fed mineral mixture to dairy animal in the Saharanpur area of Western Uttar Pradesh.

2.2.2 Housing management practices

Studies conducted by various researchers showed that better housing facilitates helps dairy animals to exhibit their in normal behavior, improved production performance and avoid stress (Brade, 2001; Sinha *et al.*, 2017; Sahu *et al.*, 2018)

Bhakat and Nagpaul (2005) reported that thatched roof with raised- slotted floor was suited for growth, production and higher economic returns from the dairy animals. Kumar *et al.* (2006) conducted study in Punjab and observed that majority of dairy farmers had loose house with Kaccha floor. About 15 per cent animals shed had drainage facilities or pit and 28.57 per cent had slope in shed floor.

Meena *et al.* (2008) reported that 86.66 per cent sheds had kaccha type, 91.66 per cent farmers had tree leaves bedding in winter and 15 per cent farmers had proper space for their animals. Ventilation, light, drainage facilities and fumigation of shed had 10.33, 18.33, 3 and 38.33 per cent, respectively. Ninety one per cent farmer's clean dung weekly and 93.33 per cent practiced group feeding.

Sinha *et al.* (2009) conducted study in Bareilly district of Uttar Pradesh and reported that 63.30 per cent of the rural farmers had animal shed within or near the residence while in semi-urban areas it was higher (83.3 per cent). In rural, semi-urban and urban areas, brick floor was 85.6, 72.2 and 80 per cent animals shed, respectively, and height of the houses were optimum in 75, 65 and 90 per cent of the animals shed in rural, semi-urban and urban areas, respectively.

Tiwari *et al.* (2009) conducted study in commercial dairy farms of Uttar Pradesh and observed that 49.35 per cent animals shed were closed design with open from one side and only 9 per cent shed were closed from all sides with one door without any ventilation facilities. Rathore *et al.* (2010) observed that all animals shed had kaccha floor in shed and 70.50 per cent thatched and 45.50 per cent single slope roof. Fifty eight per cent dairy animals shed had near dwelling in Churu district of Rajasthan.

Sabapara *et al.* (2010) conducted study in tribal area of South Gujarat and reported that 98 per cent of animals house were close type, 87 per cent animals house had Kaccha floor and 94 per cent had earthen plates with thatched roof. Eighty five per cent of the houses had wooden poles to support roof and only 6 per cent of animal shed had drainage facility. Prajapati (2015) conducted study in Navsari district of South Gujarat and reported that about 72.33 per cent respondents had manger in animal house and 23 per cent respondent had wooden manger.

Malsawmdawnglian and Rahman (2016) conducted study in Aizawl and Kolasib district of Mizoram and observed that 94 per cent of cattle barn roof had tin, 97 per cent cattle barn had bamboo side walls and 78 per cent had wooden slated floor in their cattle barn. All the farmers used aluminum vessel for feeding of concentrate feeds in study area of Mizoram. Singh *et al.* (2017) conducted study in the coastal area of south Gujarat and reported that majority of animals shed were constructed with locally available materials and floor had mud or non-concrete. Savale *et al.* (2017) observed that 78 per cent of sheds had pacca or concrete floor and 18 per cent had mud floor.

Tewari *et al.* (2018) conducted study in Tarai region of Uttarakhand and observed that 91 per cent of respondent practiced group feeding. 79.50 per cent had kuccha, 20.50 per cent kuccha followed by pacca, 41.50 per cent kuccha followed by pacca flooring, 35.50 per cent bricks and 24 per cent had cement or concrete flooring. Twenty six per cent had asbestos sheet, 25.50 per cent thatched, 25.50 per cent galvanized iron (G.I.)

sheets and remaining 23 per cent had cemented roof and 89.50 had shade from trees for their animals.

2.3 Effect of multi-nutrient block supplementation on dry matter intake

Sharma and Singh (2014) reported significant ($p < 0.05$) improvement of dry matter intake due to UMMB supplementation in dairy animals in Kapurthala district of Punjab. Similar results were found by Lawania *et al.* (2017), Mishra *et al.* (2006), Akter *et al.* (2004) and Choubey *et al.* (2015) in dairy animal. Choudhary *et al.* (2018) reported significant ($p < 0.05$) increase in feed intake due to UMMB supplementation to crossbred cattle and buffaloes in Bhadohi district of Utter Pradesh.

Kour *et al.* (2022) reported significantly ($p < 0.05$) higher average dry matter intake (kg/animal/day) due to UMMB supplementation in treatment group (15.69 ± 0.03) of buffaloes as compared to control group (15.60 ± 0.05).

2.4 Effect of multi-nutrient block supplementation on milk yield

Patidar *et al.* (2014) conducted a series of feeding trails to assess the response of multi-nutrient block (MNB) supplementation on milk production of dairy animals (cattle and buffaloes) maintained under smallholder mixed farming system in Nagaur district of Rajasthan. They reported that supplementation of MNB increased milk yield by 11.45 per cent in cows and 6.30 per cent in buffaloes.

Sharma and Singh (2014) conducted an experiment on dairy cow to assess the effect of urea molasses mineral block at Kapurthala district of Punjab. They observed significant ($p < 0.05$) increase (44 per cent) in milk yield of cattle due to supplementation of UMMB. Tripathi *et al.* (2006) observed significant ($p < 0.05$) improvement in milk yield of cow (3.58 per cent) and buffaloes (35.18 per cent) due to UMMB supplementation in Bilaspur district of Himachal Pradesh. Whereas, Sihag *et al.* (2007) replaced the concentrate mixture with UMMB on milk yield of Murrah buffaloes and recorded non-significant differences in milk yield.

Verma *et al.* (2009) reported significantly ($p < 0.01$) higher milk production, total serum protein and serum calcium level in buffaloes due to Multi-nutrient supplementation in Ranchi district of Jharkhand. Patil *et al.* (2019) reported that the dietary multi-nutrient supplementation to dairy animals (cows and buffaloes) significantly ($p < 0.05$) improved the milk yield by 18 and 16 per cent in MMS-1 and MMS-2, respectively at IVRI, Izatnagar.

Singh *et al.* (2010) assessed the response of supplementation of UMMB on buffaloes in Rajouri district of Jammu and reported significantly ($p<0.05$) increase (51.70 per cent) in milk yield due to supplementation. Misra *et al.* (2006) reported significant ($p<0.05$) increase in milk yield in crossbred cattle due to UMMB supplementation in Andhra Pradesh.

Misra and Bipate (2020) reported significantly ($p<0.05$) increase in milk production from dairy cattle (10.00 ± 0.33 vs 7.93 ± 0.16 l/h/d) due to UMMB supplementation in Muzaffarnagar district of Uttar Pradesh. Lawania *et al.* (2017) reported significantly ($p<0.05$) increased milk yield (27.65 per cent) of UMMB supplemented group of zebu cattle in Jalore district of Rajasthan. Regar *et al.* (2020) observed significantly higher ($P < 0.05$) milk yield in lactating crossbred cattle due to UMMB supplementation.

Tanwar *et al.* (2013) conducted an experiment on 60 lactating buffaloes to assess the effect of UMMB under field conditions in Jaipur district of Rajasthan, and observed that the overall milk yield was increased by 1.02 lit (13.21 per cent) per day as compared to pre-treatment. Average consumption of urea molasses mineral block per buffalo was 375 gram per day and net profit from sale of extra milk was Rs. 13.75 per day. Singh and Singh (2003) recorded significant ($p<0.01$) improvement in milk yield of buffaloes (35.97 per cent) and cattle (33.8 per cent) due to UMMB supplementation, however non-significant effect on body condition score was observed.

Upreti *et al.* (2010) conducted an experiment on lactating crossbred Jersey cow to assess the production and reproduction performance of dairy cow due to UMMB supplementation and observed significant ($p<0.05$) increase in milk production (litre/day/ head) (6.24 vs. 7.37) in Jersey crossbred cattle. Tekeba *et al.* (2012) also found significant ($p<0.05$) increase in milk yield in UMMB supplemented group as compared to un-supplemented group of dairy cow.

Shah *et al.* (2018) studied the effect of feeding medicated UMMB (*Azadirachta indica*) on the production and parasite control in dairy buffaloes. They found the mean milk yield (kg) of buffaloes supplemented with UMMB was significantly ($p<0.05$) higher (8.54 per cent) than control group. Akter *et al.* (2004) studied the urea molasses multi-nutrient block supplementation to the dairy cows and reported substantial effect on milk output compared to the control group. Prior to block feeding, the average milk

output for the control and UMMB groups was 2.86 litre. The average daily milk yield for the control and UMMB groups during the 45-day experiment was 1.93 and 4.43 litre, respectively.

Anuraj *et al.* (2017) conducted an experiment to assess the effect of molasses based multi-nutrient liquid supplement (MMLS) on the lactation performance of early lactating crossbred dairy cows. The control group was fed basal diet without supplementing with molasses based multi-nutrient liquid supplement, whereas, another two treatment groups were fed MMLS replacing 15 per cent concentrate feed in one group and 30 per cent concentrate in another treatment group. They find that there was no adverse effect on the lactation performance of crossbred dairy cows. Brar and Nanda (2008) reported that pre-partum UMMB supplemented buffaloes produced 88 kg more milk per head during the first 60 days of lactation than non-supplemented buffaloes. An average increase of 8 per cent in milk yield and 7 per cent in milk fat was seen after UMMB supplementation post-partum.

Nibalkar *et al.* (2020) assessed the effect of Urea-molasses Multinutrient blocks (UMMB) supplementation on buffaloes productivity in rural area of Punjab, India. They observed that additional supplementation of UMMB had significantly ($p < 0.05$) higher daily milk yield per buffalo and lowered values of all reproductive parameters. Kachhawaha *et al.* (2022) studied the effect of multi-nutrient feed block (MNFB) supplementation on production performance of buffaloes in arid region of Rajasthan. They found that the average daily milk yield (treatment; 10.07 ± 0.21 vs. control; 7.64 ± 0.20 litre per animal per day) and peak milk yield (treatment: 10.87 ± 0.78 ; control: 7.54 ± 0.47 litre per animal per day) were significantly ($p < 0.01$) higher in supplemented group of buffaloes.

Windsor *et al.* (2021) assessed the effect of supplementation of the molasses nutrient blocks on production performance on swamp buffaloes. They observed significantly ($P < 0.05$) average daily milk production of buffaloes with two supplementation groups were increased (31 per cent and 24 per cent as compared to treatment group). Choudhary (2018) studied the effect of urea molasses mineral block supplementation on production performance of dairy animals in the Bhadohi district of Uttar Pradesh. They observed that the average daily milk yield was increased significantly ($p < 0.05$) (initial: 2.55 ± 0.27 , final; 3.51 ± 0.53).

Aung *et al.* (2001) reported significantly ($p<0.05$) higher mean milk yield in UMMB supplemented (8.86 kg/day/cow) Friesian cattle as compared to non-supplemented group (7.77 kg/day/cow). Nkya *et al.* (2002) observed significantly ($p<0.05$) increased milk production in UMMB supplemented (1.2 litre) crossbred cattle, whereas decrease (0.2 litre) milk production in non-supplemented group. Alam *et al.* (2006) reported significantly ($p<0.05$) higher milk yield in UMMB supplemented group (12 ± 1.6 litre) of crossbred zebu cattle compared to non-supplemented group (3.3 ± 1.0 litre) of crossbred zebu cattle.

Khanum *et al.* (2007) found significantly ($p<0.05$) higher (30 per cent) average milk yield in UMMB supplemented buffaloes compared to non-supplemented buffaloes. Alam *et al.* (2009) reported significantly ($p<0.05$) higher milk yield in UMMB supplemented group of desi cows compared to un-supplemented group of desi cows. Similarly results were observed by Sahoo *et al.* (2009) in crossbred cattle.

Duressa and Bersissa (2016) reported significantly ($p<0.01$) higher average milk yield in UMMB supplemented group (2.38 litre) of Horro cattle compared to non-supplemented group (1.62 litre). Gupta *et al.* (2018) observed significantly ($p<0.05$) higher average daily milk yield in UMMB supplemented group (13.25 ± 1.53 litre) of crossbred cattle as compared to non-supplemented group (11.46 ± 1.19 litre).

Kumar *et al.* (2018) reported significantly ($p<0.05$) higher daily milk yield in UMMB supplemented group T1 (9.09 kg) and T2 (8.25 kg) of crossbred cattle compared to non-supplemented group (8.16 kg). Upadhyay (2018) conducted study in Nepal on UMMB supplementation to lactating cattle. They found significantly ($p<0.05$) increased (1.58 litre per day) milk production in treated cattle as compared to un-treated. Hassan *et al.* (2019) reported significantly ($p<0.05$) higher average daily milk yield in UMMB supplemented group (4.20 ± 0.77 litre) of crossbred cattle compared to non-supplemented group (3.21 ± 1.07 litre).

2.5 Effect of multi-nutrient block supplementation on milk composition

Kachhawaha *et al.* (2022) studied the effect of multi-nutrient feed block (MNFB) supplementation on production performance of buffaloes in Rajasthan. They found that the milk fat (treatment; 6.08 ± 0.10 , control; 5.79 ± 0.17 per cent) was significantly ($p<0.05$) increased in supplemented group of buffaloes as compare to un-supplemented group. Similarly, Sharma and Singh (2014) found significant ($p<0.05$) increase in fat per

cent (11 per cent) in cattle due to supplementation of UMMB. Upreti *et al.* (2010) observed significant ($p < 0.05$) increase in average fat per cent (per cent /day/ head) (control: 0.41 ± 0.01 , treatment 1.12 ± 0.02) in Jersey cattle due to UMMB supplementation.

Tekeba *et al.* (2014) studied the effect of UMMB supplementation in Fogera and crossbred cows. They observed that the milk fat and SNF in supplemented group of Fogera cow's milk (49.6 g/l and 139.9 g/l respectively) and crossbred cow milk was (42.7 g/l and 126.1 g/l, respectively) significantly ($p < 0.05$) higher than un-supplemented group of Fogera cow's milk (45.4 g/l and 134.2 g/l respectively) and crossbred cow milk (41.5 g/l and 125 g/l, respectively). Sahoo *et al.* (2009) reported significant ($p < 0.05$) increase milk composition due supplementation of UMMB in crossbred cow at hilly region of Uttarakhand.

Shah *et al.* (2018) studied the effect of feeding medicated UMMB (*Azadirachta indica*) on the production and parasite control in dairy buffaloes. They found the mean milk lactose of buffaloes supplemented with UMMB was significantly ($p < 0.05$) higher (8.54 per cent) than control group.

Akter *et al.* (2004) reported non-significant effect of urea molasses multi-nutrient block supplementation to dairy cows on milk composition between treatment and control group, however, milk fat and protein per cent in the treated group increased slightly compared to initial values.

Garg *et al.* (2016) conducted an experiment to determine the impact of feeding balanced rations (upto 8 week) on the SNF content of milk and other production parameters in crossbred cows and Murrah buffaloes in Ludhiana district of Punjab. After feeding of balanced ration, there was significant ($p < 0.05$) increase in SNF content from 7.86 to 8.54 per cent and 8.12 to 9.12 per cent in cows and buffaloes, respectively and milk fat per cent from 4.13 to 4.27 per cent in cows and 6.54 to 7.01 per cent in buffaloes. Average daily milk yield increased from 9.35 to 10.36 kg in cows and from 7.54 to 8.25 kg in buffaloes.

Jayawickrama *et al.* (2013) conducted an experiment to assess the effect of UMMB supplementation on the performance of early lactating crossbred dairy cattle. Treatment group fed 300g crushed UMMB with basal diet daily throughout experimental

period. They found that supplementation of UMMB had non-significant effect ($p>0.05$) on milk yield and milk constituents such as milk fat, protein SNF, and lactose.

Vu *et al.* (1999) reported significantly ($p<0.05$) higher milk fat in UMMB supplemented group (3.32 ± 0.22 per cent) of dairy cattle compared to un-supplemented group (3.21 ± 0.12 litres) of dairy cattle. Similarly, Kumar *et al.* (2018) also observed significantly ($p<0.05$) higher milk fat in UMMB supplemented (4.04 per cent) crossbred cattle as compared to non-supplemented group (3.94 per cent) of crossbred cattle.

2.6 Effect of multi-nutrient block supplementation on service per conception and conception rate

Service per conception is most imported measure for breeding management in dairy animals. Srivastav (2008) reported that supplementation of 30-40 g commercial mineral mixture daily in concentrate for 20 days induced ovulatory estrus in 93.93 per cent of anestrus crossbred heifers with first service conception rate of 32.14 per cent.

Sahoo *et al.*, (2017) reported that mineral mixture supplementation showed significantly ($p<0.05$) higher reproductive performance, 76.92 per cent anestrus animal shows estrus and increase conception rate. Agrawalla *et al.* (2017) conducted a study on lactating crossbred cattle at Kakatpur block of Puri district of Odisha and reported that the reproductive performance of crossbred cattle in terms of days to first postpartum estrus, number of services per conception, and service period were reduced significantly ($p<0.05$) due to mineral mixture supplement. Vu *et al.* (1999) reported significantly ($p<0.05$) higher conception rate in UMMB supplemented dairy cattle (70 per cent) as compared to non-supplemented (60 per cent) dairy cattle. Nkya *et al.* (2002) reported significantly ($p<0.05$) higher conception rate in UMMB supplemented crossbred cattle (66.7 per cent) compared to non-supplemented (42.9 per cent) crossbred cattle.

Gupta *et al.* (2018) reported significantly ($p<0.05$) higher conception rate in UMMB supplemented crossbred dairy cattle (73.33 per cent) as compared to non-supplemented (53.33 per cent) crossbred dairy cattle. Kumar *et al.* (2018) reported significantly ($p<0.05$) reduced number of A.I. per conception in both UMMB supplemented groups T1 (1.60) and T2 (1.80) of crossbred cows compared to non-supplemented crossbred cows (2.0).

Hassan *et al.* (2019) reported significantly ($p<0.05$) improved fertility rate in UMMB supplemented crossbred cattle compared to non-supplemented crossbred cattle.

Kachhawaha *et al.* (2022) found that the conception and post partum reproductive complications differed significantly ($p < 0.05$) between multi-nutrient feed block (MNFB) supplemented (86.6 per cent and 0.06 per cent respectively) and non-supplemented group (60 per cent and 30 per cent, respectively).

2.7 Effect of multi-nutrient block supplementation on post partum estrus period

Aung *et al.* (2001) reported significantly ($p < 0.05$) reduced calving to first service period in UMMB supplemented (81 ± 23.38 days) Friesian cattle compared to non-supplemented (129 ± 12.72 days) Friesian cattle. Nkya *et al.* (2002) reported significantly ($p < 0.05$) reduced period of post partum estrous in UMMB supplemented (99.7 ± 12.8 days) crossbred cattle compared to non-supplemented (115.9 ± 15 days) crossbred cattle.

Alam *et al.* (2009) reported significantly ($p < 0.05$) reduced period of post partum behavioral estrous (149.0 ± 46.3) in UMMB supplemented group of desi cows, whereas none of non-supplemented desi cattle came in estrous during study period. Alam *et al.* (2006) reported significantly ($p < 0.05$) reduced period of post partum behavioral estrous (96.2 ± 2.3) in UMMB supplemented crossbred zebu cattle compared to non-supplemented (141.6 ± 4.6) crossbred zebu cattle.

Tekeba *et al.* (2014) observed that the supplementation of urea molasses multi-nutrient block resulted in behavioral estrus in 38 per cent of Fogera cows and 75 per cent of cross-bred cows. In contrast, only 25 per cent of the non-supplemented Fogera cows and 13 per cent of crossbred animals came into heat. UMMB supplementation appeared to have a stronger effect in crossbred cows than in Fogera cows. Shah (2018) reported 90 per cent UMMB supplemented post-partum anestrous buffaloes came into estrous due to supplementation, whereas only 50 per cent control group buffaloes came in estrous. Gupta *et al.* (2018) observed significantly ($p < 0.05$) reduced period of post partum estrous (49.1 ± 3.16 days) in UMMB supplemented crossbred dairy cattle compared to non-supplemented (57.7 ± 2.59 days) crossbred dairy cattle.

Kumar *et al.* (2018) reported significantly ($p < 0.05$) reduced period of post partum estrous in both UMMB supplemented groups T1 (56.50 days) and T2 (62.40 days) of crossbred cows compared to non-supplemented crossbred cows (79.8 days). Choudhary (2018) observed that the after completion of 90 days study period, 68.18 per cent anoestrus buffaloes and 66.66 per cent crossbred cows comes in estrus due to UMMB supplementation. Kachhawaha *et al.* (2022) observed that the sign of post partum estrus

differed significantly ($p < 0.05$) between multi-nutrient feed block (MNFB) supplemented (90 per cent) and non-supplemented group (70 per cent) of buffaloes in arid region of Rajasthan.

2.8 Effect of multi-nutrient block supplementation on service period

Aung *et al.* (2001) reported significantly ($p < 0.05$) reduced calving to conception interval in UMMB supplemented (177 ± 14.84 days) Friesian cattle as compared to non-supplemented (199.6 ± 15.74 days) (531 days) Friesian cattle. Nkya *et al.* (2002) reported significantly ($p < 0.05$) reduced service period in UMMB supplemented (120.2 ± 10 days) crossbred cows as compared to non-supplemented (120.2 ± 10 days) crossbred cows. Singh *et al.* (2010) assessed the effect of supplementation of UMMB on buffaloes in Rajouri district of Jammu and reported that there was none of the anoestrus buffaloes came in heat during the study period however after 30-45 days of completion of study, 72.72 per cent buffaloes came in heat and conceived.

Lawania *et al.* (2017) reported significant ($P < 0.05$) reduction in post-partum estrus and service period in UMMB supplemented group. Similar result was reported by Puvarajan and Vijayarajan (2013) in crossbred heifers due to mineral mixture supplementation. Significantly ($p < 0.05$) reduced service period was recorded in UMMB supplemented (73.7 ± 2.69 days) crossbred dairy cattle as compared to non-supplemented (89.5 ± 1.94 days) crossbred dairy cattle (Gupta *et al.*, 2018).

Gasselin *et al.* (2020) reported that micronutrient supplementation significantly ($p < 0.05$) reduces the first service period of dairy cows. Kour *et al.* (2022) studied the effect of UMMB supplementation on performance of buffaloes in Jammu district and reported that post-partum estrus and conception interval reduced in UMMB supplemented group in comparison to un-supplemented group.

2.9 Effect of multi-nutrient block supplementation on calving interval

Vu *et al.* (1999) reported significantly ($p < 0.05$) reduced calving interval in UMMB supplemented (13.4 ± 1.6) dairy cattle compared to non-supplemented (14.4 ± 1.7) dairy cattle. Pal *et al.* (2020) reported that the significant ($p < 0.05$) reduction in the first post-partum estrus period, number of per conception in both crossbred and desi cow and increase in number of cows conceived and conception rate (per cent) were recorded due supplementation of mineral mixture. Gasselin *et al.* (2020) reported that the

supplementation of micronutrient significantly ($p<0.05$) reduces the calving interval of dairy cows.

2.10 Effect of multi-nutrient block supplementation on body weight and body condition score

Patidar *et al.* (2014) reported that the supplementation of MNB improved intake of basal feed, and maintained body weight and body condition (BCS) of dairy animals and also improved the milk yield and general health of the animals with enhanced B: C ratio ranging between 1.93 and 6.16 under smallholder mixed farming system. Misra *et al.* (2006) reported significantly ($p<0.05$) higher BCS in crossbred cattle due to UMMB supplementation in Andra Pradesh. In another study Misra and Bipate (2020) reported significantly ($p<0.05$) improved BCS (2.98 ± 0.07 to 3.15 ± 0.06) of dairy cows due to UMMB supplementation in Muzaffarnagar of Uttar Pradesh.

Singh and Singh (2003) reported non-significant effect of UMMB supplementation on body condition score of buffaloes and cattle. Upreti *et al.* (2010) reported that supplementation of crossbred dairy cattle with UMMB during the dry season significantly ($p<0.05$) improved the body condition score of the cattle from 3.5 to 4 in Nepal.

Kour *et al.* (2022) recorded significantly ($p<0.05$) higher body weight (1.59 per cent), BCS (1.67 per cent) and heart girth in UMMB supplemented group of buffaloes than un-supplemented group. Windsor *et al.* (2021) observed that the BCS of buffaloes with UMMB supplemented group (C2) was significantly ($P<0.05$) higher as compared to control group. Akter *et al.* (2004) reported that the BCS of dairy cows fed with UMMB, were higher (3.0) compared to those fed control diet (2.79) but treatment groups did not had significant differences in BCS from control. Similarly, Choubey *et al.* (2015); Duressa and Bersissa (2016); Purnamaningsih *et al.* (2018) reported that the average daily weight gain of buffaloes, Horro cattle and Peranakan Ongole heifers, respectively fed UMMB-supplemented was higher than the control group, although the differences were non-significant.

Gasselin *et al.* (2020) reported that the supplementation of micronutrient had significantly ($p<0.05$) improved BCS and body weight of dairy cows without modifying dry matter intake, milk yield and milk composition. Nkya *et al.* (2002) reported

significantly ($p < 0.05$) increased (0.15) BCS in UMMB supplemented of crossbred cattle compared to non-supplemented cattle.

Alam *et al.* (2006) reported significantly ($p < 0.01$) higher body weight gain (18.4 ± 3.4 kg) in UMMB supplemented group of crossbred zebu cattle as compared to non-supplemented group (8.3 ± 3.2 kg). In another study, Alam *et al.* (2009) reported body weight gain (17.2 ± 1.3 kg) was significantly ($p < 0.05$) higher in UMMB supplemented group of desi cows as compared to non-supplemented group of cattle (-12.5 ± 5.4 kg) in 32week study period.

Suharyono *et al.* (2014) reported that UMMB-SBM (soya bean meal) supplementation was increase daily body weight gain of Bali cattle, Ongole, Simmental, and Holstein Frisian crossbred cattle by 0.34, 0.30, 0.38 and 0.36 kg/head/day, respectively. Shah (2018) reported significantly ($p < 0.05$) higher BCS in UMMB supplemented buffaloes (2.92) as compared to non-supplemented buffaloes (2.65). Hassan *et al.* (2019) reported significantly ($p < 0.05$) higher body weight gain in UMMB supplemented group of crossbred cows compared to non-supplemented cows.

2.11 Effect of multi-nutrient block supplementation on hematological and biochemical parameters of dairy animals

Sankar *et al.* (2020) evaluated the effect of feeding of solid multi-nutrient blocks on feed intake, nutrient utilization and haemato-biochemical profile of crossbred calves. They found that haemato-biochemical parameters like Hb, PCV, glucose, total protein, globulin, A:G, SGOT and SGPT showed non-significant differences ($p > 0.05$) among the groups, however, serum concentrations of albumin, urea and creatinine was higher in crossbred calves at 75 and 150 days of experiment in comparison to 0 day.

Patil *et al.* (2017) studied the effect of molasses based multi-nutrient (MMS-1) and Multi-nutrient containing chromium picolinate (MMS-2) (250 g/Bufalo/day) on the hematological and blood biochemical profile of buffaloes and reported significantly ($p < 0.05$) higher value of globulin and Hb and blood urea at 90 and 180 days of post feeding. Singh *et al.* (2010) reported significantly ($p < 0.05$) increased total plasma protein and albumin level due to UMMB supplementation in buffaloes. There was non-significant effect on Hb, PCV and glucose.

Sahoo *et al.* (2017) reported non-significant difference ($P > 0.05$) in the value of glucose, RBC, PCV, MCV and MCHC due to UMMB supplementation in crossbred

cattle. Hosamani *et al.* (1998) observed that the concentration of blood serum urea nitrogen increased significantly ($p < 0.05$) in UMMB treated group as compare to control group. Handique *et al.* (2019) conclude the result after 90 days supplementation of liquid UMMB, that there was non-significant difference ($p > 0.05$) in Hb (g/dl), PCV (per cent), WBC and RBC of treatment group.

2.12 Economics of milk production in dairy animals due MNB supplementation

Patidar *et al.* (2014) reported that the Supplementation of MNB improved the straw consumption and general health of the animals with enhanced B: C ratio ranging between 1.93 and 6.16 under smallholder mixed farming system. Lawania *et al.* (2017) reported significant ($p < 0.05$) reduction (12.12 per cent) in cost of milk production due to UMMB supplementation of zebu cattle in Jalore district of Rajasthan.

Misra *et al.* (2006) reported that UMMB supplementation significantly ($p < 0.05$) increased feed intake, milk yield and maintained live weight and body condition score with enhanced cash benefit of over Rs. 10 per day per cow under small holder mixed farming system. Garg *et al.* (2016) reported increase in SNF, milk fat and milk yield and additional daily monetary benefit of about Rs. 25 and 34 in cows and buffaloes respectively due to feeding of balanced ration.

Kour *et al.* (2022) reported that supplementation of UMMB increased milk yield per animal per day upto 1.5litre with benefit cost ratio of 1:2.73 in buffaloes. Meel *et al.* (2015) conducted the economic analysis of feeding of UMMB supplementation found that the cost per kg of milk was Rs. 6.94 and Rs.6.53 in un-supplemented and supplemented group, respectively. Net profit per day had significantly ($p < 0.05$) greater in supplemented group (Rs. 1935.81) as compared to non-supplemented group (Rs.1641).

Windsor *et al.* (2021) reported that the molasses nutrient blocks supplementation to buffaloes had total additional return of USD 453.60 and USD 340.20 from both treatment and control group during 30 day study period. Vu *et al.* (1999) reported significantly ($p < 0.05$) higher profit gain due to UMMB supplementation (USD 2.61/cow/day) to cows as compare to control group (USD 1.84/cow/day). Similarly Nkya *et al.* (2002) reported that the overall gain from UMMB supplementation was as USD 0.34/cow/day as compare to control cattle group.

Tanwar *et al.* (2013) observed that due to UMMB supplementation to lactating buffaloes had Rs. 13.75 per day net profit due to sale of extra milk with benefit cost ratio of 1:3.67. Kumar *et al.* (2018) reported significantly ($p<0.05$) higher gross return (Rs.) over control (T1: 22.40; T2: 6.65) and return over feed cost (Rs.) (T1: 10.40; T2: 4.65) in both UMMB supplemented group compared to non-supplemented crossbred cattle group. Upadhyay (2018) found 1:1.28 benefit cost ratio in UMMB supplementation to lactating cattle as compared to control group

2.13 Effect of rubber mat bedding on animal production and welfare

There is a critical role of flooring on comfort of animal welfare. Soft flooring reduces the hock, knee injuries and integument injuries, improves the hoof health and cleanliness of animals and shed whereas concrete flooring provoke more leg, hoof injuries and animals remains dirtier. Therefore, cleanliness of animals and shed, lameness of cow, skin alteration and milk yield are critical indicator of cow welfare.

Madke *et al.* (2010) studied the effect of various kinds of shelter modifications in different seasons, viz. hot dry, hot humid and winter on physiological and behavioral responses of Karan Fries cows. They reported that the final body weight of cows in straw bedding (G3) for hot dry and winter season were significantly ($P<0.01$) higher as compared to body weights of cows of two other groups i.e., concrete flooring (G1) and rubber mattress (G2). Mean time spent on feeding and sitting/lying rumination for cows of G3 groups in all the three seasons were significantly ($P<0.01$) higher, however, for standing rumination were significantly ($p<0.01$) lower as compared to other groups. Time spent on sleeping was significantly ($P<0.01$) lower than G1 and higher than G2 group cows in different seasons.

Weerasinghe *et al.* (2021) studied the effect of two floor types i.e., rubber mat and concrete on Friesian dairy cows on comfort and milk production. Significant ($p<0.05$) increase in milk production was recorded on rubber mat (16.67 ± 2.24 kg/h/d) compared to concrete (13.37 ± 1.46 kg/h/d) at the fourth week of the experiment. Kremer *et al.* (2012) observed that the cow on rubber flooring showed significantly ($p<0.05$) less days to first breeding (rubber floor: 76.8, concrete: 94.6; $p<0.01$) and days open (DO) (rubber floor: 98.8, concrete: 138.4; $p<0.01$) compared with concrete flooring. Heat detection rate (rubber floor: 54.9 per cent; concrete: 27.9 per cent) and conception rate at first service (rubber floor: 39.4; concrete: 29.4) also significantly ($p<0.05$) higher in

rubber mat flooring. Non-significant differences between rubber and concrete floor for service per conception (rubber floor: 1.5; concrete: 1.7; $p=0.267$) and 100 days in milk yield were recorded.

Kara *et al.* (2015) studied the influence of rubber mat concrete and sand resting surface types on milk yield and animal health in Bursa, Turkey. They found that the milk yield of dairy cow significantly ($p<0.01$) higher on rubber mat resting surface ($7,402.7\pm133.43$ kg) in comparison to concrete ($6,279\pm59.12$ kg) and sand floor ($6,314\pm106.24$ kg). Further, they reported that the cases of repeat breeding, mastitis and retained placenta are lesser on rubber mat resting surface in comparison to sand and concrete resting surface.

Jain *et al.* (2013) studied the effect of concrete floor and rubber mat floor on cow comfort and reported that the average laying down time of cow was significantly ($p<0.05$) increased on rubber mat floor from 2.00 to 4.28 hours and the time required to sit and to stand the cow on rubber mat was less compared to concrete floor. The average maximum number of slippages on concrete floor was 4.4 and on rubber mat floor was 2.6. The milk production was increased by 30.4 per cent when cow was housed on rubber mat as compared to concrete floor. Norring *et al.* (2010) found that cow significantly ($p=0.018$) spent higher time on rubber mat compared with concrete and sand floor, however, non-significant effect on the frequency of laying bout ($p=0.16$) and duration of laying bout ($p=0.35$) was recorded.

Eicher *et al.* (2013) conducted an experiment on heifers before calving to study the effect of rubber flooring on production performance and immune response. They found that the treatment heifers (rubber flooring) after calving showed significant ($p<0.05$) higher milk fat and milk protein. White blood cell count values were significantly ($p<0.05$) lower for cows reared on rubber flooring, whereas, cows housed on concrete floor showed greater white blood cell count. Herzog *et al.* (2020) assess the effect of implementing rubber-mat flooring on productivity of dairy animals. Dairy cows housed on rubber mat floor showed greater milk yield with reducing physical trauma and reduces the emission of rumen gasses.

Sinha *et al.* (2018) conducted an experiment on lactating crossbred cow to assess the effect of modified housing on production performance of crossbred cows. In this experiment crossbred cows divided into two groups, group 1 was housed in loose housing

with concrete floor and group 2 under modified housing with raising roof height, width and soft sand bedding. They revealed that the modified housed crossbred cows had significantly ($p < 0.05$) higher feed intake and average milk yield. Further, Sahu *et al.* (2018) investigated the effect of thermal insulated roof and soft flooring on production performance and physiological response of crossbred Jersey cows. The milk yield of crossbred cows with soft sand flooring were significantly ($p < 0.05$) higher ($p < 0.01$) as compared to concrete floor. Jain *et al.* (2013) reported significantly ($p < 0.05$) increase milk production (30.4 per cent) in cattle housed on rubber mat floor as compared to cattle was housed on concrete floor.

2.14 Effect of rubber mat bedding on hock and knee injury score of dairy animals

Gurung *et al.* (2020) studied the effect of different types of flooring i.e., concrete flooring (T1), sand flooring (T2), cow dung bed flooring (T3) and rubber mat installed flooring (T4) on the hock health of Sahiwal heifer at Mathura. They found that the pooled mean value of hock score of T2 group was significantly higher ($P < 0.05$) than T3 and the pooled mean value of hock score of T1 and T4 group was found to be comparatively higher than T3 group. Sadharakiya *et al.* (2019) assessed the effect of rubber mat flooring on hygiene, locomotion, hock and knee injury scoring on lactating crossbred cows. They revealed overall locomotion score on rubber mat (1.33 ± 0.07) was significantly lower ($p < 0.01$) than cows on concrete floor (1.70 ± 0.10). Whereas, the overall hock and knee injury score were found significant ($p < 0.01$) difference in cows on rubber mat and concrete floor was 1.21 ± 0.04 and 1.90 ± 0.05 , respectively.

Schutz and Cox (2014) conducted an experiment to study the effect of short-term repeated exposure to different flooring surfaces (concrete, 12-mm-thick rubber mat, 24-mm-thick rubber mat, and deep-bedded wood chips) on the behavior and physiology of dairy cattle. They found that the cows on wood chips spent the most time on lying, and cows on concrete spent the least time lying compared with those on other surfaces (wood chips: 10.8 h, 24-mm rubber mat: 7.3 h, 12-mm rubber mat: 6.0 h, and concrete: 2.8 h/18 h) and they did not observed any significant ($p > 0.05$) effect on body weight change of the animals. Chaplin *et al.* (2000) assessed the effect of rubber (Ethyl ethane vinyl acetate) mat and mattresses of loose rubber crumb on locomotion, claw conformation, loading, claw and leg disorder on dairy cow. They found that there were no significance difference between cows on mats and mattresses in milk yield, composition, feed intake

and weight loss or body condition score, in severe hock or knee injury, or in the incidence of lameness.

Bergsten *et al.* (2015) assessed the effect of soft (straw bedding, slatted rubber) and hard floor (slatted concrete) on locomotion, claw conformation, loading, claw and leg disorder. They found that the after calving, first-calvers on hard floors had higher odd for lameness (Odd Ratio = 3.6; $p < 0.01$), Sole hemorrhage/ulcer (Ulcers (Odd Ratio = 2.2; $p < 0.034$), white-line hemorrhage (Odd Ratio = 2.8; $p < 0.01$) and leg lesions (OR = 2.6; $p < 0.02$) than those on soft floors. Non-significant effect of floor type on severity of sole and white line hemorrhage but lower prevalence in soft floors and reared on hard floor. Cow significantly ($p < 0.01$) affected toe length in first-calving heifer (slatted hard: 88.56 ± 0.63 , slatted rubber 91.71 ± 0.81) and similar results were also reported by Fjeldaas *et al.* (2011).

Van *et al.* (2016) observed that the cow on concrete floor had a significant ($p < 0.05$) increase in claw horn growth (concrete: 3.26 ± 0.14 , rubber mat: 2.78 ± 0.14) compared to the rubber mat floor group, however, non-significant difference in wear between cow in the two different flooring groups at the end of the study were observed (2.42 ± 0.09 vs. 2.25 ± 0.09). Andreassen and Forkman (2012) reported that Holstein Frisian dairy cattle housed on sand in the free stalls were had fewer integument alterations on the hock ($p < 0.001$), and were less likely to be lame ($p < 0.03$). Significantly ($p < 0.05$) higher milk yield was recorded compared to cows housed with mattress. Non-significance difference in milk yield were recorded between cows housed in facilities with mattresses and rubber mat and also non-significant differences were recorded between all flooring group for lactation number, mean days in milk at first examination, body condition score, and proportion of cow with claw lesion at the first examination.

Vanegas *et al.* (2006) evaluated the effect of rubber mat and concrete flooring on the development of claw lesion, locomotion scores, clinical lameness, and rate of hoof growth and hoof wear on multi-perous dairy cow. They observed non-significant difference between flooring type for lactation number, mean days in milk at first examination, body condition score, and proportion of cow with claw lesion at the first examination. Weerasinghe *et al.* (2021) studied the effect of two floor types i.e., rubber mat and concrete on Friesian dairy cows on comfort and recorded significant reduction ($p < 0.05$) in swelling and wound severity of hocks.

Rushen *et al.*, (2007) reported that cow on rubber mat had significantly spending longer time compared to cows housed on concrete and significantly ($p < 0.05$) lower incidence of swelling of corpus joint, swollen knees and hock tended to be lower for cow kept on rubber mats than on concrete ($P = 0.06$). The incidence of swelling of the corpus joint was decreased in cows housed on soft flooring. The cows kept on concrete floors, on the other hand, had a higher incidence of swelling of the front knees. Vokey *et al.* (2001) observed significantly ($p < 0.05$) higher hock injury score on concrete floor housed dairy cows as compared to deep sand or rubber mattresses housed cows. In terms of clinical lameness, there was no significant difference between the group was recorded.

Magnusson *et al.* (2008) evaluated the impact of alley floor cleanliness on the hygiene of free stalls, cow udders, and teats by utilizing a mechanized scraper on rubber slatted floors. The rubber-slatted alley floor's hygiene was substantially improved by the use of scrapers. The cleanliness of the free-stalls and the cow's udder and teat had a favourable correlation with the cleanliness of the alley floor. The use of a scraper on top of a rubber-slatted floor enhanced the cleanliness of the alley floor, lowered the dung content in the free-stalls, and maintains cows' teats and udder clean.

Sahu *et al.* (2021) reported that the sand bed flooring as a cushioning effect had significantly ($p < 0.05$) higher for knee, hock, leg and other body parts of Jersey crossbred cow. Jha *et al.* (2019) reported that the dairy cow's housed on muddy floor (1.02 ± 0.57) and rubber mat floor (1.34 ± 0.48) had lower hock injury lesion compared to house on cemented floor (1.63 ± 0.489) and brick paved floor (1.83 ± 0.44). Islam *et al.* (2020) reported that the occurrence of skin lesion and hair loses on body parts of dairy cattle were significantly ($p < 0.01$) higher in brick made floor (62 per cent) and concrete floor (88 per cent) as compared to soil bedded floor (31 per cent).

2.15 Effect of rubber mat bedding on cow Cleanliness score of dairy animals

Sadharakiya *et al.* (2019) investigated the effect of rubber mat flooring on hygiene, locomotion, hock and knee injury scoring of lactating crossbred cows. Mean overall hygiene score were found significantly ($p < 0.01$) different for the cow kept in rubber mat (1.66 ± 0.09) as compared to cows kept on concrete floor (2.00 ± 0.08). Chaplin *et al.* (2000) studied the effect of rubber (Ethyl ethane vinyl acetate) mat and mattresses of loose rubber crumb on locomotion, claw conformation, and claw and leg disorder. They found that cows on mattresses tended to have slightly higher total dirtiness scores

than those on mats (Mattresses: 7.06, Mat: 6.95; $P=0.074$) and had dirtier udder on mattresses, (Mattresses: 7.50, Mat: 6.52; $P=0.05$).

Hultgren and Bergsten (2001) compared rubber mat floor and solid stall floor on dairy cow cleanliness and foot health. They found that the cows housed on rubber-mat floor had significantly ($p<0.05$) lower risk of dirtier as compared to the solid stall floor. The overall per cent of cow dirty on foot, leg and body on rubber mat floor 61, 91, 43 and solid stall floor was 80, 35 and 59 per cent. Andreasen and Forkman (2012) reported that cows housed on sand in the free stalls were at lower risk of being dirty ($p<0.001$). Islam *et al.* (2020) reported that the dairy cows housed on muddy soil type floor were lower cleanliness and hygiene status in compared to cows housed on brick made floor and concrete floor.

2.16 Incidence of mastitis (SCC, CMT) and milk production on rubber mat floor

Livestock productivity is an important indicator of cow comfort. It indicates that dairy animals are in better health, as seen by higher milk yields. In addition, careful cleaning of soft bedding at the appropriate time helps to prevent the prevalence of lameness and mastitis (Norrington *et al.*, 2010; Bradley *et al.*, 2018; Singh *et al.*, 2020). Valde *et al.* (1997) reported that the Norwegian cattle housed on concrete floor had 14 per cent higher clinical mastitis than cattle housed with rubber mat flooring.

Kremer *et al.* (2006) conducted an experiment on dairy cattle. Animals were kept on concrete slatted floor and rubber mat, and they concluded that somatic cell count were significantly higher in concrete slatted floor than rubber mats. Ruud *et al.* (2010) found that occurrence of clinical mastitis and teat lesion associated with softer free-stall base were lesser compared with harder stall surfaces such as concrete floor.

CHAPTER –3

Materials & Methods

MATERIALS AND METHODS

3.1 Description of study area

The present study was conducted in two villages (Pinjori and Malimajra) of Yamunanagar district of Haryana and in one village (Patlion) of Sirmaur district of Himachal Pradesh, India. The majority of farmers depend on agriculture for their livelihood and dairy act as secondary income source.

3.2 Location and boundaries

Yamunanagar district is bounded by Sirmaur district of Himachal Pradesh on the north, Ambala district on the west, Saharanpur district of Uttar Pradesh on the east and South east, Karnal and Kurukshetra district to the south west. The district has fertile soil with abundant water supply and naturally suited for the agriculture and animal husbandry.

Sirmaur district of Himachal Pradesh is sharing borders with Solan district to the north west, Simla district to the north east, Ambala, Panchkula and Yamunanagar district of Haryana to the west and south west, Dehradun district of Uttarakhand to the south east and east, and Saharanpur district of Uttar Pradesh to the south. It is largely mountainous with 90% of its population living in village. The district has hilly and mountainous topography with intermontane valleys, prominent being the Poanta valley. The details of selected district are given in Table 3.1.

Table 3.1 Climate and agro-climatic zone of study area

	Yamunanagar	Sirmaur
Agro-ecological Sub region (ICAR)	Northern Plain, Hot Sub-humid (Dry) Eco-Region (9.1)	Western Himalayas, Warm Sub humid Eco-Region.
Agro-climatic region (Planning commission)	Trans Gangetic Plain region (VI)	Western Himalayan Region (I)
Agro-climatic zone (NARP)	Eastern Zone (HR-1)	Sub- mountain and low hills, Sub-Tropical (HP-1)
Geographic coordinates of districts	Latitude: 30° 07'58.70" N	Latitude: 30°22'30" - 31°01'20" N
	Longitude: 77°17'16.02" E	Longitude: 77° 01'12" - 77°49'40" E
	Altitude: 307 m	Altitude: 400 to 3647 m

Materials and Methods

Temperature	Min 6.8°C (Dec/Jan) Max 48.8°C (May/June)	Min -2°C(Dec/Jan) Max 30°C (May/June)
Average Rainfall (mm) (IMD, 2020)	Annual: 952.2	Annual: 1446.2
	Monsoon: 890	Monsoon: 1160.1

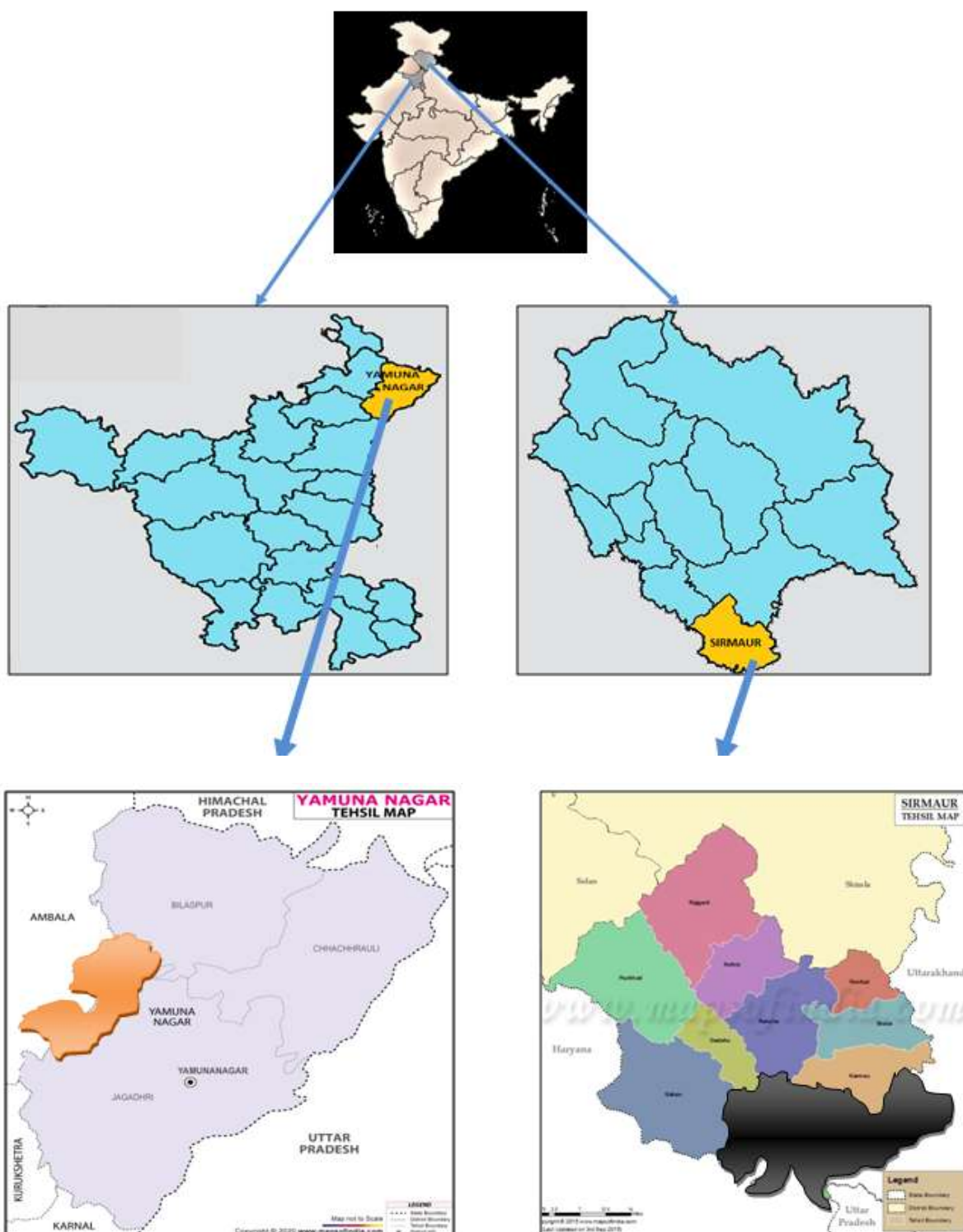


Plate 3.1 Selected study locations

3.3 Profile of the selected villages of Yamunanagar and Sirmaur districts

Yamunanagar district of Haryana and Sirmaur district of Himachal Pradesh are neighbor district and livelihood pattern of farmer, agriculture practices and livestock management strategies of both districts are nearly similar. Majority of population in both districts depends on agriculture and livestock for their livelihood. Livestock production is subsidiary enterprise for extra income and house hold needs. Majority of farmer cultivate their own land and grew commercial crops like wheat, sugarcane and rice, and fodder crops like maize, sorghum, and berseem. In livestock production, dairy animals specially crossbred cattle and buffaloes are mainly reared in both the districts. Small ruminant and pig farming are rarely seen. Dairy animals are reared under intensive management system as they don't have pasture land for open grazing. Agriculture is completely mechanized that's why no one uses draught animals for their agriculture purpose.

Average milk production from cross-bred cattle, buffaloes, and local cows in the region is about 10 litres, 6 litres, and 4 litres per head per day, respectively. According to livestock census 2019, Yamunanagar district contribute about 5.55% cattle, 2.88% buffalo and 3.70% total bovine population in Haryana state and Sirmaur district contributes 11.52% cattle, 6.49% buffalo and 10.03% total livestock population of Himachal Pradesh (DAHD, Govt. of Haryana, 2022; DAHD, Govt. of Himachal Pradesh, 2022).

3.4 The sampling framework and data collection

Primary data was collected with the help of structured validated interview scheduled, and secondary information was collected from various published and unpublished sources. Two villages of Yamunanagar district, namely Pinjori and Malimajra and one village (Patlion) of Sirmaur district of Himachal Pradesh have been selected purposefully because they have mainly agriculture and husbandry based livelihood along with lower intervention in the husbandry sector. From each village, 40 recently parturated (within 3 month) cattle and buffalo were selected for intervention. The selection of animals was done by observations and interview with farmers in selected villages.

3.5 Primary data

Personal interview was taken for selection of suitable animals and followed by using appropriate interview schedule for collection of primary information from farmers.

For collection period, multiple visits were done to collect the data as per objectives. The animals in early lactation stage (about 5-6 weeks after calving), preferably of second to fourth parity, were selected for the on-farm feeding trial based on their willingness to participate. The sampling framework and selected villages are presented in Table 3.2. This was achieved through a Participatory Rural Appraisal. Based on the local feeding practices, body weight, milk yield, stage of lactation and parity, the animals were divided into two groups (ten each) as Control (T_0) and Treatment (T_1). The animals in the control group were fed according to the farmers' practice and those in the treatment group were additionally offered MNB lick *ad-libitum*. The experiment was conducted as per the guidelines of institutional ethical committee.

All the selected animals were dewormed before the commencement of the experiment and checked for any ailment before entering to the experiment. During the experimental period routine health management was followed and animals found sick were immediately treated. Animals were managed by the farmers according to their farm practice. Sample of feed, milk and blood collected from each treatment and control group in respective suitable collection containers for further analysis in laboratory. Primary data includes herd size, type and number of animal's, different housing structure and facilities, watering, feeding and milking type and their spaces. Actual feeding practices, feed intake of the animals were noted at the time of visit at periodical intervals. Data on BCS, lameness, cleanliness, hock and knee injury and animal's body parameters (heart girth and body length) were noted and recorded. Data about milk production, lactation length, lactation yield, age at first calving, service period, service per conception, calving interval were collected on spot proceeded to each farmers and also from available farm records and by asking to the farmers. Information on various economic aspects such as animals' present values, machinery and equipment, family and hired labor, feed prices and miscellaneous expenditure were collected from the farmers.

3.6 Secondary data

Secondary data related to state geography, demographic features, agro-climatic features, livestock population, milk production, etc were collected from various published sources viz., state dairy development board, state animal husbandry department, state statistical abstracts etc.

3.7 Sampling framework

Table 3.2 Sampling frame work of study

Objective 1: MNB (multi-nutrient block) supplement					sampling type
State		Haryana		Himachal Pradesh	Purposive sampling
Districts		Yamunanagar		Sirmaur	Purposive sampling
Village		V1	V2	V3	Purposive sampling
Cattle (N: 38) Buffalo (N: 38)	T0	Cattle:6, Buffalo: 6		Cattle:7, Buffalo: 7	Random sampling
	T1	Cattle:6, Buffalo: 6		Cattle:7, Buffalo:7	
Objective 2: Rubber mat bedding					sampling type
State		Haryana			Purposive sampling
Districts		Yamunanagar			Purposive sampling
Village		V1		V2	Purposive sampling
Cattle (N: 24) Buffalo (N: 24)	T0	Cattle:6, Buffalo: 6			Random sampling
	T1	Cattle:6, Buffalo: 6			

3.8 General profile of the selected dairy farmers and dairy husbandry practices

The selected dairy farmers were grouped basis on family type, occupation status, education status, land holdings and herd size, as mention in Table 3.3 to 3.5

Table 3.3 Occupation status of the selected dairy farmers

SI. No.	Occupation	Occupation status
1	Agriculture	Primary or secondary
2	Dairy	Primary or secondary
3	Govt./private services	Primary or secondary
4	Business	Primary or secondary
5	Labour	Primary or secondary

Table 3.4 Education status of the selected dairy farmers

SI. No.	Occupation	Description
1	Illiterate	No education
2	Primary	Upto 5 th class
3	Middle	6-8 th class
4	Secondary	10 th class
5	Higher secondary	Up to 12 th class

Table 3.5 Classification of farmers based land holdings

SI. No.	Farmers category	Size of land
1	Marginal farmers	< 1 ha
2	Small farmers	1-2 ha
3	Medium farmers	2-10 ha
4	Large farmers	>10 ha

3.9 Herd size

It refers to the total number of cattle and buffaloes owned by the farmer at the time of investigation.

3.10 Feed and fodders

1. Availability of feeds and fodders

Actual measurements of availability and quality of the green fodder, silage, dry fodders and concentrate mixture offered to the various categories the animals on the day of visit was done. Different categories of feed and fodders offered to dairy animals and feeding management practice are presented in Table 3.6 and 3.7.

Table 3.6 Feed and fodder supply for dairy animals in study area

Months	January to April, 2022	May to August, 2022
Green fodder	Berseem, Oat, Mustard	Maize, Sorghum
Dry fodder	Wheat straw (Tuddi), Sorghum straw (Chari), Rice straw	
Concentrate	Mustard seed cake (Sarrso khal), Cotton seed cake (Binolla Khal), Wheat and Maize	

Table 3.7 Feeding management practice

S. No.	Practices	
1.	Feeding animals	Interview schedule
2.	Type of fodder	Interview schedule
3.	Type of concentrate fodder	Interview schedule
4.	Pretreatment of fodder	Interview schedule
5.	Quantity of fodder	Interview schedule

2. Feeding and watering frequency

Frequency of watering and feeding during summer and winter for dairy animals in study area were observed by actual observation.

3. Proximate analysis of feed and fodder

Proximate analysis of feedstuffs offered to dairy animals has been presented in Table 3.8.

Table 3.8 Proximate component of feed and fodder

Proximate component (%)		DM	CP	EE	OM	ADF	NDF	TA
Dry Fodder	Wheat Straw	91.52	2.23	0.86	89.44	52.54	78.96	7.73
	Berseem	10.44	1.04	1.73	88.94	28.56	44.33	10.23
Green Fodder	Maize	30.59	8.15	1.7	94.74	26.78	58.95	4.43
	Concentrate	92.58	21.18	3.64	89.51	14.49	29.33	8.66
Concentrate	Wheat	91.45	10.92	2.52	84.18	4.13	15.72	7.27
	Maize	89.54	8.92	4.12	82.41	3.63	15.32	7.13
MNB for treatment		97.3	22.9	4.1	78.3			

(DM-Dry Matter, CP-Crude Protein, EE- Ether Extract, ADF- acid detergent fiber, NDF- Neutral detergent fibre, TA- total acid, OM- Organic matter)

3.11 Housing and other facilities

1. Type of housing

Actual observation of open and covered areas and type of housing system in study area were recorded. (Table 3.9)

Table 3.9 Information related to housing type

S.No.	Type of housing
1.	Loose housing
2.	Tie stall housing
3.	Milking parlour facilities

2. Type and height of roof

Actual measurement of the height of the sheds and observation of the roofing materials used. Some farmers haven't availability of any roofed area. The information details related to type of roof are presented in Table 3.10.

Table 3.10 Information related to types of roof

Type of roof (roofing material)	Asbestos, cement concrete, tiles, wooden, good quality thatch, stone slab and GI sheet
Feature of roof	Single slop, double slop, Flat
Height of roof	15-20 feet, 10-15 feet, less than 10 feet

3. Type of floors and bedding material

The on-site observation of the type of floors in both open as well as covered areas were found following type of flooring of animal shed in farmer's field. The information details related to type of floor are presented in Table 3.10.

Table 3.11 Information related to flooring

Type of floor	Cement/concrete (RCC/brick paved)
	Sand bedded
	Dry earthen without pits
	Non Slippery good drainage
	Without drainage and slippery floor
Bedding material	Straw, Sand, Saw dust, Compost manure, Rubber mat, corn cobs etc.

4. Microclimate protection measures inside animal houses and other practices for protection against heat and cold stress

Actual observations of microclimate protection measures used by the farmers were recorded. Cooler, fan, heater, shower, and other practices for protection against heat and cold stress inside the animal's house are examples of microclimate protection measures. Provision of cooling such as installation of ceiling fans, bathing and shady trees in open area as well as on the periphery are also a good microclimatic protection measures against heat stress. Keeping the cattle inside covered area during day time and in the open area during night with occasional bathing, and wallowing of buffalo in a pond with fresh water or no use of any other special summer protection measure

5. Location of shed recorded as:

- a. Inside dwelling house
 - b. Near dwelling house
 - c. Separate from dwell
6. Facilities for treatment: by the interviewing the owner

Objective 1. Multi-nutrient blocks (MNB) supplementation on productive and reproductive performance of dairy animals

The present study was conducted in recently parturated cattle and buffaloes at Pinjori and Malimajra villages of Yamunanagar district, Patlion village of Sirmaur district. The animals reared under semi intensive and intensive management, kept in loose housing with concrete, brick, tiles, mud and rubber mat flooring.

3.12 Experimental design and experiment period

For the first objective ‘To assess the effect of multi-nutrient block supplementation on productive and reproductive performance of dairy animals’, total 38 crossbred cattle and 38 buffaloes were selected, whereas, 12 crossbred cattle and 12 buffaloes in each Pinjori and Malimajra whereas 14 crossbred and 14 buffaloes in Patlioni were divided into two groups i.e. control (T0) and treatment (T1) based on body weight, parity and previous milk yield. The experiment was conducted as per the guideline of institutional ethical committee.

The early lactating cattle and buffaloes were randomly selected and divided into two groups as treatment (T1) (with MNB supplementation) and control group (T0) (without MNB). Animals were offered routine ration as per the feeding schedule followed by the farmers. In addition to farmers practice, animals of treatment group were given MNB (multi-nutrient block) daily for licking for 4 month.

Preparation of multi-nutrient block and feeding schedule

The Multi-nutrient blocks (MNB) were procured from ICAR- Central Arid Zone Research Institute (CAZRI), Jodhpur. The MNB was prepared by mixing different ingredient (Table 3.12).

Table 3.12 Principal feed ingredient of multi-nutrient block (2kg Multi-nutrient block)

MNB ingredient	%	Proximate component	%
Molasses	45	Dry matter	97.3
Wheat bran	25	Crude protein	22.9
Mustard cake	10	Ether extract	4.1
Guar meal	7	Organic matter	78.3
Urea	5	Minerals	21.7
Mineral mixture	3	Total carbohydrate %	51.3
Common salt	2	Gross energy, Kcal	381
Dolomite	2		
Guar gum dust	1		

The MNB was offered during morning and evening hours. The experiment was conducted between 2nd week of January 2022 and last week of July 2022.

3.13 Parameters recorded

3.13.1 Dry matter (DM) intake

Dry matter intake of crossbred cattle and buffaloes of study area by recording the daily feed offered to dairy animals from dairy farmers. Concentrate, green fodder and dry fodder samples were collected from study area. The dry matter content in feed sample was estimated as percentage.

$$\% \text{ DM} = \frac{\text{Weight of sample after drying}}{\text{Weight of sample before drying}} \times 100$$

3.13.2 Average daily milk yield (kg)

Milk record card were given to the participatory farms. The actual milk yield of all the animals recorded in milk record card daily in both morning and evening time milking. Along with milk record cards, milk yield recorded by personal observation on 15 days interval during the experimental period. Since different animals were not in similar stage of lactation, the average of the milk yield on the day of visit was taken as the average daily milk yield.

3.13.3 Lactation length

The length of milk production period after calving is known as lactation length. Data on previous lactation length as collected through questionnaire for each cattle in the herd for the previous lactation based on the owner's information and available records.

3.13.4 Milk fat percent, SNF percent and protein percent

Estimation of milk fat, protein, SNF was performed by automated milk analyzer (MILKOSCAN), which was kept in laboratory of Livestock Production Management division.

Reproductive performance

The various parameter of reproductive performance were recorded by onsite observation from farmers. The following reproductive parameters were assessed.

3.13.5 Age at first calving

This was assessed based on available records and owners information.

3.13.6 Number of services per conception

Number of service in the form of artificial insemination were assessed by available records and information provided by the farmers.

$$\text{Number of service per conception} = \frac{\text{No.Of Insemination}}{\text{No.of conception}}$$

3.13.7 Service period

It is the period between date of calving and date of successful conception. It was estimated by available records and information provided by the farmers.

3.13.8 First post partum estrus

Information of first post partum estrus of experiment animals were taken from dairy farmers, who regularly observed along with personal observation during in regular period of visit during experiment period.

3.13.9 Conception rate

Conception rate of the first service in dairy animals were calculated as

$$\text{Conception rate} = \frac{\text{No.of animals pregnant}}{\text{No.of animal inseminated}} \times 100$$

3.13.10 Retention of fetal membrane

The cattle or buffalo that did not shed the fetal membrane within 12 hr of parturition were considered as cases of retention of fetal membrane. After parturition, the cattle or buffaloes were kept under constant watch for recording the time of expulsion of fetal membranes (RFM).

3.13.11 Body condition score

Actual scoring of the body condition of lactating cattle using the following body condition scoring scale were done periodically as mentioned in Table 3.13 (Sprecher et al, 1997).

Table 3.13 Body condition score

Score	Description
1	Very bad condition (emaciated): spinal crest look like the teeth of a saw, transverse process are very prominent >1/2 length visible, ischial bone very prominent with a deep V-shaped cavity below the tail.
2	Skeleton clearly visible: spinal crest vertebrae individually recognizable, transverse processes are for ½-1/3 visible, ischial bone prominent, U-shaped cavity below the tail.
3	Skeleton and covering well balanced: spinal crest forms a sharp edge transverse processes ¼ visible, ischial bones softly curved, shallow cavity below the tail.
4	Almost everything covered: vertebrae of spinal crest are flat and cannot be individual defined, transverse processes are softly curved, Ischia bones surrounded by fat, cavity filled with some fat under the tail.
5	Too much fat: spinal crest covered with fat, edge of transverse processes barely visible because of fat, ischial bone covered by fat, cavity filled with fat, fold arise

3.13.12 Animal body weight

Body weight of the animals was calculated by the body length and heart girth of the animal's with help of measuring tape. These measures were taken from selected animals. After collection of measures onsite, further Schaeffer's formula/equation was used to calculate the animal's body weight as;

$$W = (L \times G^2)/300$$

Where: W is body weight in lbs

L is length of the animal from point of shoulder to pin bone in inches

G is the chest girth of the animal in inches

(The final weight was converted into kg)

3.13.13 Hematological and biochemical profile

Blood samples were collected from treatment and control group in sterile EDTA Vacutainer tubes from jugular vein with minimum possible discomfort. Representative sample were collected on monthly during experiment period. Sample were brought to the analytical laboratory in chilled icebox soon after collection of blood samples for further analysis of hematological parameters Viz. RBC ($\times 10^6$ cell / μ L), TLC ($\times 10^3$ cells/ μ L), PCV (%), Hb (g/dl) and blood urea (mg/dl) at HPVK, Karnal.

Milk quality and udder health (SCC, CMT)

Detection of subclinical mastitis was done on the basis of different tests viz. MCMT and SCC.

3.13.14 California mastitis test (CMT)

The CMT test is based on the principle of increasing in number of leukocyte and alkalinity of the mastitis milk. These changes are due to inflammatory exudation and increased content of basic salts. The MCMT tests were performed with help of DeLaval California Mastitis Test (CMT) kit (DeLaval Private Limited) (Based on Schalm, O.W., Carrol, E.J. and Jain, N.C. 1971. Bovine mastitis, Lea and Febiger Inc. Philadelphia ,PA, USpp 136-143).

Procedure of CMT

1. Before taking milk sample in paddle, remove first 1-2 strips of milk.
2. Take 1-2 strips of milk directly into each cup (LF, LH, RH and RF) of plastic saddle from respective four quarters (about 3ml)
3. To ensure equal quantity of milk in each cup, the paddle was slightly at an angle of 45degree to allow overflow of excess of milk samples
4. Take 3ml CMT reagent in tilt measure on the bottle and pour (3ml) in each cup. Stir the mixture of milk and solution in anticlockwise direction.
5. Milk from infected teat/ quarter will show gel formation. Thicker and quicker formation of gel is more infectious in udder (compare with picture shown on bottle/box)
6. The reaction was grade by intensity of gel formation as detailed in table
7. Thoroughly wash the saddle/cup after testing each cattle/ buffalo

Table 3.14 Grading of CMT based on gel formation

Description	Points	Mastitis condition	Average SCC (in Lakh)
No gel formation	0	Not infected /Negative	≤ 1.0
Slight gel formation	1	Subclinical Mastitis	2.0-3.5
Distinct gel formation in centre of test cup	2	Mild Mastitis	3.5-5.5
Dense gel formation	3	Mastitis Infection	>5.5

3.13.15 Somatic cell count (SCC)

Once in 15 days, evening or morning milk sample were collected from all the experimental lactating dairy crossbred cattle and buffaloes. For this purpose, animals number or owner of animals (If animal tag number was not available) written on the milk sample collecting vials. Approximately 40-45 ml milk was collected aseptically in the clean sample vials. Before taking the sample, the teats were thoroughly disinfected and allowed to dry and 1st 2-3 strips of fore milk were discarded. The number of cattle or buffalo and the quarters from which the samples collected was labeled according on vials. The milk samples collected separately in sterilized sampling vials were brought to the laboratory as soon short possible time for further analysis. Estimation of SCC in milk samples was performed by automatic somatic cell counter (LACTOSCAN), which was kept in laboratory of Livestock Production Management Division.

3.13.16 Economics of milk production in study area

A partial budget analysis was done to assess the feasibility of feeding MNB supplementation. In partial budget analysis only those items of income and expenses were considered that change (Misra and Bipate, 2020). Therefore, the costs of MNB only have been considered, since all other variable cost remains same for both the groups. The partial budget analysis was done by the taking all the parameters of expenditure and return from sale of milk as:

1. Variable cost

The variable costs are those cost, which are very with the level of production and can be altered in the short run.

2. Feed and fodder cost

Cost on green fodder, dry fodder and concentrate were worked out by multiplying of daily average feed and fodders intake by dairy animals with their respective prevailing prices in the study area.

3. Gross return from milk production

It was obtained by multiplying milk yield of individual animals with respective prevailing prices in the study area i.e.

$$\text{Gross return (Rs./animal/day)} = \text{Quantity of milk} \times \text{Local market price of milk}$$

4. Net return

It was return calculated from subtracting total variable cost from gross return.

$$\text{Net return (Rs./animal/day)} = \text{Gross return per litre} - \text{Total variable cost}$$

5. Benefit cost ratio

BCR (benefit cost ratio) was calculated by dividing gross return by total expenses.

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total expenses}}$$

Objective2. Effect of rubber mat bedding on production and welfare of dairy animals in the study area

3.14 Experimental design

The early lactating cattle and buffaloes were randomly selected and divided into treatment (with rubber-mat) and control group (without rubber-mat). The control group of dairy animals have been flooring as per farmers practices and offered routine ration as per the feeding schedule followed by the farmers. The details of experimental design, number of animals and sampling framework are given in below;

For the objective second total 24 crossbred cattle and 24 buffaloes were selected, whereas, 12 crossbred cattle and 12 buffaloes in Pinjori and Malimajra were divided into two groups i.e. control (T0) and treatment (T1) based on body weight, parity and previous milk yield. The experiment was conducted as per the guideline of institutional ethical committee.

The early lactating cattle and buffaloes were randomly selected and divided into two groups as treatment (T1) (with rubber mat bedding) and control group (T0) (without rubber mat bedding). Animals were offered routine ration as per the feeding schedule followed by the farmers along with ensured before selection of animals for study area were free from any physiological, anatomical and infectious disease. The experiment was conducted for 4 month of time period in study area.

3.15 Parameter recorded

The following parameters were recorded and procedure is described in objective-1

3.15.1 Hock Injury Score (HIS)

Actual scoring of the animals for hock lesions using the following hock lesions scoring scale (Cook et al., 2004) was done (Table 3.15)

Table 3.15 Hock Injury Score

Score	Description
4	No damage
3	Hair loss patches are 0.5 inches in diameter or larger
2	Swelling are 3 inches in diameter or less
1	Swelling are greater than 3 inches in diameter or extensive, bleeding

3.15.2 Cow Cleanliness Score (CCS)

Actual scoring of the animals for cleanliness using the following cow cleanliness score (Napolitano et al., 2005) five ano-genital area, back of the udder, the bottom part of the hind legs (from the hock to the dewclaws), the udder sides and belly and the thighs are observed for scoring. (Table 3.16)

Five ano-genital area was selected (5 point scale will be used)

1. Back of udder
2. Bottom part of hind leg (hock to dew claw)
3. Udder sides
4. Belly
5. Thigh

Table 3.16 Cow Cleanliness Score

Score	Description
5	No dirt (a total clean cow)
4	Some small dirty parts
3	Large dirty parts covering less than half of the area
2	Large dirty parts covering more than half of the area
1	Area completely covered with dirt

3.16 Statistical analysis

Collected data were scrutinized, tabulated and analyzed by descriptive statistical and also implying various analytical tools. The data collected through survey was compiled and tabulated using Microsoft excel, 2010 software and analysed systematically commensurate with the objective of the study using statistical software SPSS as per schedule. The following statistical parameters were applied

- ✓ Independent t test
- ✓ Mean
- ✓ Standard error

Means and standard error were compared at significance level of 0.05 Graphs were prepared using Microsoft excel, 2010.



Plate 3.2 Feeding practices in study area



Plate 3.3 Housing structures in study area



a. California Mastitis test



b. Somatic cell count

Plate 3.4 California mastitis test and Somatic cell count



Plate 3.5 Milk analysis



Plate 3.6 Body measurements



Plate 3.7 Blood collection



a. Between pin and hooks



b. Tail head to pin



c. Overhanging shelf



d. Spinous processes

Plate 3.8 Body condition scoring



1. Belly



2 &3. Thigh and Bottom part of hind leg



4. Back of udder



5. Side of udder

Plate 3.9 Cow Cleanliness Score



a. Hock and Knee Injury Score on concrete floor



b. Hock and Knee Injury Score on rubber mat bedding floor

Plate 1.10 Hock and Knee Injury Score

CHAPTER -4

Results and Discussion

RESULTS AND DISCUSSIONS

The commensurate with the objectives of the present study on performance and welfare of dairy animals in Haryana and Himachal Pradesh, data were gathered from the selected dairy farmers of study area and have been tabulated, analyzed and interpreted using suitable statistical tools. The findings are presented in this chapter under the following sections:

4.1 General Profile of the Dairy Farmers

The demographic profile of respondents i.e. family type, occupation and size of land holding have been presented in Table 4.1, 4.2, and 4.3., respectively. Almost equal proportion of farmers belongs to joint and nuclear family. The majority of farmers of study area had hierarchical experience of dairy farming and they were regularly practicing vaccination (FMD, HS, and BQ) and treatment of dairy animals, as promoted by the government institution and veterinary clinician.

Table 4.1: Family type of the selected dairy farmers

Family type	Pinjori		Malimajra		Patlion		Pooled	
	N (20)	%	N (20)	%	N (15)	%	N(55)	%
Joint family	11	55	10	50	6	40	27	49.09
Nuclear family	9	45	10	50	9	60	28	50.91

The primary occupation of the selected farmers was agriculture (92 per cent) and majority of farmers practiced animal husbandry as secondary occupation, except two farmers in Patlion village (13 per cent) and they primarily engaged with dairy farming. Some of the farmers were also engaged with services and labour work (Table 4.2).

It is believed that education of farmers has direct relation with adoption of technologies, because improved knowledge enable better comprehension of rearing practices. The education status of farmers has been presented in Table 4.3. About 82 per cent farmers had education upto secondary (10th class) level. Not even single farmer was graduated in the study area.

Table 4.2: Occupation status of the selected dairy farmers

Villages	Occupation	N	Agriculture	Dairy	Business/service	Labour
Pinjori (n=20)	Primary	N	20	0	3	1
		%	100	0	15	5
	Secondary	N	0	20	3	4
		%	0	100	15	20
Malimajra (n=20)	Primary	N	20	0	0	2
		%	100	0	0	10
	Secondary	N	0	20	1	8
		%	0	100	5	40
Patlion (n=15)	Primary	N	11	2	2	0
		%	73.33	13.33	13.33	0
	Secondary	N	1	12	2	3
		%	6.67	80	13.33	20
Pooled (n=55)	Primary	N	51	2	5	3
		%	92.73	3.64	9.09	5.45
	Secondary	N	1	52	6	15
		%	1.82	94.55	10.91	27.27

Table 4.3: Education status of the selected dairy farmers

Villages	Pinjori		Malimajra		Patlion		Pooled	
	N (20)	%	N (20)	%	N (15)	%	N (55)	%
Illiterate	1	5	1	5	0	0	2	3.64
Primary (upto 5 th class)	7	35	13	65	2	13.33	22	40
Middle (6-8 th class)	5	25	3	15	5	33.33	13	23.64
Secondary (10 th class)	5	25	2	10	3	20	10	18.18
Higher secondary (up to 12 th class)	2	10	1	5	0	0	3	5.54

The land holding size of farmers in selected villages is presented in Table 4.4. Majority of selected farmers were marginal i.e. 75 per cent, 80 per cent and 26 per cent in Pinjori, Malimajra and Patlioni respectively, only 7 per cent farmers comes under medium land holding categories. Not even single farmers had more than 10 hectare of land in the study area.

Table 4.4 Land holding size of selected dairy farmers

Farmers categories	Pinjori		Malimajra		Patlioni		Pooled	
	N (20)	%	N (20)	%	N (15)	%	N (55)	%
Lend less	1	5	2	10	0	0	3	5.45
Marginal (< 1 ha)	15	75	16	80	4	26.66	35	63.64
Small (1-2 ha)	4	20	2	10	2	13.33	8	14.55
Medium (2-10 ha)	0	0	0	10	4	26.66	4	7.27
Large (>10 ha)	0	0	0	0	0	0	0	0

4.2 Average herd size and its composition

Herd size is an important indicator to access the economic status of the dairy farmers. The herd size and its composition are presented in Table 4.5, 4.6 and 4.7. In Pinjori and Malimajra, majority of farmers were rearing buffaloes 61 per cent and 67.5 per cent, respectively whereas, in Patlioni, 32.50 per cent farmers rearing buffaloes. The overall milking and dry animal ratio was 73: 27, 69:31 and 67:33 in Pinjori, Malimajra and Patlioni, respectively. In study area all most all farmers were keeping only crossbred cattle and buffalo. The average herd size of selected farmers in Pinjori, Malimajra and Patlioni were 4.4, 4.0 and 6.8, respectively (Table 4.7). Among this, milch and dry animals were 2.0, 1.8, 3.13 and 0.75, 0.80, 1.53 respectively.

Table 4.5 Information related to dairy animals herd size of selected dairy farmers

Category	Pinjori		Malimajra		Patlioni		Pooled	
Herd size (No.)	87		80		102		269	
	N	%	N	%	N	%	N	%
Cross bred cattle	34	39	26	32.50	54	67.50	114	42.38
Buffalo	53	61	54	67.50	48	32.50	155	57.62

Table 4.6 Information related to dairy animal composition of selected dairy farmers

Category	Milch	Dry	Heifers	Calves	% Milch	% Dry
Pinjori	40	15	9	23	72.73	27.27
Malimajra	36	16	7	21	69.23	30.77
Patlion	47	23	10	22	67.15	32.85
Pooled	123	54	26	66	69.49	30.51

Table 4.7 Mean $\pm$ S.E. values of herd of selected dairy farmers

Category	Pinjori	Malimajra	Patlion	Pooled
Herd size	4.35 $\pm$ 0.37	4.00 $\pm$ 0.21	6.8 $\pm$ 0.85	5.05 $\pm$ 0.88
Cross bred cattle	1.70 $\pm$ 0.29	1.30 $\pm$ 0.24	3.60 $\pm$ 1.28	2.20 $\pm$ 0.71
Buffalo	2.65 $\pm$ 0.26	2.70 $\pm$ 0.25	3.20 $\pm$ 1.25	2.85 $\pm$ 0.18
Milch	2.00 $\pm$ 0.17	1.80 $\pm$ 0.11	3.13 $\pm$ 0.96	2.31 $\pm$ 0.41
Dry	0.75 $\pm$ 0.15	0.80 $\pm$ 0.12	1.53 $\pm$ 0.49	1.03 $\pm$ 0.25
Calves	1.15 $\pm$ 0.17	1.05 $\pm$ 0.14	1.47 $\pm$ 0.58	1.22 $\pm$ 0.13
Heifers	0.45 $\pm$ 0.11	0.35 $\pm$ 0.11	0.6 $\pm$ 0.33	0.47 $\pm$ 0.07

4.3 Feeding management practices

More than 90 per cent of the farmers in the selected villages practice group stall feeding and only 7 per cent farmers having individual stall for feeding (Table 4.8). The watering frequency was more diverse. Watering frequency was recorded twice in a day during winter season in almost all farmers and some farmer's offers free time's water to dairy animals. While almost all farmer offered feed twice in a day during all seasons. About 95 per cent, 90 per cent and 93.33 per cent farmers were using homemade concentrate mixture in Pinjori, Malimajra and Patlion, respectively. They were providing concentrate mixture to all lactating animals.

Table 4.8 Information related of feeding management practices

Variable		Pinjori		Malimajra		Patlion		Pooled	
		N (20)	%	N (20)	%	N(15)	%	N(55)	%
Feeding of animals									
Group stall		17	85	19	95	15	100	51	92.73
Individual stall		3	15	1	5	0	0	4	7.27
Concentrate feed type									
Home prepared		19	95	18	90	14	93.33	51	92.72
Ready made		13	65	12	60	10	66.67	35	63.64
Concentrate Mixture offered									
Lactating animals		20	100	20	100	15	100	55	100
To all animals		4	20	2	10	4	26.67	10	18.18
Watering frequency									
Summer	Twice	16	80	18	90	7	46.67	41	74.55
	Thrice	0	0	0	0	3	20	3	5.45
	Ad-lib	4	20	2	10	5	33.33	11	20
Winter	Twice	6	30	10	35	9	60	25	45.45
	Thrice	7	35	8	50	2	13.33	17	30.91
	Ad-lib	7	35	2	20	4	26.67	13	23.64

The intake of feed and fodder (kg/h/d) by crossbred cattle and buffaloes are presented in Table 4.9. The green fodder, dry fodder and concentrate intake was 26.41 ± 0.55 , 5.28 ± 0.12 and 3.12 ± 0.10 kg/h/d in crossbred cattle and 30.79 ± 0.45 , 6.44 ± 0.11 and 3.43 ± 0.31 kg/h/d in buffaloes, respectively.

Table 4.9 Intake of feed and fodder (Mean $\pm$ S.E.) of lactating animals

Ration	Green Fodder (kg/h/d)	Dry Fodder (kg/h/d)	Concentrate (kg/h/d)
Crossbred cattle	26.41 ± 0.55	5.28 ± 0.12	3.12 ± 0.10
Buffaloes	30.79 ± 0.45	6.44 ± 0.11	3.43 ± 0.31

4.4 Housing Management practices

Information related to housing structures of dairy animals in study area are presented in Table 4.10. All farmers kept their animals in tie stall house type, whereas, about 62 per cent of farmers kept their animals inside their dwell. Rough concrete and Katcha floor were most common type of floor in study area, whereas, some of the farmers kept rubber mat bedding for the dairy animals. Rubber mat were used by 30 per cent, 20 per cent and 6.7 per cent of the farmers in Pinjori, Malimajra and Patlion, respectively and rest farmers were not using any kind of bedding materials. Almost every farmer provides bathing. About 50 per cent farmers of Pinjori and Patlion (53.30 per cent) use ceiling fan for micro-climatic protection.

Table 4.10 Information related to dairy animals housing type of selected dairy farmers

Variable	Pinjori		Malimajra		Patlion		Pooled	
	N(20)	%	N(20)	%	N(15)	%	N (55)	%
Housing type								
Loose housing	0	0	0	0	0	0	0	0
Tie stall housing	20	100	20	100	15	100	55	100
Location of Shed								
Inside Dwell	12	60	13	65	9	60	34	61.82
Out/near to dwell	8	40	7	35	6	40	21	38.18
Roof material								
Asbestos	14	70	13	65	4	26.67	31	56.36
Galvanized tin	2	10	7	35	8	53.33	17	30.91
Cement-concrete	3	15	0	0	3	20	6	10.91
Wooden	2	10	0	0	0	0	2	3.64
Tiles or stone slab	1	5	0	0	0	0	1	1.82

Type of roof								
Open	14	70	10	50	7	46.67	31	56.36
Sloped	2	10	3	15	6	40	11	20
Plan	18	90	17	75	9	60	44	80
Roof height								
>20feet	0	0	0	0	1	6.67	1	1.82
15-20 feet	4	20	2	10	4	26.67	10	18.18
10-15 feet	12	60	11	55	7	46.67	30	54.55
<10 feet	4	20	7	35	3	20	14	25.45
Type of floor								
Concrete, Brick paved	19	95	20	100	11	73.33	40	72.72
Non slippery with good drainage	15	75	10	50	7	46.67	32	58.18
Slippery with bad drainage	5	25	10	50	3	20	18	32.72
Sand bedded (open area)	1	5	0	0	3	20	4	72.72
Dry earthen without pits (open area)	15	75	13	65	4	26.67	32	58.18
Bedding in house								
Rubber mat	6	30	4	20	1	6.67	11	20
No bedding	14	70	16	80	14	93.33	44	80
Microclimate protection								
Good shady tree in loafing area	0	0	1	5	1	6.67	2	3.64
Bathing	20	100	20	100	15	100	55	100
Ceiling fan	10	50	3	15	8	53.33	21	38.18
Exhaust fan	0	0	0	0	1	6.67	1	1.82

4.5 Breeding management practices

The information related to breeding management practices have been presented in Table 4.11. All farmers of selected villages were practiced artificial insemination for crossbred cattle and buffaloes. Every dairy farmer use bellowing and vaginal mucus discharge as sign for detection of estrus in dairy animals. About 2/3rd farmers detecting heat both in the morning and evening and only 7 per cent farmers detect heat during morning time. The reproductive problems observed under study area were repeat breeding, delay in estrus and retention of placenta (Table 4.11). Among reproductive problems, delayed cyclicity (40 per cent) was major problem followed by frequent vaginal discharge (27 per cent) and retention of placenta (17 per cent) and repeat breeding (17 per cent).

4.6 Milking management practices

Information related to management of milking of dairy animals was presented in Table 4.12. All most all farmers practice calf suckling except one farmer in Patlion village was weaned the calf within one week after parturition. Concentrate feed was used after death of calf for milk let-down purpose. Almost every farmer practice knuckling method of milking and they didn't have separate place for milking. Eighty per cent farmer's clean udder before milking and most of the farmers followed intermittent milking for drying off the animals. None of the farmers had practiced day old weaning of calves.

4.7 Productive and reproductive performance of dairy animals

The productive and reproductive parameters (overall mean $\pm$ S.E.) of crossbred cattle and buffaloes are presented in Table 4.13. The average body weight (kg) crossbred cattle was 414.15 $\pm$ 21.36, 405.23 $\pm$ 20.61, 422.72 $\pm$ 21.01 kg whereas in buffaloes it was 566.49 $\pm$ 26.62, 571.84 $\pm$ 18.86 and 572.12 $\pm$ 26.56 kg in Pinjori, Malimajra and Patlion villages, respectively. The BCS of the crossbred cattle was 3.29 $\pm$ 0.04, 3.12 $\pm$ 0.08, 3.28 $\pm$ 0.05, whereas, in buffaloes it was 3.31 $\pm$ 0.09, 3.26 $\pm$ 0.01, 3.48 $\pm$ 0.09 in the selected villages viz Pinjori, Malimajra and Patlion. Parity of selected crossbred cattle was between 2.15 $\pm$ 0.04 to 2.64 $\pm$ 0.04 and in buffaloes it was 2.35 $\pm$ 0.03 to 2.75 $\pm$ 0.05 in the study area. The average daily milk yield of crossbred cattle was 10.82 $\pm$ 60, 10.21 $\pm$ 87, 14.37 $\pm$ 1.70 kg/h/d, whereas, in buffaloes it was 8.52 $\pm$ 83, 10.04 $\pm$ 1.17, 12.15 $\pm$ 2.14 kg/h/d.

Table 4.11 Information related to breeding management and reproductive problem

Variable	Pinjori (n=55)		Malimajra (n=52)		Patlion (n=70)		Pooled (n=177)	
	N	%	N	%	N	%	N	%
Breeding practices								
Natural	0	0	0	0	0	0	0	0
A.I.	55	100	52	100	70	100	177	100
Method of heat detection								
Bellowing	55	100	52	100	70	100	177	100
Vaginal discharge	55	100	52	100	70	100	177	100
Frequency of heat detection								
Morning time	5	9.09	2	3.84	5	7.14	12	6.78
Evening time	15	27.27	9	17.30	6	8.57	30	16.95
Both time	35	63.64	41	78.85	59	84.29	135	76.27
Reproductive problem faced								
Retention of placenta	2	3.64	2	3.84	1	1.43	5	2.82
Delayed cyclicity	5	9.09	3	5.77	4	5.72	12	6.78
Frequent vaginal discharge	3	5.45	4	7.69	1	1.43	8	4.52
Repeat breeder	1	1.81	2	3.84	2	2.86	5	2.82

Table 4.12 Information related to milking management practices

Variable	Pinjori		Malimajra		Patlion		Pooled	
	N (20)	%	N (20)	%	N (15)	%	N (55)	
Milking method								
Full hand	1	5	0	0	2	13.33	3	5.45
Knuckling	19	95	20	20	13	86.67	52	94.55
Strip milking	0	0	0	0	0	0	0	
Milking place								
No separate place	20	100	20	100	15	100	55	100
Milking parlour	0	0	0	0	0	0	0	0
Udder cleaning								
Before milking only	20	100	20	100	12	80	52	94.55
After milking only	0	0	0	0	0	0	0	0
Both times	0	0	0	0	3	20	3	5.45
Drying of Practice								
Abrupt stoppage of milking / Incomplete milking	0	0	0	0	0	0	0	0
Intermittent milking	20	100	20	100	13	86.67	53	96.36
Incomplete milking with intermittent milking	3	15	4	20	2	13.33	9	16.36

Time for calf suckling								
Early weaning of calves	0	0	0	0	1	6.67	1	1.82
Less than 4 month	18	90	19	95	11	73.33	48	87.27
Upto 6 month of age	2	10	1	5	3	20	6	10.91
Above 6 month of age	0	0	0	0	0	0	0	0
Milk let down method after early death of calf	All applied concentrate feed for milk let down							

Table 4.13 Information on production and reproduction (Mean $\pm$ S.E.) of dairy animal

Village	Pinjori	Malimajra	Patlion	Pooled
N	48	48	28	124
Production parameter				
Body weight (kg)				
Crossbred cattle	414.15 $\pm$ 21.36	405.23 $\pm$ 20.61	422.72 $\pm$ 21.01	414.03 $\pm$ 19.13
Buffalo	566.49 $\pm$ 26.62	571.84 $\pm$ 18.86	572.12 $\pm$ 26.56	570.15 $\pm$ 22.32
BCS				
Crossbred cattle	3.29 $\pm$.04	3.12 $\pm$ 0.08	3.28 $\pm$ 0.05	3.23 $\pm$ 0.07
Buffalo	3.31 $\pm$ 0.09	3.26 $\pm$ 0.01	3.48 $\pm$ 0.09	3.35 $\pm$ 0.03
Parity (number)				
Crossbred cattle	2.23 $\pm$ 0.01	2.64 $\pm$ 0.04	2.15 $\pm$ 0.04	2.34 $\pm$ 0.15
Buffalo	2.45 $\pm$ 0.02	2.35 $\pm$ 0.03	2.75 $\pm$ 0.05	2.52 $\pm$ 0.12

Average daily milk yield (kg)				
Crossbred cattle	10.82±60	10.21±87	14.37±1.70	11.80±1.30
Buffalo	8.52±83	10.04±1.17	12.15±2.14	10.24±1.05
Lactation stage (days)				
Crossbred cattle	37.80±3.23	40.50±4.87	49.20±8.66	42.50±3.44
Buffalo	34.50±5.34	51.10±7.62	36.00±6.48	40.53±5.30
Reproduction parameters				
Age at first conception (months)				
Crossbred cattle	28.67±1.45	32.00±3.28	27.38±1.54	29.35±1.37
Buffalo	37.00±0.90	40.00±1.01	35.25±1.09	37.42±1.39
Lactation length (days)				
Crossbred cattle	296.67±19.65	258±21.35	281.54±12.50	278.74±11.25
Buffalo	322.5±18.87	290.71±13.94	326.25±11.25	313.15±11.27
Dry period (days)				
Crossbred cattle	140.00±13.22	138.00±7.35	126.92±6.03	134.97±4.07
Buffalo	170.00±13.30	143.57±13.77	153.75±14.38	155.77±7.70

4.8 Effect of MNB supplementation on total dry matter intake (kg/h/d)

Effect of MNB supplementation in crossbred cattle and buffaloes are presented Table 4.14 and Figure 4.1 and 4.2. There was significant ($p < 0.05$) difference in daily dry matter intake of crossbred cattle of control and treatment group in Pinjori (T_0 : 12.22±0.06; T_1 : 12.64±0.05 kg/h/d) and Malimajra (T_0 : 11.83±0.01; T_1 : 12.16±0.06 kg/h/d) village. The same effect was observed for pooled values (T_0 : 12.46±0.03; T_1 : 12.73±0.04 kg/h/d). Whereas, non-significant ($p > 0.05$) difference was found in crossbred cattle of Patlion village and buffaloes of all selected villages.

Table 4.14 Mean $\pm$ S.E. of daily dry matter intake (kg/h /d)

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	0	12.37 $\pm$ 0.21	12.77 $\pm$ 0.33	15.73 $\pm$ 0.53	16.17 $\pm$ 0.43
	30	12.25 $\pm$ 0.26	12.48 $\pm$ 0.58	15.96 $\pm$ 0.51	16.23 $\pm$ 0.40
	60	12.01 $\pm$ 0.33	12.60 $\pm$ 0.35	16.08 $\pm$ 0.41	16.11 $\pm$ 0.52
	90	12.18 $\pm$ 0.24	12.63 $\pm$ 0.33	16.49 $\pm$ 0.50	16.27 $\pm$ 0.31
	120	12.29 $\pm$ 0.25	12.67 $\pm$ 0.30	16.21 $\pm$ 0.51	16.26 $\pm$ 0.51
Mean $\pm$ S.E.		12.22$\pm$0.06	12.64$\pm$0.05	16.10$\pm$0.12	16.21$\pm$0.03
Malimajra	N	6	6	6	6
	0	11.84 $\pm$ 0.57	12.22 $\pm$ 0.49	15.57 $\pm$ 0.39	15.89 $\pm$ 0.57
	30	11.81 $\pm$ 0.44	12.31 $\pm$ 0.56	15.61 $\pm$ 0.49	15.83 $\pm$ 0.24
	60	11.80 $\pm$ 0.47	11.95 $\pm$ 0.30	15.97 $\pm$ 0.52	16.18 $\pm$ 0.61
	90	11.84 $\pm$ 0.21	12.23 $\pm$ 0.41	15.95 $\pm$ 0.64	16.47 $\pm$ 0.80
	120	11.85 $\pm$ 0.48	12.08 $\pm$ 0.46	16.04 $\pm$ 0.39	16.46 $\pm$ 0.46
Mean $\pm$ S.E.		11.83^a$\pm$0.01	12.16^b$\pm$0.06	15.83$\pm$0.09	16.17$\pm$0.13
Patlion	N	7	7	7	7
	0	13.44 $\pm$ 0.25	13.43 $\pm$ 0.22	16.16 $\pm$ 0.15	16.53 $\pm$ 0.19
	30	13.34 $\pm$ 0.67	13.33 $\pm$ 0.37	15.77 $\pm$ 0.25	16.50 $\pm$ 0.54
	60	13.23 $\pm$ 0.42	13.26 $\pm$ 0.39	16.34 $\pm$ 0.58	16.55 $\pm$ 0.57
	90	13.29 $\pm$ 0.58	13.46 $\pm$ 0.34	16.36 $\pm$ 0.57	16.84 $\pm$ 0.31
	120	13.40 $\pm$ 0.50	13.53 $\pm$ 0.21	16.71 $\pm$ 0.34	16.94 $\pm$ 0.59
Mean $\pm$ S.E.		13.34$\pm$0.04	13.41$\pm$0.05	16.27$\pm$0.11	16.67$\pm$0.08
Pooled	N	19	19	19	19
	0	12.54 $\pm$ 0.21	12.81 $\pm$ 0.12	15.82 $\pm$ 0.21	16.20 $\pm$ 0.17
	30	12.46 $\pm$ 0.11	12.71 $\pm$ 0.11	15.78 $\pm$ 0.09	16.19 $\pm$ 0.15
	60	12.34 $\pm$ 0.13	12.60 $\pm$ 0.09	16.13 $\pm$ 0.14	16.28 $\pm$ 0.18
	90	12.43 $\pm$ 0.10	12.77 $\pm$ 0.50	16.27 $\pm$ 0.16	16.53 $\pm$ 0.25
	120	12.50 $\pm$ 0.11	12.76 $\pm$ 0.47	16.32 $\pm$ 0.21	16.55 $\pm$ 0.12
Overall mean $\pm$ S.E.		12.46^a$\pm$0.03	12.73^b$\pm$0.04	16.07$\pm$0.17	16.35$\pm$0.23

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

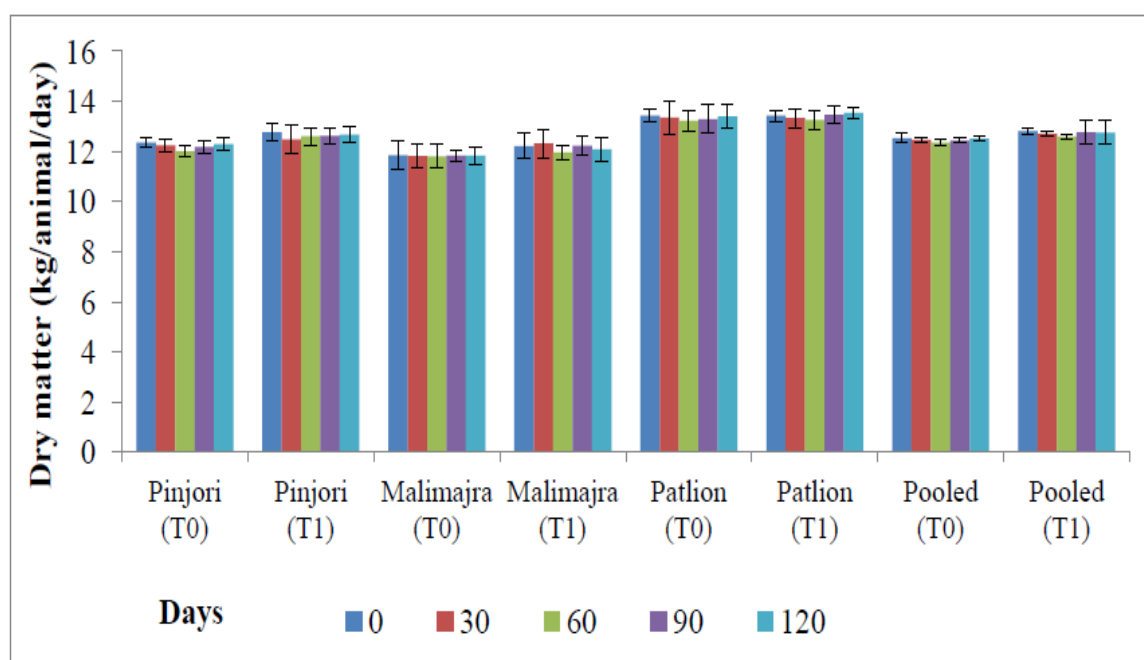


Figure 4.1 Dry matter intake (kg/h/d) of lactating crossbred cattle

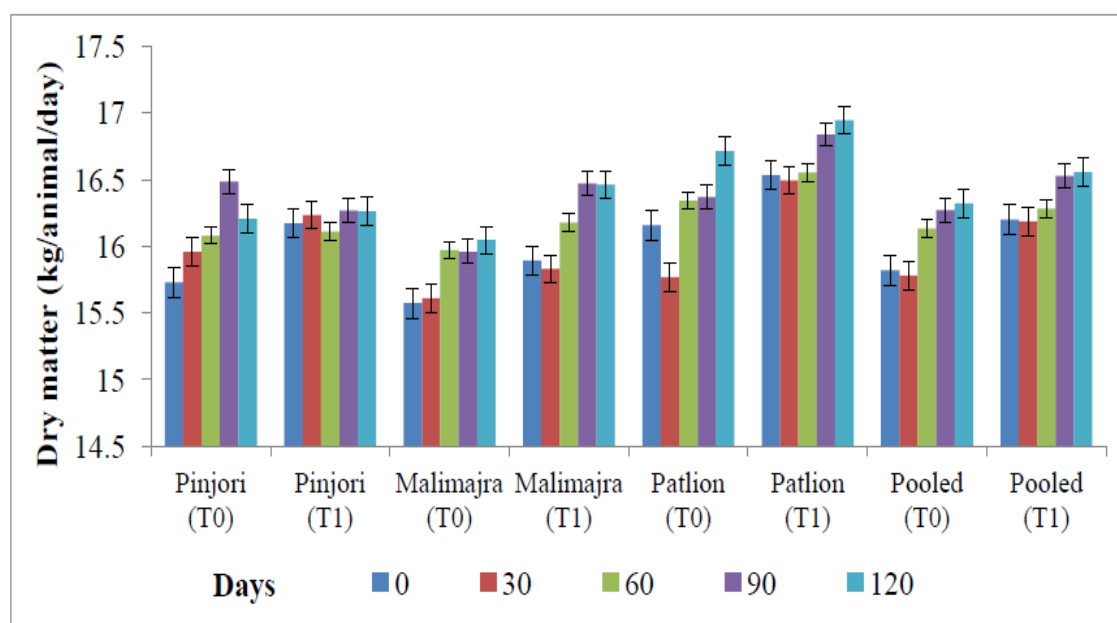


Figure 4.2 Dry matter intake (kg/h/d) of lactating buffaloes

The present findings were in agreement with the results of Sharma and Singh, (2014), Misra *et al.* (2006) and Singh and Singh (2003) in dairy cattle. They reported significantly ($p<0.05$) increase in feed intake due to UMMB supplementation. Sahoo *et al.* (2004) reported non-significant effect of UMMB supplementation on dry matter intake in buffaloes. Kour *et al.* (2022) reported significant ($p<0.05$) higher dry matter intake in treatment group (15.69 ± 0.03) of buffaloes as compared to control group (15.60 ± 0.05) due to UMMB supplementation. Increase in dry matter intake in treatment group may be due to supply of soluble nitrogen and fermentable carbohydrate that helps to optimizes the ruminal fermentation and increased rate of dietary fibre digestion (Leng *et al.* 1991; Tekeba *et al.* 2014).

4.9 Effect of MNB supplementation on dry matter intake (per cent body weight)

The effect of MNB supplementation on dry matter intake (per cent body weight) in crossbred cattle and buffaloes are present in Table 4.15. The differences between control and treatment group was found to be non-significant ($p>0.05$) in crossbred cattle and buffaloes for all selected villages as well as pooled values. The overall pooled value of DM intake in control and treatment group of crossbred cattle was 3.07 ± 0.03 and 3.11 ± 0.04 , respectively, whereas for buffaloes it was 2.68 ± 0.03 and 2.71 ± 0.03 in control and treatment group, respectively.

Similarly, Akter *et al.* (2004) also reported non-significant effect of UMMB supplementation on feed intake in dairy animals. Contrary to our findings Choudhary *et al.* (2018) and Kour *et al.* (2022) reported significant ($p<0.05$) increase in DM intake due to UMMB supplementation.

4.10 Effect of MNB supplementation on milk yield (kg/h/d) in lactating dairy animals

The milk yield (kg/h/d) of lactating crossbred cattle and buffaloes are presented in Table 4.16 and Figure 4.3 and 4.4. The average milk yield (Mean $\pm$ S.E.) was significantly ($P<0.05$) higher in treatment group (11.43 ± 0.60 , 10.94 ± 0.57 and 15.06 ± 0.68 kg/h/d) as compared to control group (10.21 ± 0.18 , 9.48 ± 0.04 and 13.69 ± 0.11 kg/h/d) in crossbred cattle, whereas, the overall milk yield (Mean $\pm$ S.E.) of buffaloes were significantly ($P<0.05$) higher in treatment group (9.06 ± 0.58 , 10.64 ± 0.60 and 13.73 ± 0.72 kg/h/d) as compared to control group (7.98 ± 0.07 , 9.44 ± 0.12 and 11.58 ± 0.16 kg/h/d).

Table 4.15 Mean $\pm$ S.E. of dry matter intake (per cent body weight basis)

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	0	3.01 $\pm$ 0.08	3.06 $\pm$ 0.15	2.59 $\pm$ 0.06	2.67 $\pm$ 0.12
	30	3.02 $\pm$ 0.16	3.03 $\pm$ 0.06	2.64 $\pm$ 0.07	2.70 $\pm$ 0.09
	60	3.00 $\pm$ 0.09	3.10 $\pm$ 0.14	2.69 $\pm$ 0.10	2.70 $\pm$ 0.12
	90	3.08 $\pm$ 0.13	3.15 $\pm$ 0.08	2.77 $\pm$ 0.04	2.76 $\pm$ 0.13
	120	3.11 $\pm$ 0.09	3.18 $\pm$ 0.12	2.75 $\pm$ 0.06	2.78 $\pm$ 0.08
Mean $\pm$ S.E.		3.04$\pm$0.06	3.10$\pm$0.05	2.69$\pm$0.03	2.72$\pm$0.02
Malimajra	N	6	6	6	6
	0	2.96 $\pm$ 0.09	2.98 $\pm$ 0.12	2.61 $\pm$ 0.12	2.59 $\pm$ 0.13
	30	2.98 $\pm$ 0.10	3.04 $\pm$ 0.07	2.63 $\pm$ 0.08	2.61 $\pm$ 0.08
	60	2.99 $\pm$ 0.06	2.98 $\pm$ 0.05	2.71 $\pm$ 0.07	2.7 $\pm$ 0.06
	90	3.01 $\pm$ 0.06	3.09 $\pm$ 0.11	2.71 $\pm$ 0.05	2.76 $\pm$ 0.06
	120	3.04 $\pm$ 0.02	3.12 $\pm$ 0.04	2.74 $\pm$ 0.10	2.77 $\pm$ 0.05
Mean $\pm$ S.E.		2.99$\pm$0.01	3.04$\pm$0.064	2.68$\pm$0.03	2.69$\pm$0.04
Patlioni	N	7	7	7	7
	0	3.13 $\pm$ 0.10	3.11 $\pm$ 0.09	2.64 $\pm$ 0.02	2.67 $\pm$ 0.09
	30	3.14 $\pm$ 0.06	3.12 $\pm$ 0.13	2.59 $\pm$ 0.10	2.67 $\pm$ 0.08
	60	3.17 $\pm$ 0.14	3.16 $\pm$ 0.16	2.69 $\pm$ 0.06	2.69 $\pm$ 0.11
	90	3.18 $\pm$ 0.09	3.19 $\pm$ 0.08	2.71 $\pm$ 0.09	2.74 $\pm$ 0.08
	120	3.20 $\pm$ 0.12	3.24 $\pm$ 0.11	2.77 $\pm$ 0.14	2.77 $\pm$ 0.10
Mean $\pm$ S.E.		3.16$\pm$0.04	3.16$\pm$0.05	2.68$\pm$0.03	2.71$\pm$0.02
Pooled	N	19	19	19	19
	0	3.03 $\pm$ 0.08	3.05 $\pm$ 0.15	2.61 $\pm$ 0.10	2.64 $\pm$ 0.12
	30	3.05 $\pm$ 0.06	3.06 $\pm$ 0.08	2.62 $\pm$ 0.12	2.66 $\pm$ 0.06
	60	3.05 $\pm$ 0.02	3.08 $\pm$ 0.12	2.70 $\pm$ 0.10	2.70 $\pm$ 0.07
	90	3.09 $\pm$ 0.15	3.14 $\pm$ 0.10	2.73 $\pm$ 0.09	2.75 $\pm$ 0.07
	120	3.11 $\pm$ 0.10	3.18 $\pm$ 0.11	2.75 $\pm$ 0.12	2.77 $\pm$ 0.08
Overall mean $\pm$ S.E.		3.07$\pm$0.03	3.11$\pm$0.04	2.68$\pm$0.03	2.71$\pm$0.03

The pooled value of milk yield of crossbred cattle and buffaloes were significantly ($p<0.05$) higher in control (11.13 ± 1.35 and 9.67 ± 1.19 kg/h/d) as compared to treatment (12.47 ± 1.89 and 10.81 ± 0.99 kg/h/d) group. In present study on increase of 12.03 per cent in milk of crossbred cattle and 11.78 per cent milk yield in buffaloes were recorded due to supplementary feeding of MNB.

Similar finding were reported by various authors on supplementation of urea molasses block to dairy cattle (Sharma and Singh, 2014; Tripathi *et al.*, 2006 and Patil *et al.* 2019). Akter *et al.* (2004) reported significant ($P<0.01$) increase in milk production (2.86 to 4.43 litre/day) of dairy cattle. Gupta *et al.* (2018) observed significantly higher average daily milk yield in UMMB supplemented group (13.25 ± 1.53 litres) of crossbred cattle as compared to non-supplemented group (11.46 ± 1.19 litre). Patidar *et al.* (2014) reported that supplementation of MNB, increased milk yield by 11.45% in cows and 6.30% in buffaloes. The higher level milk production was due to positive effect of MNB supplementation on rumen environment which ultimately leads to higher microbial protein synthesis (Sharma and Singh, 2014). Another reason for increased milk production may be due to increased dry matter intake (Uperti *et al.* 2010), increased intake of energy and nitrogen (Akter *et al.* 2004).

Table 4.16: Mean $\pm$ S.E. milk yield (kg/h/ d) of crossbred cattle and buffaloes

Village		Crossbred cattle		Buffaloes	
Pinjori	N	6	6	6	6
	Day	T ₀	T ₁	T ₀	T ₁
	0-15	9.67 $\pm$ 0.93	9.75 $\pm$ 1.08	7.62 $\pm$ 1.09	7.76 $\pm$ 0.83
	15-30	9.83 $\pm$.91	11.05 $\pm$ 1.10	7.80 $\pm$ 1.03	8.12 $\pm$ 0.93
	30-45	9.99 $\pm$ 0.89	11.78 $\pm$ 1.04	7.78 $\pm$ 0.78	9.49 $\pm$ 1.03
	45-60	10.54 $\pm$ 0.92	12.93 $\pm$ 1.14	8.13 $\pm$ 1.09	9.49 $\pm$ 1.03
	60-75	10.92 $\pm$ 0.90	12.56 $\pm$ 1.18	8.27 $\pm$ 1.03	9.75 $\pm$ 1.04
	75-90	10.61 $\pm$ 0.87	12.34 $\pm$ 1.17	8.22 $\pm$ 0.78	9.68 $\pm$ 0.97
	90-105	10.28 $\pm$ 0.91	12.15 $\pm$ 1.12	8.17 $\pm$ 1.09	9.43 $\pm$ 1.15
	105-120	9.91 $\pm$ 0.95	11.81 $\pm$ 1.13	7.87 $\pm$ 0.82	8.87 $\pm$ 1.06
Mean $\pm$ S.E.		10.21^a$\pm$0.18	11.43^b$\pm$0.60	7.98^a$\pm$0.07	9.06^b$\pm$0.58

Results and Discussion

Malimajra	N	6	6	6	6
	0-15	8.96±0.60	9.42±1.26	9.10±0.30	9.50±0.92
	15-30	9.28±0.68	9.69±1.19	9.45±0.40	9.63±0.93
	30-45	9.47±0.70	10.16±1.09	9.56±0.39	9.71±0.95
	45-60	9.88±0.63	11.63±1.10	9.94±0.36	10.42±0.88
	60-75	9.86±0.66	12.04±1.07	9.77±0.37	11.75±0.91
	75-90	9.97±0.64	12.09±1.03	9.51±0.33	11.69±1.40
	90-105	9.53±0.62	11.40±1.04	9.34±0.31	11.39±0.99
	105-120	8.86±0.60	11.07±1.02	8.87±0.34	10.99±1.01
Mean ± S.E.		9.48^a±0.04	10.94^b±0.57	9.44^a±0.12	10.63^b±0.60
Patlion	N	7	7	7	7
	0-15	13.36±2.09	13.67±2.02	10.57±1.63	10.38±1.92
	15-30	13.57±2.21	14.07±2.11	11.31±1.40	11.61±1.93
	30-45	13.92±2.29	14.74±2.06	11.97±1.79	12.41±1.95
	45-60	14.54±2.33	15.67±2.09	12.67±1.83	13.99±1.88
	60-75	13.93±2.30	16.12±2.21	12.54±1.87	13.70±1.91
	75-90	13.75±2.2	15.79±2.21	11.90±1.83	13.54±1.40
	90-105	13.30±2.34	15.41±2.23	11.08±1.71	13.29±1.99
	105-120	13.08±2.33	14.98±2.26	10.61±2.01	12.98±2.03
Mean ± S.E.		13.69^a±0.11	15.06^b±0.68	11.58^a±0.16	12.73^b±0.72
Pooled	N	19	19	19	19
	0-15	10.66±1.31	10.95±1.73	9.10±0.96	9.21±0.78
	15-30	10.89±1.40	11.27±1.80	9.52±1.10	9.79±0.86
	30-45	11.12±1.33	11.89±1.79	9.77±1.25	10.50±0.95
	45-60	11.65±1.35	13.08±1.85	10.24±1.21	11.30±1.01
	60-75	11.61±1.48	13.57±1.95	10.19±1.23	11.74±1.02
	75-90	11.41±1.38	13.41±1.99	9.88±1.31	11.64±1.11
	90-105	11.04±1.22	12.99±2.20	9.53±1.19	11.37±0.99
	105-120	10.62±1.34	12.62±1.86	9.11±1.30	10.95±1.05
Overall mean ± S.E.		11.13^a±1.35	12.47^b±1.89	9.67^a±1.19	10.81^b±0.99

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

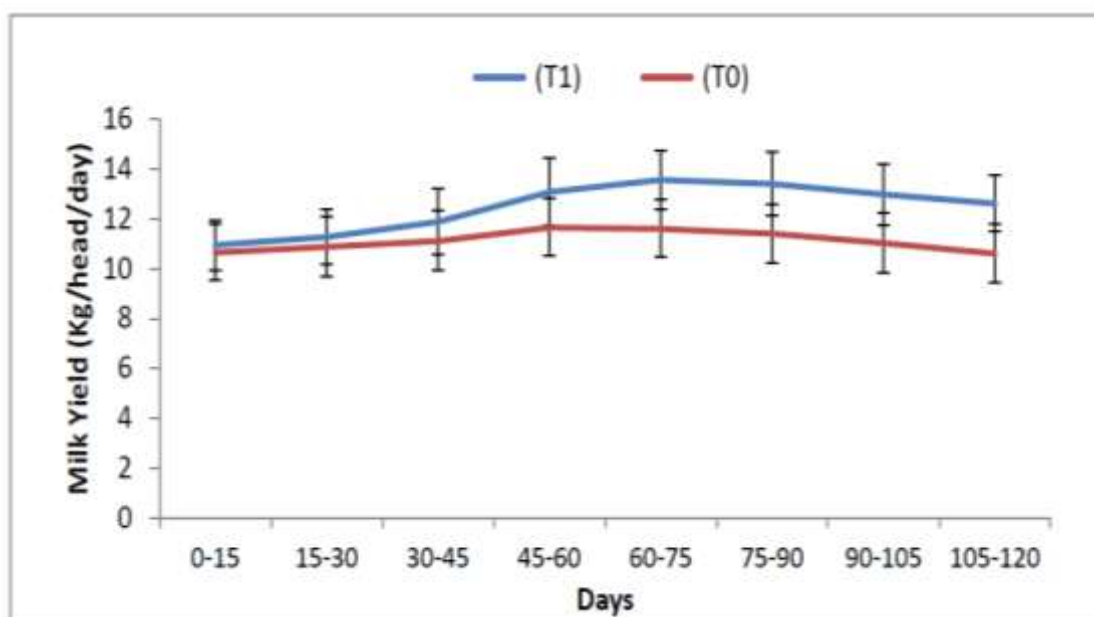


Figure 4.3 Milk yield (kg/h/ d) of lactating crossbred cattle (Pooled)

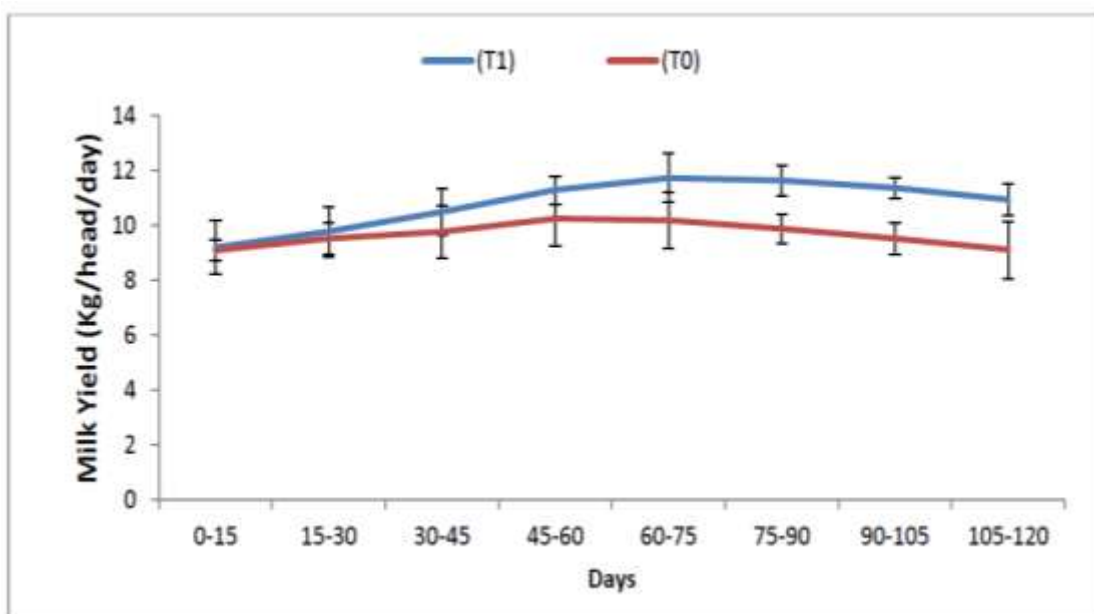


Figure 4.4 Milk yield (kg/h/d) of lactating buffaloes (Pooled)

4.11 Effect of MNB supplementation on milk composition of lactating dairy animals

4.11.1 Milk fat (per cent) of lactating crossbred cattle and buffaloes

The milk fat per cent of lactating crossbred cattle and buffaloes are presented in Table 4.17 and Figure 4.5 and 4.6. The overall milk fat per cent in Pinjori village of crossbred cattle were significantly ($P<0.05$) higher in treatment group (4.26 ± 0.02) as compared to control group (4.03 ± 0.02). Overall pooled value of fat per cent was significantly ($P<0.05$) higher in treatment group (4.31 ± 0.14 and 7.59 ± 0.09) and as compared to control group (4.12 ± 0.14 and 7.49 ± 0.05) in crossbred cattle and buffaloes. Similar findings of increase in milk fat per cent due to UMMB supplementation were reported by Upreti *et al.* (2010) in Jersey cattle. Sahoo *et al.* (2009), Jayawickrama *et al.* (2013), Tekeba *et al.* (2014) and Kumar *et al.* (2018) in crossbred cattle and Garg *et al.* (2016) in buffaloes. The significantly ($p<0.05$) higher milk fat in treatment group may be due to increased dry matter intake and better nutrition management to the treatment group of dairy animals (Upreti *et al.* 2010). It may also be associated with the higher cellulolytic fibre utilization by the microbes in the presence of urea ammonia of UMMB (Mengistu and Hassen, 2018), as in the present study also, significant ($p<0.05$) higher level of blood urea was obtained in both cattle and buffaloes.

4.11.2 Milk SNF (per cent) of lactating crossbred cattle and buffaloes

The milk SNF content of lactating crossbred cattle and buffaloes are presented in Table 4.18 and Figure 4.7 and 4.8. Non-significant ($P<0.05$) difference of milk SNF between control and treatment group of crossbred cattle and buffaloes was observed in selected villages. The pooled SNF per cent in milk was significantly ($P<0.05$) higher in treatment group (8.70 ± 0.02 per cent) as compared with control group (8.60 ± 0.03 per cent) in crossbred cattle, whereas non-significant difference was recorded between control and treatment group in buffaloes.

The findings of present experiment are in accordance with the results reported by Upreti *et al.* (2010) in Jersey cattle. Tekeba *et al.* (2014) observed in Fogera and crossbred cows. Contrary to this, non-significant effect of UMMB supplementation on milk SNF in buffaloes was reported by Shah *et al.* (2018). The significant ($p<0.05$) increase in milk SNF in treatment group was mainly due to better feed management and nutrition of dairy animals (Upreti *et al.* 2010). Garg *et al.* (2016) reported that, UMMB provided the optimum level of energy, protein and mineral for rumen function and synthesis of milk component in mammary gland.

Table 4.17: Mean $\pm$ S.E. values of milk fat % of lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	30	4.03 $\pm$ 0.07	4.31 $\pm$ 0.29	7.47 $\pm$ 0.42	7.55 $\pm$ 0.90
	60	3.99 $\pm$ 0.25	4.22 $\pm$ 0.50	7.38 $\pm$ 0.38	7.62 $\pm$ 0.75
	90	4.07 $\pm$ 0.21	4.22 $\pm$ 0.45	7.48 $\pm$ 0.39	7.58 $\pm$ 0.65
	120	4.02 $\pm$ 0.24	4.30 $\pm$ 0.43	7.39 $\pm$ 0.35	7.58 $\pm$ 0.77
Mean $\pm$ S.E.		4.03^a$\pm$0.02	4.26^b$\pm$0.02	7.43$\pm$0.05	7.58$\pm$0.03
Malimajra	N	6	6	6	6
	30	4.02 $\pm$ 0.24	4.18 $\pm$ 0.39	7.67 $\pm$ 0.25	7.74 $\pm$ 0.50
	60	3.85 $\pm$ 0.33	3.97 $\pm$ 0.44	7.70 $\pm$ 0.49	7.69 $\pm$ 0.62
	90	3.98 $\pm$ 0.28	4.08 $\pm$ 0.45	7.62 $\pm$ 0.41	7.73 $\pm$ 0.59
	120	3.84 $\pm$ 0.33	4.39 $\pm$ 0.47	7.63 $\pm$ 0.30	7.74 $\pm$ 0.53
Mean $\pm$ S.E.		3.92$\pm$0.02	4.16$\pm$0.09	7.66$\pm$0.07	7.73$\pm$0.04
Patlion	N	7	7	7	7
	30	4.38 $\pm$ 0.21	4.56 $\pm$ 0.25	7.39 $\pm$ 0.47	7.47 $\pm$ 0.60
	60	4.62 $\pm$ 0.20	4.52 $\pm$ 0.24	7.42 $\pm$ 0.42	7.39 $\pm$ 0.56
	90	4.83 $\pm$ 0.18	4.53 $\pm$ 0.21	7.36 $\pm$ 0.46	7.45 $\pm$ 0.55
	120	4.71 $\pm$ 0.19	4.50 $\pm$ 0.20	7.31 $\pm$ 0.41	7.49 $\pm$ 0.53
Mean $\pm$ S.E.		4.41$\pm$0.02	4.35$\pm$0.01	7.37$\pm$0.02	7.45$\pm$1.01
Pooled	N	19	19	19	19
	30	4.14 $\pm$ 0.15	4.35 $\pm$ 0.06	7.51 $\pm$ 0.03	7.58 $\pm$ 0.01
	60	4.04 $\pm$ 0.14	4.24 $\pm$ 0.19	7.50 $\pm$ 0.04	7.57 $\pm$ 0.12
	90	4.18 $\pm$ 0.17	4.27 $\pm$ 0.24	7.49 $\pm$ 0.10	7.62 $\pm$ 0.12
	120	4.10 $\pm$ 0.17	4.36 $\pm$ 0.13	7.46 $\pm$ 0.07	7.58 $\pm$ 0.13
Overall Mean $\pm$ S.E.		4.12^a$\pm$0.14	4.31^b$\pm$0.14	7.49^a$\pm$0.05	7.59^b$\pm$0.09

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

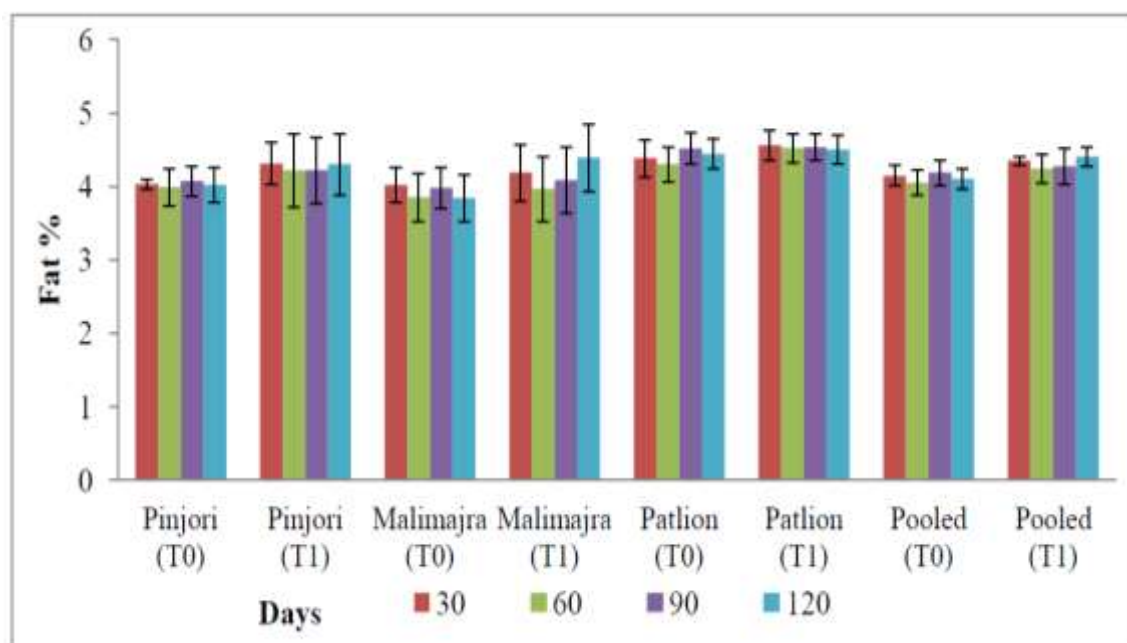


Figure 4.5 Milk fat per cent in lactating crossbred cattle

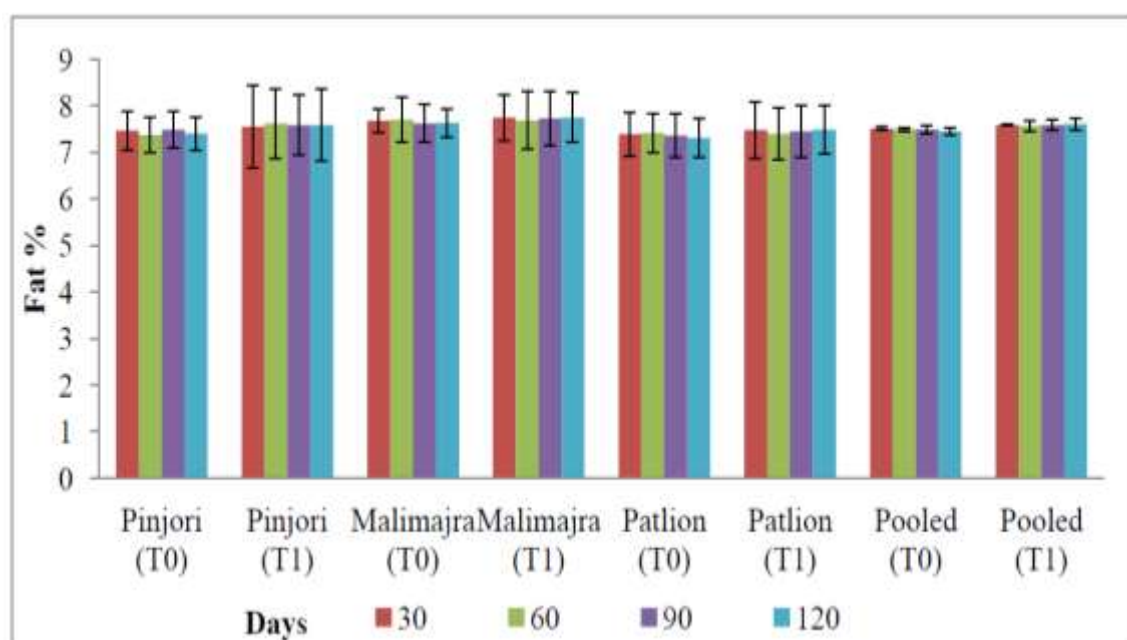


Figure 4.6 Milk fat per cent in lactating buffaloes

Table 4.18: Mean $\pm$ S.E. value of SNF % of lactating crossbred cattle and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	30	8.46 $\pm$ 0.40	8.70 $\pm$ 0.18	9.16 $\pm$ 0.37	9.14 $\pm$ 0.33
	60	8.67 $\pm$ 0.45	8.80 $\pm$ 0.15	9.23 $\pm$ 0.27	9.18 $\pm$ 0.37
	90	8.77 $\pm$ 0.45	8.82 $\pm$ 0.11	9.39 $\pm$ 0.33	9.39 $\pm$ 0.42
	120	8.75 $\pm$ 0.39	8.77 $\pm$ 0.12	9.43 $\pm$ 0.29	9.26 $\pm$ 0.41
Mean $\pm$ S.E.		8.67$\pm$0.07	8.78$\pm$0.03	9.30$\pm$0.04	9.24$\pm$0.06
Malimajra	N	6	6	6	6
	30	8.64 $\pm$ 0.33	8.77 $\pm$ 0.42	9.26 $\pm$ 0.33	9.13 $\pm$ 0.37
	60	8.47 $\pm$ 0.52	8.67 $\pm$ 0.30	9.50 $\pm$ 0.52	8.76 $\pm$ 0.50
	90	8.53 $\pm$ 0.47	8.48 $\pm$ 0.43	9.41 $\pm$ 0.47	9.20 $\pm$ 0.39
	120	8.45 $\pm$ 0.53	8.53 $\pm$ 0.26	9.37 $\pm$ 0.53	9.19 $\pm$ 0.44
Mean $\pm$ S.E.		8.52$\pm$0.04	8.62$\pm$0.06	9.39$\pm$0.11	9.07$\pm$0.05s
Patlion	N	7	7	7	7
	30	8.88 $\pm$ 0.27	8.66 $\pm$ 0.20	9.19 $\pm$ 0.02	9.43 $\pm$ 0.27
	60	8.52 $\pm$ 0.20	8.76 $\pm$ 0.21	9.36 $\pm$ 0.22	9.48 $\pm$ 0.26
	90	8.56 $\pm$ 0.22	8.75 $\pm$ 0.17	9.07 $\pm$ 0.21	9.63 $\pm$ 0.22
	120	8.52 $\pm$ 0.05	8.65 $\pm$ 0.17	9.54 $\pm$ 0.23	9.51 $\pm$ 0.30
Mean $\pm$ S.E.		8.62$\pm$0.07	8.71$\pm$0.03	9.29$\pm$0.18	9.52$\pm$0.02
Pooled	N	19	19	19	19
	30	8.66 $\pm$ 0.09	8.71 $\pm$ 0.07	9.20 $\pm$ 0.03	9.23 $\pm$ 0.11
	60	8.55 $\pm$ 0.04	8.75 $\pm$ 0.02	9.36 $\pm$ 0.33	9.14 $\pm$ 0.10
	90	8.62 $\pm$ 0.08	8.68 $\pm$ 0.06	9.29 $\pm$ 0.05	9.41 $\pm$ 0.07
	120	8.58 $\pm$ 0.04	8.65 $\pm$ 0.09	9.45 $\pm$ 0.13	9.32 $\pm$ 0.06
Overall mean $\pm$ S.E.		8.60^a$\pm$0.03	8.70^b$\pm$0.02	9.32$\pm$0.14	9.28$\pm$0.09

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

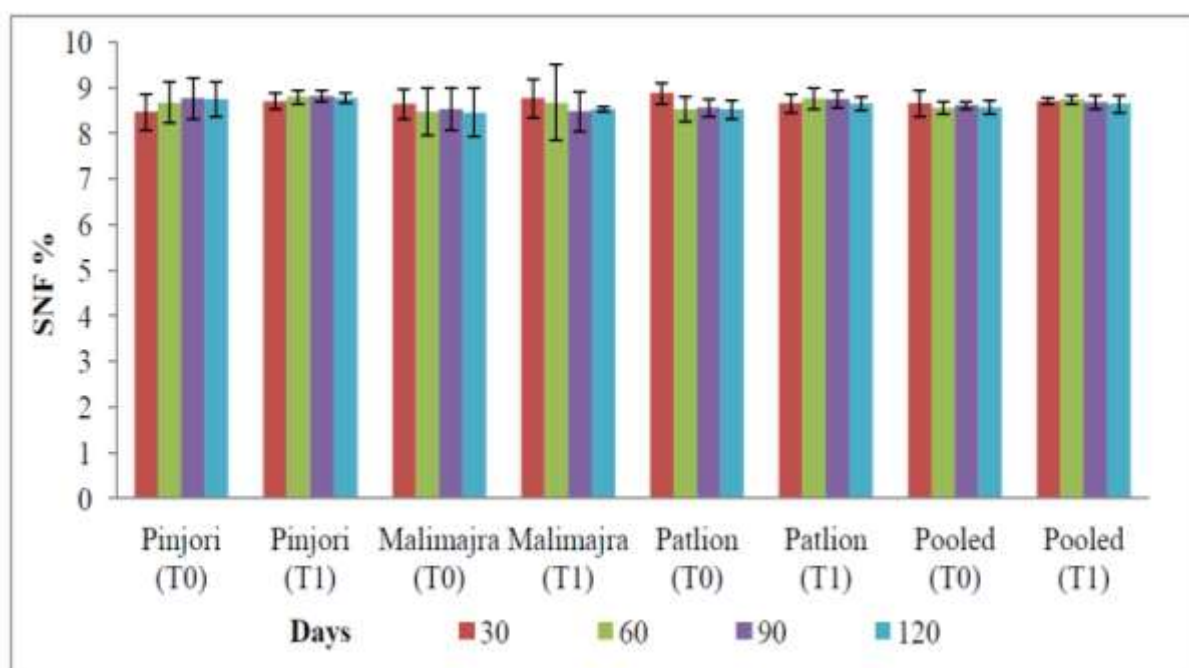


Figure 4.7 Milk SNF per cent in lactating crossbred cattle

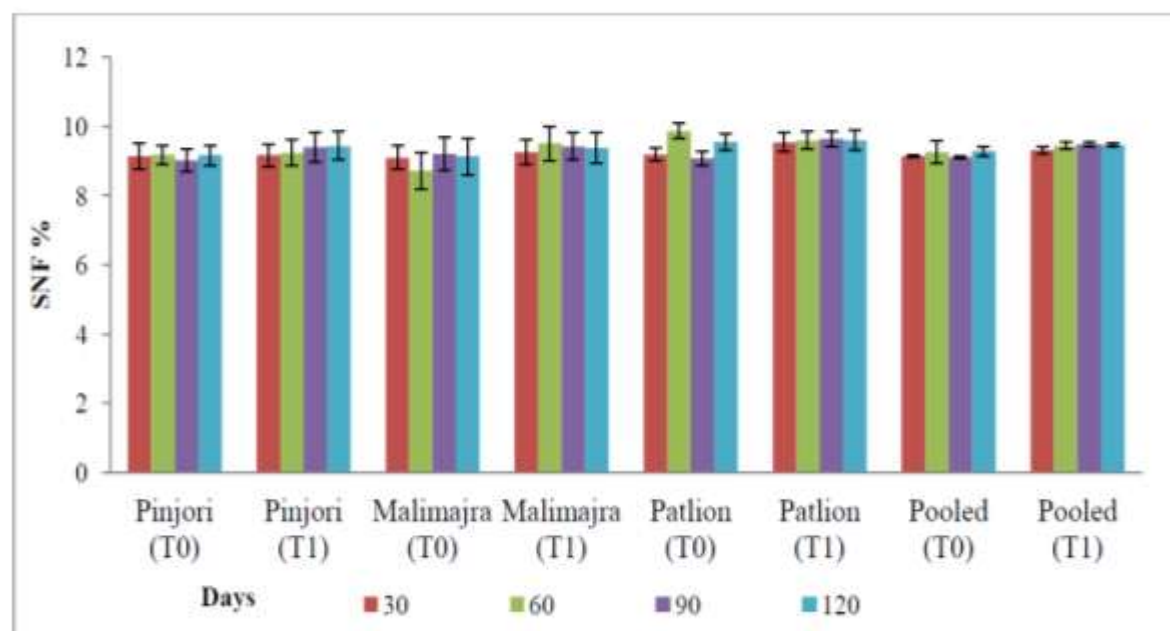


Figure 4.8 Milk SNF per cent in lactating buffaloes

4.11.3 Milk protein (per cent) of lactating crossbred cattle and buffaloes

The effect of MNB supplementation on milk protein is presented in Table 4.19 and Figure 4.9 and 4.10. Non-significant difference was observed in milk protein between treatment and control group in crossbred cattle and buffaloes in the all three villages. The pooled value of control and treatment group was 3.22 ± 0.10 per cent and 3.31 ± 0.03 per cent in crossbred cattle whereas, it was 3.44 ± 0.02 per cent and 3.36 ± 0.12 per cent in buffaloes.

Akter *et al.* (2004) observed non-significant effect of UMMB supplementation on milk protein in dairy cow. Jayawickrama *et al.* (2013) also reported non-significant effect of UMMB supplementation on milk protein of crossbred cattle. Non-significant effect on milk protein due to UMMB supplementation was reported by Kachhawaha *et al.* (2022) and Shah *et al.* (2018) in buffaloes.

4.12 Effect of MNB supplementation on body condition score and body weight (kg) of lactating dairy animals

4.12.1 Body condition score (BCS) of lactating crossbred cattle and buffaloes

The body condition score of lactating crossbred cattle and buffaloes are presented in Table 4.20 and Figure 4.11 and 4.12. There was non-significant ($P > 0.05$) difference observed between control (2.90 ± 0.12 and 2.99 ± 0.10) and treatment (2.95 ± 0.15 and 3.10 ± 0.08) group of crossbred cattle and buffaloes.

Similarly, non-significant ($P > 0.05$) effect of BCS of dairy cows were reported by Akter *et al.* (2004) due to UMMB supplementation, however, final body condition score of treatment group (initial: 2.71; Final: 3) of dairy cows was higher as compared to control group (initial: 2.71; Final: 2.79). Similar results ($P > 0.05$) were reported by Windsor *et al.* (2021) in Asiatic swamp buffaloes.

Table 4.19: Mean $\pm$ S.E. value of milk protein % of lactating crossbred cattle and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	30	3.28 $\pm$ 0.21	3.39 $\pm$ 0.23	3.36 $\pm$ 0.13	3.61 $\pm$ 0.11
	60	3.36 $\pm$ 0.18	3.28 $\pm$ 0.19	3.54 $\pm$ 0.25	3.27 $\pm$ 0.15
	90	3.44 $\pm$ 0.17	3.57 $\pm$ 0.16	3.47 $\pm$ 0.13	3.38 $\pm$ 0.13
	120	3.47 $\pm$ 0.07	3.46 $\pm$ 0.29	3.67 $\pm$ 0.15	3.26 $\pm$ 0.14
Mean $\pm$ S.E.		3.39$\pm$0.04	3.43$\pm$0.06	3.49$\pm$0.04	3.40$\pm$0.08
Malimajra	N	6	6	6	6
	30	2.97 $\pm$ 0.18	3.13 $\pm$ 0.10	3.62 $\pm$ 0.15	3.56 $\pm$ 0.20
	60	3.05 $\pm$ 0.20	3.23 $\pm$ 0.17	3.55 $\pm$ 0.15	3.55 $\pm$ 0.18
	90	3.14 $\pm$ 0.15	3.33 $\pm$ 0.18	3.47 $\pm$ 0.11	3.55 $\pm$ 0.17
	120	3.22 $\pm$ 0.24	3.35 $\pm$ 0.39	3.54 $\pm$ 0.16	2.59 $\pm$ 0.16
Mean $\pm$ S.E.		3.10$\pm$0.07	3.25$\pm$0.05	3.54$\pm$0.04	3.54$\pm$0.03
Patlion	N	7	7	7	7
	30	3.16 $\pm$ 0.15	3.32 $\pm$ 0.20	3.38 $\pm$ 0.17	2.98 $\pm$ 0.12
	60	3.08 $\pm$ 0.14	3.09 $\pm$ 0.18	3.27 $\pm$ 0.20	3.14 $\pm$ 0.14
	90	3.21 $\pm$ 0.15	3.26 $\pm$ 0.17	3.26 $\pm$ 0.16	3.30 $\pm$ 0.13
	120	3.27 $\pm$ 0.25	3.37 $\pm$ 0.21	3.28 $\pm$ 0.17	3.14 $\pm$ 0.23
Mean $\pm$ S.E.		3.18$\pm$0.04	3.26$\pm$0.06	3.26$\pm$0.05	3.15$\pm$0.08
Pooled	N	19	19	19	19
	30	3.14 $\pm$ 0.13	3.28 $\pm$ 0.06	3.46 $\pm$ 0.08	3.38 $\pm$ 0.17
	60	3.16 $\pm$ 0.09	3.20 $\pm$ 0.05	3.42 $\pm$ 0.09	3.32 $\pm$ 0.12
	90	3.26 $\pm$ 0.13	3.38 $\pm$ 0.04	3.40 $\pm$ 0.04	3.36 $\pm$ 0.11
	120	3.32 $\pm$ 0.08	3.39 $\pm$ 0.03	3.50 $\pm$ 0.04	3.35 $\pm$ 0.13
Overall mean $\pm$ S.E.		3.22$\pm$0.10	3.31$\pm$0.03	3.44$\pm$0.02	3.36$\pm$0.12

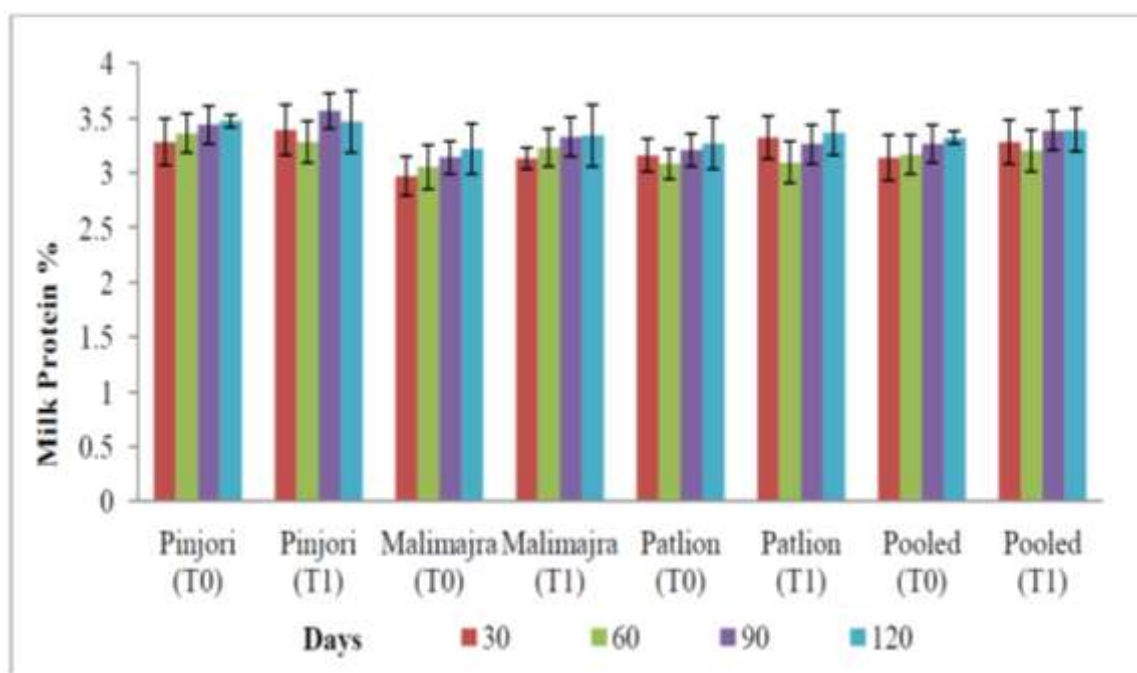


Figure 4.9 Milk protein per cent in lactating crossbred cattle

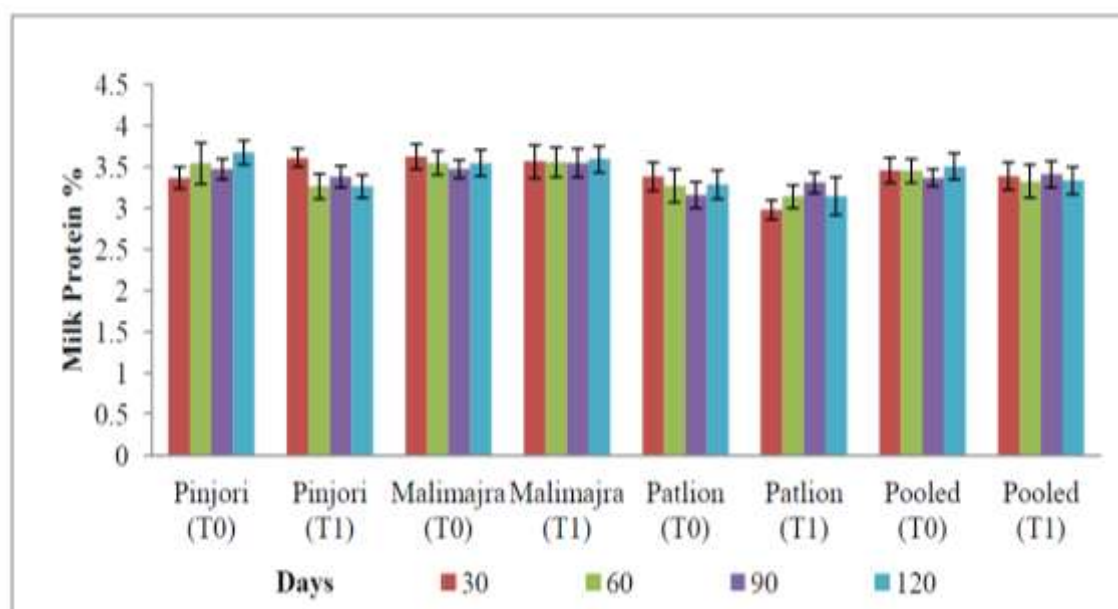


Figure 4.10 Milk protein per cent in lactating buffaloes

Table 4.20: Mean $\pm$ S.E. of BCS in lactating crossbred cattle and buffaloes

Village		Crossbred cattle		Buffaloes	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	0	3.32 $\pm$ 0.16	3.26 $\pm$ 0.07	3.27 $\pm$ 0.15	3.35 $\pm$ 0.08
	30	3.18 $\pm$ 0.14	3.20 $\pm$ 0.6	3.16 $\pm$ 0.06	3.33 $\pm$ 0.16
	60	2.51 $\pm$ 0.15	2.96 $\pm$ 0.07	3.08 $\pm$ 0.14	3.11 $\pm$ 0.09
	90	2.53 $\pm$ 0.13	3.10 $\pm$ 0.16	2.80 $\pm$ 0.09	3.13 $\pm$ 0.13
	120	2.98 $\pm$ 0.07	3.26 $\pm$ 0.16	2.84 $\pm$ 0.09	3.20 $\pm$ 0.04
Mean $\pm$ S.E.		2.90$\pm$0.09	3.16$\pm$0.35	3.03$\pm$0.12	3.22$\pm$0.04
Malimajra	N	6	6	6	6
	0	3.11 $\pm$ 0.03	3.13 $\pm$ 0.02	3.26 $\pm$ 0.06	3.26 $\pm$ 0.08
	30	2.97 $\pm$ 0.04	2.83 $\pm$ 0.03	2.74 $\pm$ 0.12	2.73 $\pm$ 0.13
	60	2.72 $\pm$ 0.02	2.70 $\pm$ 0.03	2.72 $\pm$ 0.06	2.41 $\pm$ 0.05
	90	2.76 $\pm$ 0.06	2.73 $\pm$ 0.02	2.32 $\pm$ 0.03	2.51 $\pm$ 0.02
	120	2.77 $\pm$ 0.07	2.74 $\pm$ 0.06	2.38 $\pm$ 0.05	2.76 $\pm$ 0.05
Mean $\pm$ S.E.		2.86$\pm$0.14	2.83$\pm$0.03	2.68$\pm$0.04	2.73$\pm$0.05
Patlion	N	7	7	7	7
	0	3.23 $\pm$ 0.17	3.33 $\pm$ 0.15	3.41 $\pm$ 0.06	3.54 $\pm$ 0.10
	30	3.06 $\pm$ 0.15	3.12 $\pm$ 0.12	3.33 $\pm$ 0.07	3.41 $\pm$ 0.09
	60	2.68 $\pm$ 0.08	2.52 $\pm$ 0.09	3.28 $\pm$ 0.07	3.20 $\pm$ 0.10
	90	2.72 $\pm$ 0.15	2.51 $\pm$ 0.12	3.14 $\pm$ 0.08	3.24 $\pm$ 0.04
	120	2.91 $\pm$ 0.05	2.79 $\pm$ 0.13	3.23 $\pm$ 0.08	3.35 $\pm$ 0.06
Mean $\pm$ S.E.		2.92$\pm$0.17	2.85$\pm$0.04	3.24$\pm$0.15	3.35$\pm$0.07
Pooled	N	19	19	19	19
	0	3.22 $\pm$ 0.10	3.25 $\pm$ 0.10	3.31 $\pm$ 0.10	3.38 $\pm$ 0.08
	30	3.07 $\pm$ 0.16	3.05 $\pm$ 0.15	3.07 $\pm$ 0.06	3.16 $\pm$ 0.16
	60	2.64 $\pm$ 0.15	2.73 $\pm$ 0.13	3.02 $\pm$ 0.14	2.90 $\pm$ 0.09
	90	2.67 $\pm$ 0.17	2.78 $\pm$ 0.18	2.75 $\pm$ 0.09	2.96 $\pm$ 0.13
	120	2.89 $\pm$ 0.02	2.93 $\pm$ 0.18	2.82 $\pm$ 0.12	3.10 $\pm$ 0.04
Overall mean $\pm$ S.E.		2.90$\pm$0.12	2.95$\pm$0.15	2.99$\pm$0.10	3.10$\pm$0.08

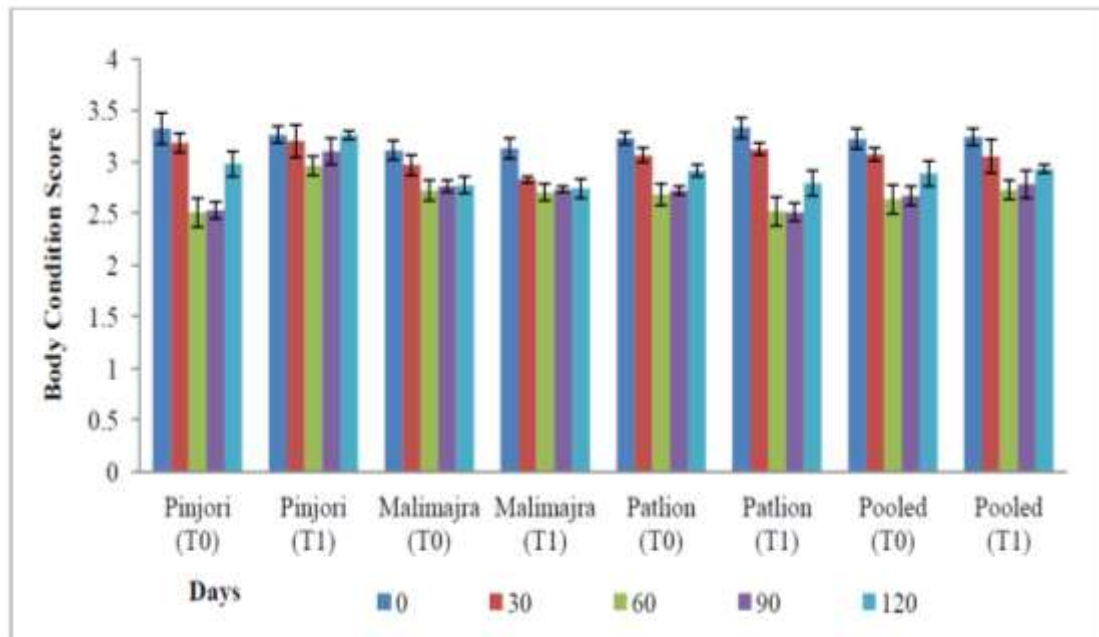


Figure 4.11 Body condition score in lactating crossbred cattle

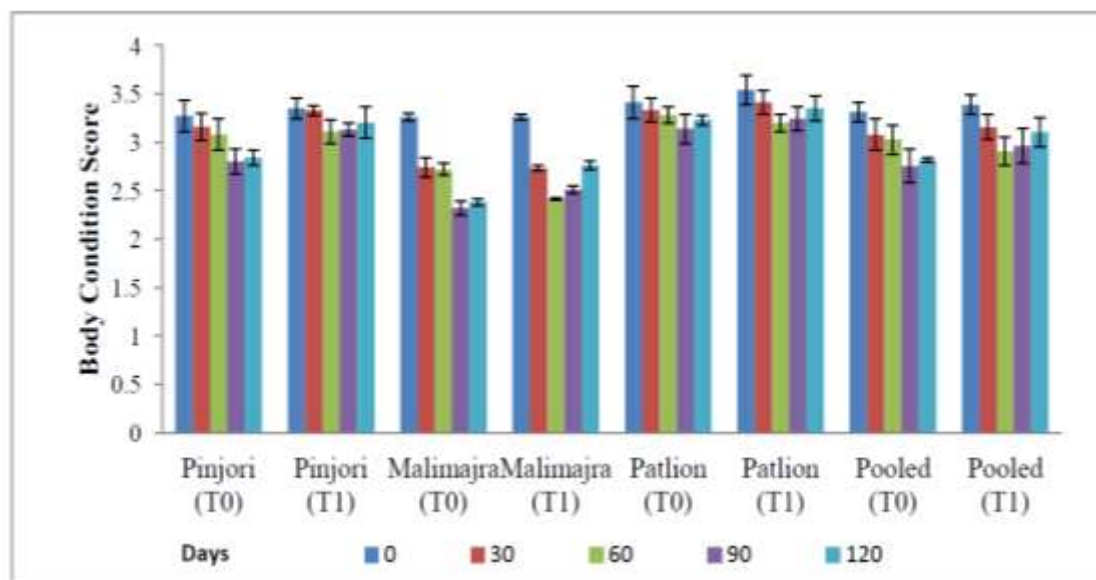


Figure 4.12 Body condition score in lactating buffaloes

4.12.2 Average body weight (kg) of lactating crossbred cattle and buffaloes

The mean body weight of lactating crossbred cattle and buffaloes at 0, 30, 60, 90, 120 days are presented in Table 4.21 and Figure 4.13 and 4.14. The mean body weight (kg) of crossbred cattle and buffaloes of all three villages in control and treatment group did not differ significantly ($P>0.05$). The pooled value of body weight (kg) of control and treatment group in crossbred cattle was 406.07 ± 11.21 and 410.21 ± 9.96 kg, respectively, whereas in control and treatment group of buffalo it was 563.64 ± 4.56 and 568.47 ± 12.39 kg.

Similarly, non-significant ($P>0.05$) effect of body weight of dairy cows were reported by Akter *et al.* (2004) in due to UMMB supplementation, However final body of treatment group (initial: 202.14 kg; Final: 204.57 kg) of dairy cows was higher as compared to control group (initial: 196.43kg; Final: 196.23 kg). Contrary to our findings, Choubey *et al.* (2015) reported significant ($p<0.05$) increase in body weight in treatment group (603.85 g/day) of buffaloes as compared to control (350.18 g/day) group of due to UMMB supplementation.

4.13 Effect of MNB supplementation on reproductive parameters

The days of first post partum estrus observed (days), service period (days) and number of service per conception of lactating crossbred cattle and buffaloes are presented in Table 4.22 and Figure 4.15 to Figure 4.20. Supplementation of MNB to lactating crossbred cattle and buffaloes significantly ($P<0.05$) reduces the number of service per conception in both crossbred cattle and buffaloes in T_1 (1.33 ± 0.21 , 1.43 ± 0.18 , 1.30 ± 0.19 and 1.67 ± 0.17 , 1.50 ± 0.25 , 1.57 ± 0.79) as compared to T_0 (2.17 ± 0.30 , 2.29 ± 0.18 , 2.25 ± 0.26 and 2.50 ± 0.33 , 2.34 ± 0.40 , 2.42 ± 0.53) of all three selected villages, respectively. Overall mean value of numbers of service per conception in control was 2.24 ± 0.35 and treatment group it was 1.35 ± 0.39 in crossbred cattle and differed significantly ($p<0.05$), in buffaloes also significant ($P<0.05$) difference was observed. First service conception rate was 31.58 per cent in control and 47.37 per cent in treatment of crossbred cattle, whereas in buffaloes, it was 26.32 per cent in control and 36.84 in treatment group.

Table 4.21: Mean $\pm$ S.E. of body weight (kg) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	0	410.83 $\pm$ 17.32	417.45 $\pm$ 17.16	567.19 $\pm$ 15.88	565.78 $\pm$ 13.73
	30	405.71 $\pm$ 19.11	411.97 $\pm$ 17.51	565.48 $\pm$ 14.67	562.22 $\pm$ 14.76
	60	400.58 $\pm$ 16.25	406.50 $\pm$ 15.62	559.77 $\pm$ 20.12	558.67 $\pm$ 18.05
	90	395.48 $\pm$ 18.50	400.96 $\pm$ 16.56	559.14 $\pm$ 15.30	553.43 $\pm$ 14.29
	120	395.37 $\pm$ 15.62	398.42 $\pm$ 15.68	555.31 $\pm$ 18.95	555.94 $\pm$ 17.18
Mean $\pm$ S.E.		401.59$\pm$2.60	407.05$\pm$2.26	561.38$\pm$7.10	559.21$\pm$2.44
Malimajra	N	6	6	6	6
	0	400.28 $\pm$ 14.73	410.19 $\pm$ 15.54	568.60 $\pm$ 18.25	575.58 $\pm$ 14.56
	30	396.41 $\pm$ 19.17	405.14 $\pm$ 26.41	562.46 $\pm$ 19.56	570.46 $\pm$ 16.87
	60	394.53 $\pm$ 12.09	401.09 $\pm$ 11.69	543.32 $\pm$ 16.90	568.22 $\pm$ 13.39
	90	393.37 $\pm$ 26.37	395.87 $\pm$ 26.47	548.89 $\pm$ 18.25	565.80 $\pm$ 15.63
	120	389.66 $\pm$ 9.76	387.19 $\pm$ 13.73	563.61 $\pm$ 14.33	567.35 $\pm$ 12.47
Mean $\pm$ S.E.		394.85$\pm$1.89	399.89$\pm$3.68	557.37$\pm$3.53	569.47$\pm$2.29
Patlioni	N	7	7	7	7
	0	429.33 $\pm$ 19.13	431.94 $\pm$ 26.11	575.06 $\pm$ 19.67	579.23 $\pm$ 16.72
	30	424.91 $\pm$ 26.62	427.27 $\pm$ 25.67	571.77 $\pm$ 16.87	578.80 $\pm$ 13.94
	60	417.50 $\pm$ 11.19	419.59 $\pm$ 13.48	573.49 $\pm$ 13.39	577.36 $\pm$ 26.28
	90	418.99 $\pm$ 26.49	421.91 $\pm$ 24.87	572.04 $\pm$ 15.63	572.57 $\pm$ 14.35
	120	418.99 $\pm$ 13.62	417.70 $\pm$ 13.36	568.41 $\pm$ 12.47	575.68 $\pm$ 24.57
Mean $\pm$ S.E.		421.76$\pm$1.77	423.68$\pm$1.27	572.15$\pm$3.70	576.72$\pm$3.99
Pooled	N	19	19	19	19
	0	413.48 $\pm$ 11.17	419.86 $\pm$ 16.23	570.29 $\pm$ 4.26	573.53 $\pm$ 12.78
	30	409.01 $\pm$ 11.11	414.80 $\pm$ 13.51	566.57 $\pm$ 7.17	570.48 $\pm$ 13.41
	60	404.20 $\pm$ 10.25	409.06 $\pm$ 8.83	558.86 $\pm$ 3.09	568.09 $\pm$ 13.69
	90	402.30 $\pm$ 12.50	406.24 $\pm$ 13.79	560.02 $\pm$ 2.89	563.93 $\pm$ 13.10
	120	401.34 $\pm$ 11.62	401.10 $\pm$ 8.21	562.44 $\pm$ 5.16	566.33 $\pm$ 9.49
Mean $\pm$ S.E.		406.07$\pm$11.21	410.21$\pm$9.96	563.64$\pm$4.56	568.47$\pm$12.39

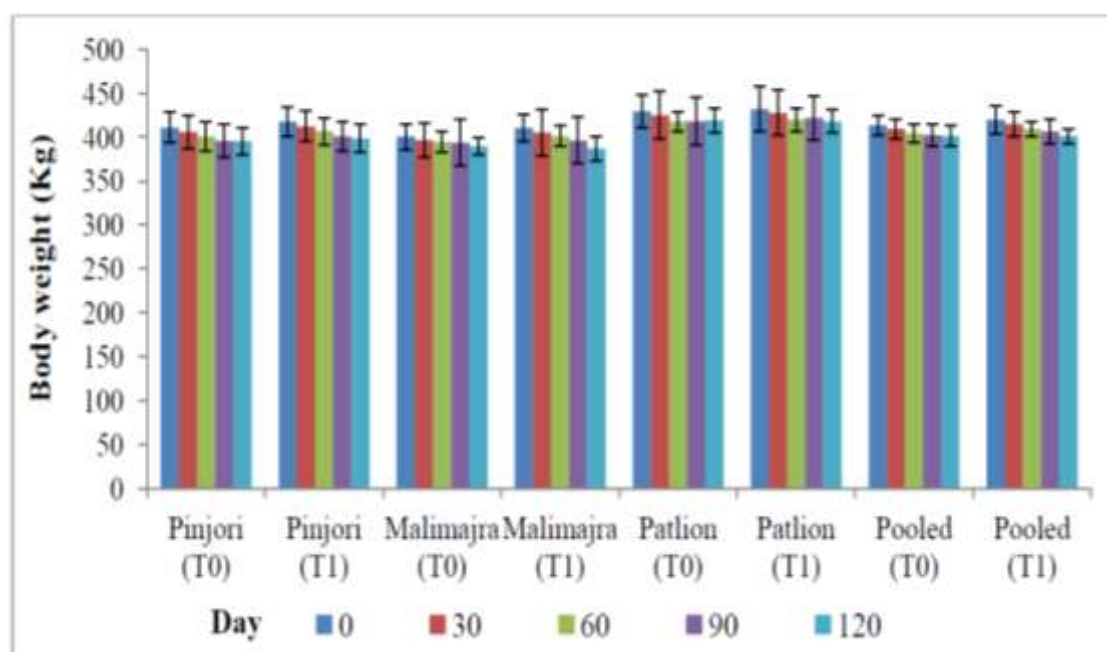


Figure 4.13 Body weight (kg) in lactating crossbred cattle

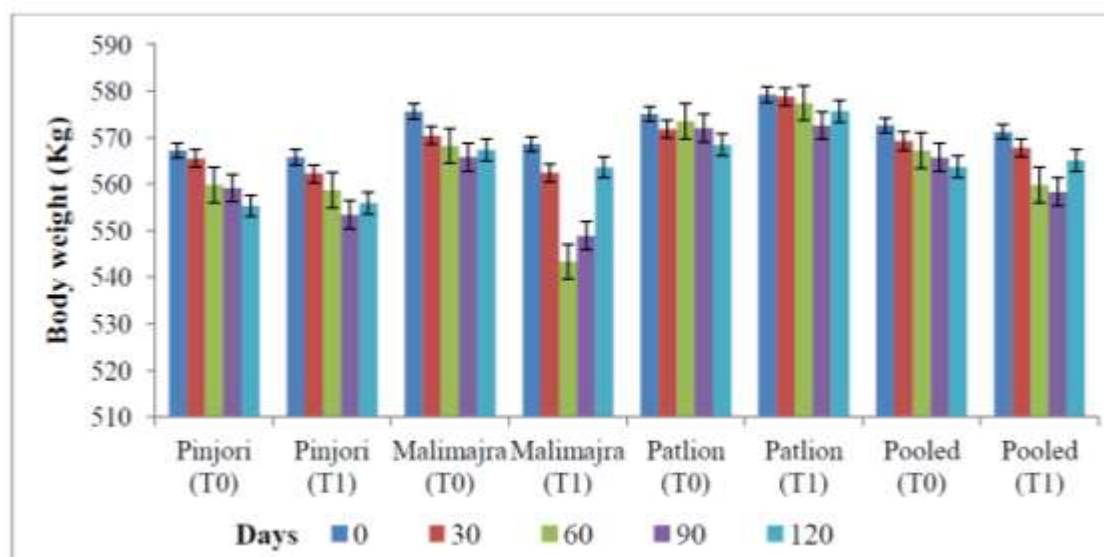


Figure 4.14 Body weight (kg) in lactating buffaloes

The days of first observed post partum estrus (days) was significantly ($P<0.05$) lower in crossbred cattle in Pinjori and Malimajra in treatment group (70 ± 3.16 , 71.25 ± 12.80) as compared to control (97.50 ± 6.42 , 92.50 ± 7.16). There was non-significant ($P>0.05$) difference of days of first observed post partum estrus (days) between control and treatment group of buffaloes in all selected villages, in crossbred cattle in Patlion village. The pooled value of first observed post partum estrus was significantly ($P<0.05$) lower in treatment (74.22 ± 3.62) group as compared with control (94.76 ± 1.46) of cross bred cattle, whereas non-significant difference was found between control and treatment group of buffaloes. The service period (days) of crossbred cattle of Pinjori and Malimajra village were significantly ($P<0.05$) lower in treatment group (95.83 ± 3.01 and 100.01 ± 13.38) as compared to control group (131.67 ± 7.14 and 129.17 ± 11.29). Service period (days) of buffaloes in Pinjori and Malimajra village were significantly ($P<0.05$) lower in T_1 (102.5 ± 7.27 and 117.14 ± 31.47) as compared to control group (135 ± 8.36 and 167.14 ± 6.71). Non-significant ($P>0.05$) difference of days of service period (days) in crossbred cattle and buffalo was observed in Patlion village. Significant difference ($P<0.05$) was observed in service period of crossbred cattle and buffaloes between control and treatment in case of pooled value.

Our findings are in accordance with the findings of Srivastava (2008), who reported that UMMB feeding induced ovulatory estrus in 93.93 per cent of anestrus crossbred heifers with first service conception rate of 32.14 %. Gupta *et al.* (2018) reported significantly ($p<0.05$) higher conception rate and lower service period in UMMB supplemented crossbred dairy cattle (73.33 per cent) as compared to non-supplemented (53.33 per cent) crossbred dairy cattle. Kumar *et al.* (2018) reported significant ($p<0.05$) reduction in number of A.I. per conception in UMMB supplemented groups (1.60) of crossbred cows compared to non-supplemented crossbred cows (2.0). Shah (2018) reported that 90 per cent UMMB supplemented post-partum anestrus buffaloes came into estrus, whereas only 50 per cent control group buffaloes came in estrus. Improvement in reproductive performance of dairy animals mainly may be due to improvement in blood nutrient level by MNB supplementation (Shah *et al.*, 2018). Ghosh *et al.* (1993) mentioned that improvement of reproductive performance in dairy animals might be due to energy balance at early lactation that helps onset of ovarian cyclicity.

Table 4.22: Reproductive parameters of lactating crossbred cattle and buffaloes (Mean $\pm$ S.E.)

Reproduction parameters	Pinjori		Malimajra		Patlion		Pooled (Mean $\pm$ S.E.)	
N	6	6	6	6	7	7	19	19
Group	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Days of first observed post partum estrus (days)								
Crossbred cattle	97.50 ^a $\pm$ 6.42	70 ^b $\pm$ 3.16	92.50 ^a $\pm$ 7.16	71.25 ^b $\pm$ 12.80	94.29 $\pm$ 10.71	81.43 $\pm$ 6.42	94.76 ^a $\pm$ 1.46	74.22 ^b $\pm$ 3.62
Buffalo	95 $\pm$ 5.01	72.50 $\pm$ 7.16	130.71 $\pm$ 5.39	87.86 $\pm$ 10.57	111.85 $\pm$ 9.37	94.29 $\pm$ 9.67	112.52 $\pm$ 10.31	84.88 $\pm$ 6.46
Service period (days)								
Crossbred cattle	131.67 ^a $\pm$ 7.14	95.83 ^b $\pm$ 3.01	129.17 ^a $\pm$ 11.29	100.01 ^b $\pm$ 13.38	124.29 $\pm$ 13.56	115.71 $\pm$ 10.76	128.37 ^a $\pm$ 2.16	103.85 ^b $\pm$ 6.05
Buffalo	135 ^a $\pm$ 8.36	102.5 ^b $\pm$ 7.27	167.14 ^a $\pm$ 6.71	117.14 $\pm$ 31.47 ^b	148.47 $\pm$ 8.36	127.85 $\pm$ 10.57	150.20 ^a $\pm$ 9.31	115.83 ^b $\pm$ 7.34
No. of services per conception (days)								
Crossbred cattle	2.17 ^a $\pm$ 0.30	1.33 ^b $\pm$ 0.21	2.29 ^a $\pm$ 0.18	1.43 ^b $\pm$ 0.18	2.25 ^a $\pm$ 0.26	1.30 ^b $\pm$ 0.19	2.24 ^a $\pm$ 0.35	1.35 ^b $\pm$ 0.39
Buffalo	2.50 ^a $\pm$ 0.33	1.67 ^b $\pm$ 0.17	2.34 ^a $\pm$ 0.40	1.50 ^b $\pm$ 0.25	2.42 ^a $\pm$ 0.53	1.57 ^b $\pm$ 0.79	2.42 ^a $\pm$ 0.46	1.58 ^b $\pm$ 0.49
First service conception rate (%)								
Crossbred cattle	16.67 (1)	33.33 (2)	33.33 (2)	50 (3)	42.86 (3)	57.14 (4)	31.58 (6)	47.37 (9)
Buffalo	33.33 (2)	33.33 (2)	16.67 (1)	33.33 (2)	28.57 (2)	42.86 (3)	26.32 (5)	36.84 (7)

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

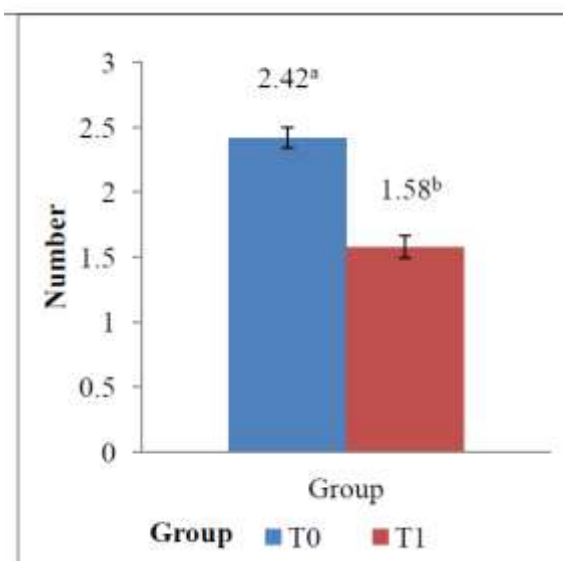


Fig. 4.15 Number of service per conception in lactating crossbred cattle (Pooled)

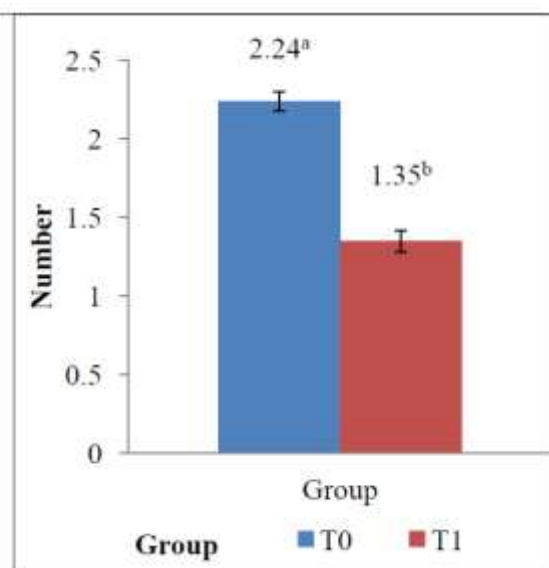


Fig. 4.16 Number of service per conception in lactating buffaloes (Pooled)

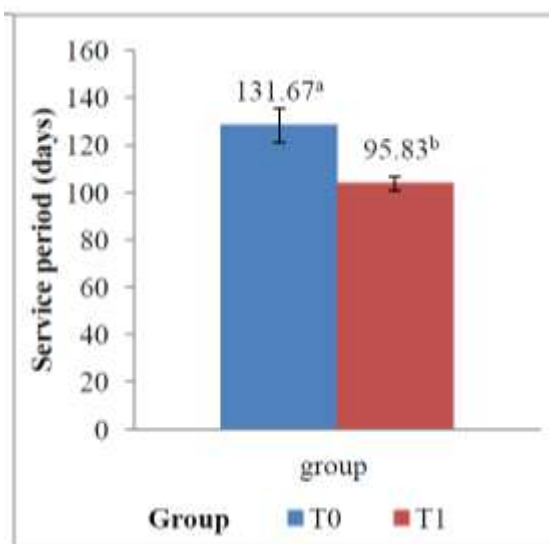


Figure 4.17 Service period (days) in lactating crossbred cattle (Pooled)

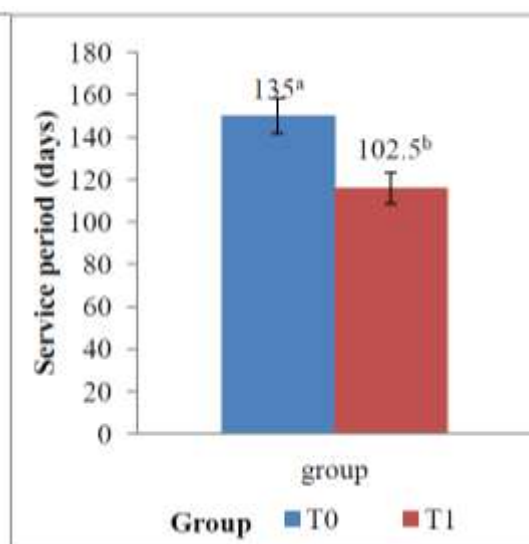


Figure 4.18 Service period (days) in lactating buffaloes (Pooled)

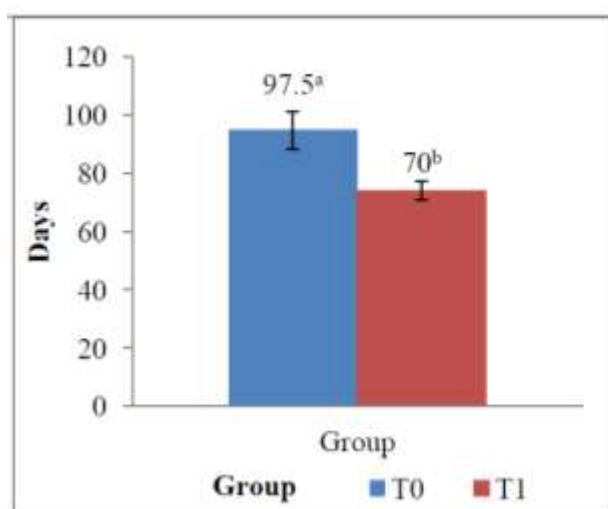


Fig. 4.19 First post partum estrus (days) in lactating crossbred cattle (Pooled)

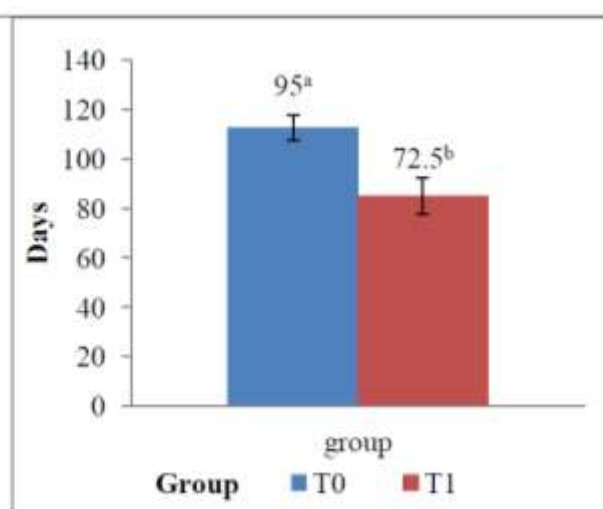


Fig. 4.20 First post partum estrus (days) in lactating buffaloes (Pooled)

4.14 Effect of MNB supplementation on subclinical mastitis

4.14.1 Effect of MNB supplementation on somatic cell count

The somatic cell count ($\times 10^3$ /ml) in milk of lactating crossbred cattle and buffaloes are presented in Table 4.23 and Figure 4.21 and 4.22. The difference between control and treatment group of crossbred cattle was found to be non-significant ($P>0.05$) in somatic cell count. The pooled values of somatic cell count in control group of crossbred cattle was 226.43 ± 27.98 ($\times 10^3$ /ml) and in the treatment group it was 192.91 ± 8 ($\times 10^3$ /ml). In buffaloes, there was non-significant ($P>0.05$) difference observed between control (98.50 ± 12.65) and treatment group (87.06 ± 8.05).

4.14.2 Effect of MNB supplementation on California mastitis test score

The California mastitis test score of milk of lactating crossbred cattle and buffaloes are presented in Table 4.24 and Figure 4.23 and 4.24. The result of California mastitis test performed as an indicator for gross udder health of dairy animals. Non-significant ($P>0.05$) difference was observed between control and treatment group in crossbred cattle and buffaloes. The overall mean (S.E.) pooled values of T_0 were 1.18 ± 0.07 and 1.63 ± 0.15 and T_1 were 1.13 ± 0.14 and 1.50 ± 0.14 in crossbred cattle and buffaloes, respectively.

Table 4.23: Mean $\pm$ S.E. of somatic cell count ($\times 10^3$ /ml) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	30	209.50 $\pm$ 25.25	190.67 $\pm$ 17.26	96.34 $\pm$ 2.86	96.83 $\pm$ 10.49
	60	215.33 $\pm$ 73.40	192.83 $\pm$ 15.54	96.50 $\pm$ 4.77	95.17 $\pm$ 9.19
	90	214.50 $\pm$ 75.56	190.08 $\pm$ 36.53	94.50 $\pm$ 2.88	89.83 $\pm$ 8.45
	120	227.16 $\pm$ 77.14	189 $\pm$ 39.65	97.33 $\pm$ 3.17	94.17 $\pm$ 11.28
Mean $\pm$ S.E.		216.62$\pm$3.74	190.65$\pm$0.81	96.16$\pm$0.60	94.00$\pm$1.49
Malimajra	N	6	6	6	6
	30	291.2 $\pm$ 51.03	227.2 $\pm$ 17.16	113.71 $\pm$ 20.04	100.86 $\pm$ 4.93
	60	297.4 $\pm$ 49.01	199.8 $\pm$ 7.90	118.43 $\pm$ 27.29	97.29 $\pm$ 4.25
	90	275.1 $\pm$ 39.80	203.2 $\pm$ 6.55	122.14 $\pm$ 25.39	99.43 $\pm$ 4.95
	120	252.6 $\pm$ 20.47	206.6 $\pm$ 6.31	133 $\pm$ 30.09	100.14 $\pm$ 3.30
Mean $\pm$ S.E.		279.08$\pm$9.98	209.2$\pm$6.15	121.82$\pm$4.10	99.43$\pm$0.77
Patlioni	N	7	7	7	7
	30	178.78 $\pm$ 70.90	189.57 $\pm$ 37.92	72.29 $\pm$ 7.63	76.43 $\pm$ 7.18
	60	168.29 $\pm$ 24.34	186.43 $\pm$ 34.10	75.14 $\pm$ 18.05	76 $\pm$ 6.44
	90	188.43 $\pm$ 32.48	172.93 $\pm$ 30.98	78.86 $\pm$ 5.23	71.93 $\pm$ 5.30
	120	198.86 $\pm$ 39.17	166.71 $\pm$ 32.08	82.57 $\pm$ 6.45	68.29 $\pm$ 5.82
Mean $\pm$ S.E.		183.58$\pm$6.54	178.91$\pm$5.44	77.21$\pm$2.23	73.16$\pm$1.91
Pooled	N	19	19	19	19
	30	226.50 $\pm$ 33.54	202.50 $\pm$ 12.36	94.11 $\pm$ 12.01	91.37 $\pm$ 7.16
	60	227.00 $\pm$ 37.73	193.02 $\pm$ 3.86	96.69 $\pm$ 12.50	89.48 $\pm$ 6.76
	90	226.01 $\pm$ 25.67	188.73 $\pm$ 8.76	98.50 $\pm$ 12.65	87.06 $\pm$ 8.05
	120	226.21 $\pm$ 15.52	187.44 $\pm$ 11.54	104.30 $\pm$ 14.96	87.53 $\pm$ 9.77
Overall mean $\pm$ S.E.		226.43$\pm$27.98	192.91$\pm$8.81	98.40$\pm$13.03	88.86$\pm$8.04

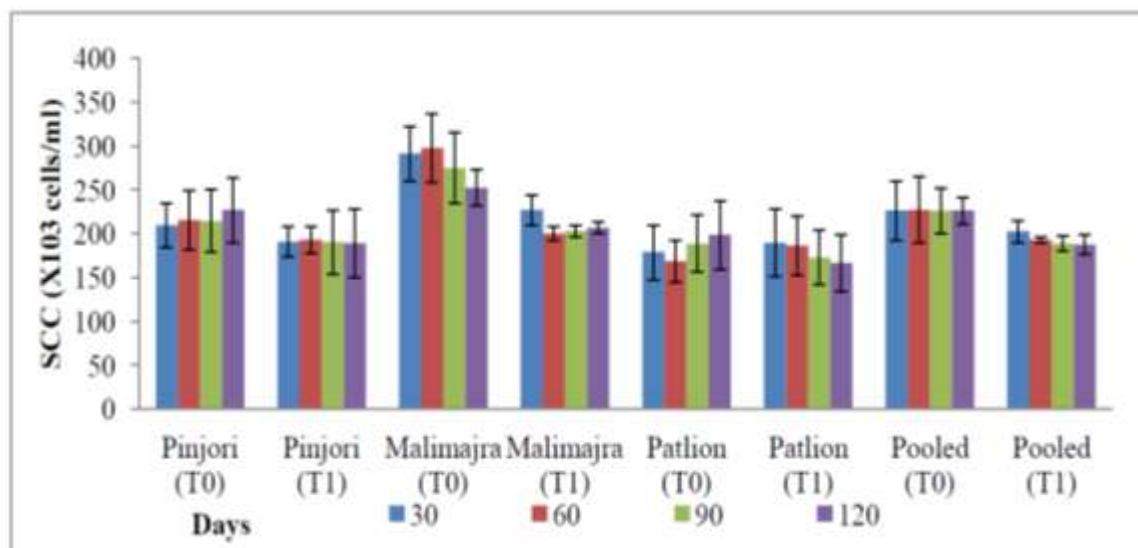


Figure 4.21 Somatic cell counts (x10³ cells/ml) in lactating crossbred cattle

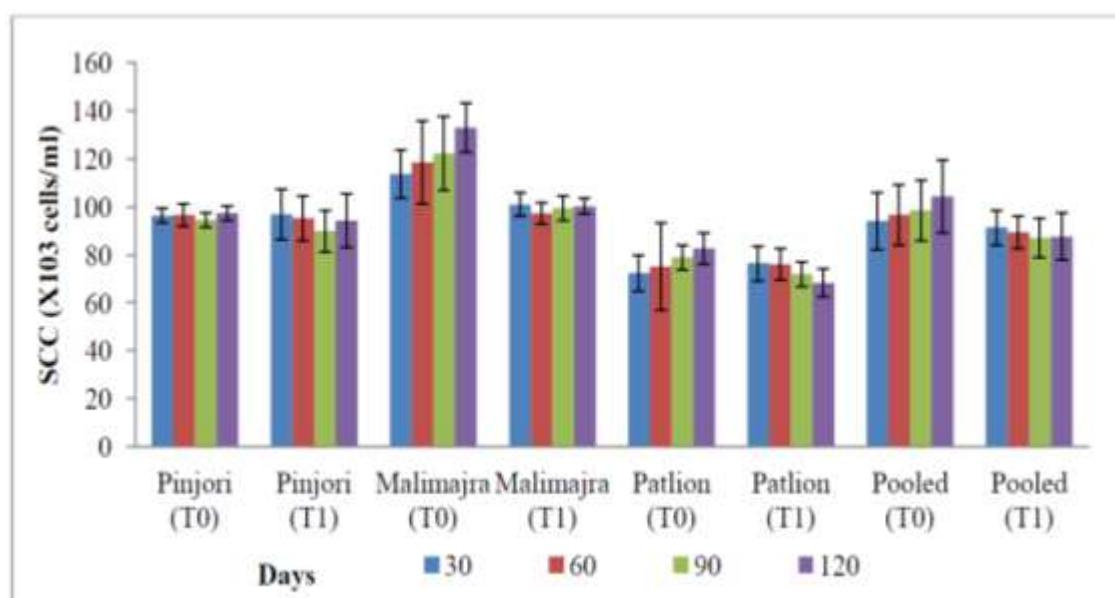


Figure 4.22 Somatic cell counts (x10³ cells/ml) in lactating buffaloes

Table 4.24: Mean $\pm$ S.E. of CMT score in lactating crossbred cattle and buffaloes

Village		Crossbred cattle		Buffalo	
	Days	T ₀	T ₁	T ₀	T ₁
Pinjori	N	6	6	6	6
	30	1.23 $\pm$ 0.21	1.17 $\pm$ 0.17	1.70 $\pm$ 0.17	1.67 $\pm$ 0.16
	60	1.16 $\pm$ 0.40	1.12 $\pm$ 0.25	1.53 $\pm$ 0.30	1.43 $\pm$ 0.34
	90	1.13 $\pm$ 0.21	1.13 $\pm$ 0.21	1.67 $\pm$ 0.25	1.59 $\pm$ 0.33
	120	1.25 $\pm$ 0.23	1.18 $\pm$ 0.16	1.68 $\pm$ 0.17	1.55 $\pm$ 0.42
Mean $\pm$ S.E.		1.19$\pm$0.19	1.15$\pm$0.10	1.65$\pm$0.19	1.56$\pm$0.26
Malimajra	N	6	6	6	6
	30	1.25 $\pm$ 0.20	1.20 $\pm$ 0.24	1.57 $\pm$ 0.29	1.33 $\pm$ 0.40
	60	1.18 $\pm$ 0.20	1.18 $\pm$ 0.01	1.61 $\pm$ 0.14	1.27 $\pm$ 0.33
	90	1.16 $\pm$ 0.24	1.09 $\pm$ 0.24	1.64 $\pm$ 0.18	1.43 $\pm$ 0.30
	120	1.18 $\pm$ 0.22	1.10 $\pm$ 0.23	1.62 $\pm$ 0.22	1.48 $\pm$ 0.21
Mean $\pm$ S.E.		1.19$\pm$0.11	1.14$\pm$0.18	1.61$\pm$0.34	1.38$\pm$0.10
Patlion	N	7	7	7	7
	30	1.16 $\pm$ 0.18	1.14 $\pm$ 0.34	1.71 $\pm$ 0.36	1.56 $\pm$ 0.14
	60	1.20 $\pm$ 0.22	0.90 $\pm$ 0.28	1.66 $\pm$ 0.14	1.60 $\pm$ 0.26
	90	1.14 $\pm$ 0.14	1.15 $\pm$ 0.28	1.47 $\pm$ 0.22	1.55 $\pm$ 0.30
	120	1.10 $\pm$ 0.14	1.15 $\pm$ 0.30	1.64 $\pm$ 0.14	1.58 $\pm$ 0.20
Mean $\pm$ S.E.		1.15$\pm$0.20	1.09$\pm$0.22	1.62$\pm$0.10	1.57$\pm$0.09
Pooled	N	19	19	19	19
	30	1.21 $\pm$ 0.07	1.17 $\pm$ 0.14	1.66 $\pm$ 0.15	1.52 $\pm$ 0.08
	60	1.18 $\pm$ 0.10	1.07 $\pm$ 0.40	1.60 $\pm$ 0.17	1.43 $\pm$ 0.23
	90	1.14 $\pm$ 0.24	1.12 $\pm$ 0.06	1.59 $\pm$ 0.24	1.52 $\pm$ 0.03
	120	1.17 $\pm$ 0.05	1.14 $\pm$ 0.37	1.65 $\pm$ 0.04	1.53 $\pm$ 0.21
Overall mean $\pm$ S.E.		1.18$\pm$0.07	1.13$\pm$0.14	1.63$\pm$0.15	1.50$\pm$0.14

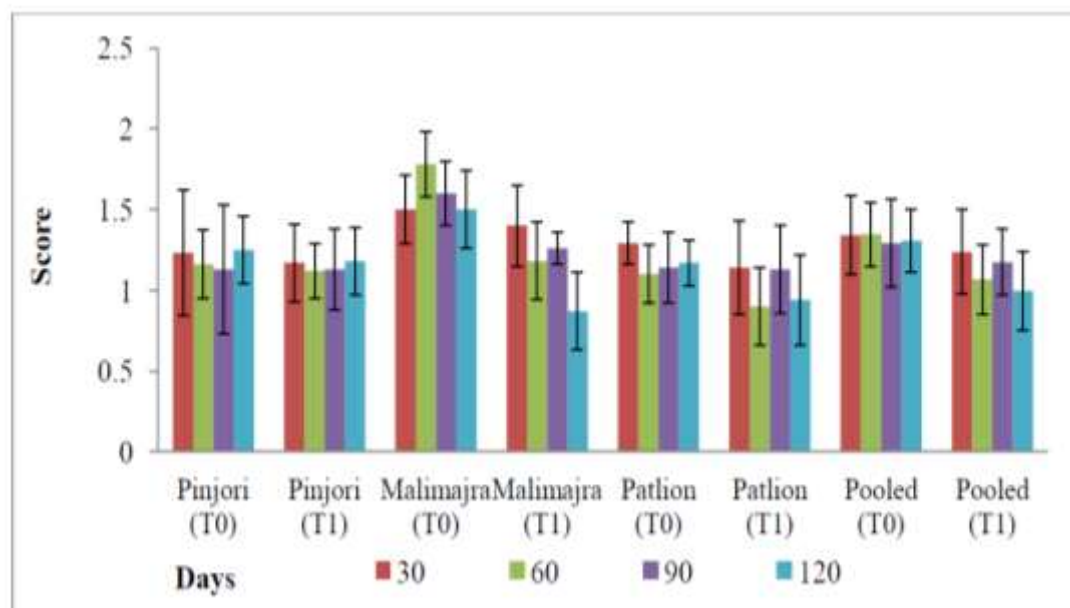


Figure 4.23 California Mastitis test score in lactating crossbred cattle

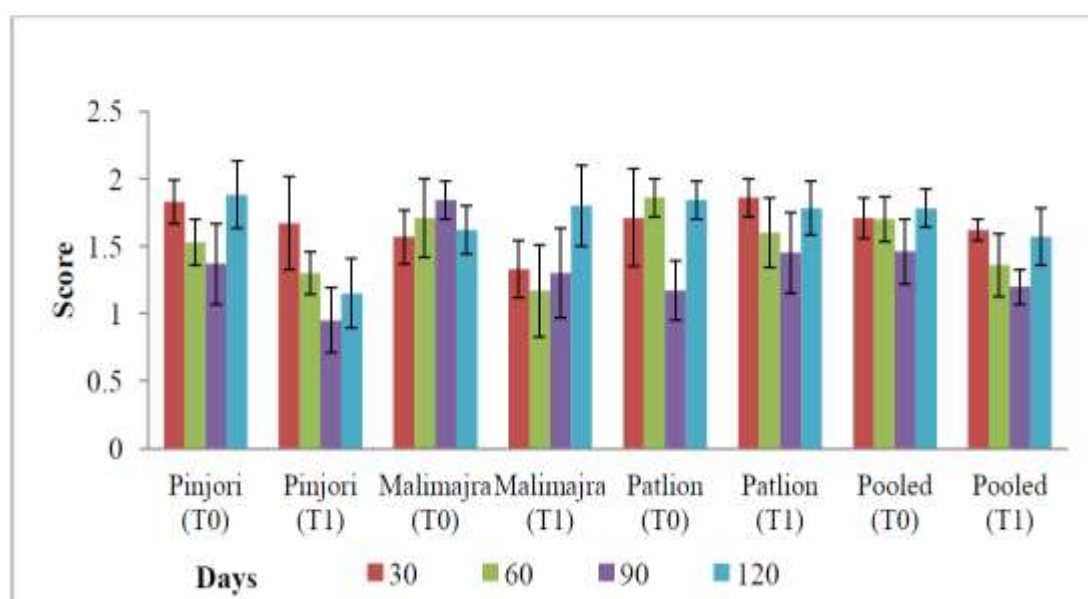


Figure 4.24 California Mastitis test score in lactating buffaloes

4.15 Effect of MNB supplementation on hematological and biochemical parameter of lactating dairy animals

The hematological and biochemical parameter of lactating crossbred cattle and buffaloes are presented in Table 4.25 and Figure 4.25 and 4.26. There was significant difference ($P<0.05$) in mean blood urea (mg/dl) between treatment (12.80 ± 0.38 , 12.88 ± 0.34 and 12.77 ± 0.39) and control group (10.91 ± 0.53 , 10.73 ± 0.48 and 10.93 ± 0.43) of all three villages of crossbred cattle. Similarly in buffaloes, significant difference ($P<0.05$) were found between treatment (13.13 ± 0.34 , 12.94 ± 0.37 and 13.56 ± 0.36) and control group (11.01 ± 0.70 , 10.30 ± 0.02 and 11.48 ± 0.69). The pooled value of blood urea in control and treatment group of crossbred cattle was (10.86 ± 0.06 vs. 12.82 ± 0.03) and buffaloes (10.93 ± 0.34 vs. 13.21 ± 0.18) and differed significantly ($P<0.05$). Whereas, other blood parameters RBC ($\times 10^6$ cell / μ L), TLC ($\times 10^3$ cells/ μ L), PCV (%) and Hb (g/dl) were non-significantly ($p>0.05$) different between treatment and control group of crossbred cattle and buffaloes.

Similar results were reported by Hosamani *et al.* (1998) and Patil *et al.* (2017). They found significant ($P<0.05$) increase in blood urea in buffaloes due to UMMB supplementation. It might be due to molasses urea based nutrient supplement. Choubey *et al.* (2015) reported significant ($p<0.05$) increase in BUN in treatment group (conventional UMMB supplementation) as compared to control group of adult buffaloes. However, present result of hematological parameter was supported by the findings of Singh *et al.* (2010) and Sahoo *et al.* (2017). They reported non-significant effect of UMMB supplementation on RBC, PCV, TLC and Hb between treatment and control group of buffaloes and crossbred cattle. The higher level blood urea in treatment group of animals may be attributed to consumption of UMMB and release of NH_3 in blood (Patil *et al.* 2017) or could be due to higher intake of nitrogen from urea (Choubey *et al.* 2015).

Table 4.25: Mean $\pm$ S.E. of hematological and biochemical parameter in lactating crossbred cattle and buffaloes

Village		Pinjori		Malimajra		Patlion		Pooled (Mean $\pm$ S.E.)	
N		6	6	6	6	7	7	19	19
Parameters		T ₀	T ₁	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Crossbred cattle	RBC ($\times 10^6$ cell / μ L)	7.00 $\pm$ 0.31	7.11 $\pm$ 0.42	7.22 $\pm$ 0.56	7.25 $\pm$ 0.58	7.04 $\pm$ 0.45	7.56 $\pm$ 0.48	7.09 $\pm$ 0.31	7.31 $\pm$ 0.42
	TLC ($\times 10^3$ cells/ μ L)	13.8 $\pm$ 0.44	14.03 $\pm$ 0.34	14.00 $\pm$ 0.45	14.09 $\pm$ 0.47	13.91 $\pm$ 0.11	13.95 $\pm$ 0.26	13.90 $\pm$ 0.22	14.02 $\pm$ 0.17
	PCV (%)	39.25 $\pm$ 1.31	35.25 $\pm$ 1.03	36.25 $\pm$ 2.78	35.5 $\pm$ 1.04	36.75 $\pm$ 3.81	33.25 $\pm$ 1.25	36.92 $\pm$ 1.71	35.50 $\pm$ 1.57
	Hb (g/dl)	12.47 $\pm$ 0.04	12.64 $\pm$ 1.03	39.25 $\pm$ 1.31	12.35 $\pm$ 0.04	13.24 $\pm$ 0.30	13.10 $\pm$ 0.07	12.65 $\pm$ 0.04	12.69 $\pm$ 1.03
	Blood urea (mg/dl)	10.91 ^a $\pm$ 0.53	12.80 ^b $\pm$ 0.38	10.73 ^a $\pm$ 0.48	12.88 ^b $\pm$ 0.34	10.93 ^a $\pm$ 0.43	12.77 ^b $\pm$ 0.39	10.86 ^a $\pm$ 0.06	12.82 ^b $\pm$ 0.03
Buffalo	RBC ($\times 10^6$ cell / μ L)	7.37 $\pm$ 0.44	6.76 $\pm$ 0.15	6.14 $\pm$ 0.19	6.87 $\pm$ 0.27	6.99 $\pm$ 0.39	7.01 $\pm$ 0.40	6.83 $\pm$ 0.56	6.88 $\pm$ 0.58
	TLC ($\times 10^3$ cells/ μ L)	13.46 $\pm$ 0.15	13.51 $\pm$ 0.05	13.82 $\pm$ 0.28	13.68 $\pm$ 0.10	13.56 $\pm$ 0.21	13.60 $\pm$ 0.14	13.61 $\pm$ 0.24	13.59 $\pm$ 0.11
	PCV (%)	34.25 $\pm$ 1.68	38.50 $\pm$ 1.60	33.75 $\pm$ 2.05	33.75 $\pm$ 1.19	39.50 $\pm$ 0.75	34.50 $\pm$ 1.85	35.17 $\pm$ 1.85	35.92 $\pm$ 2.20
	Hb (g/dl)	12.98 $\pm$ 0.14	13.35 $\pm$ 0.10	13.25 $\pm$ 0.07	13.32 $\pm$ 0.09	12.86 $\pm$ 0.13	12.88 $\pm$ 0.11	13.03 $\pm$ 1.31	13.18 $\pm$ 0.04
	Blood urea (mg/dl)	11.01 ^a $\pm$ 0.70	13.13 ^b $\pm$ 0.34	10.30 ^a $\pm$ 0.02	12.94 ^b $\pm$ 0.37	11.48 ^a $\pm$ 0.69	13.56 ^b $\pm$ 0.36	10.93 ^a $\pm$ 0.34	13.21 ^b $\pm$ 0.18

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

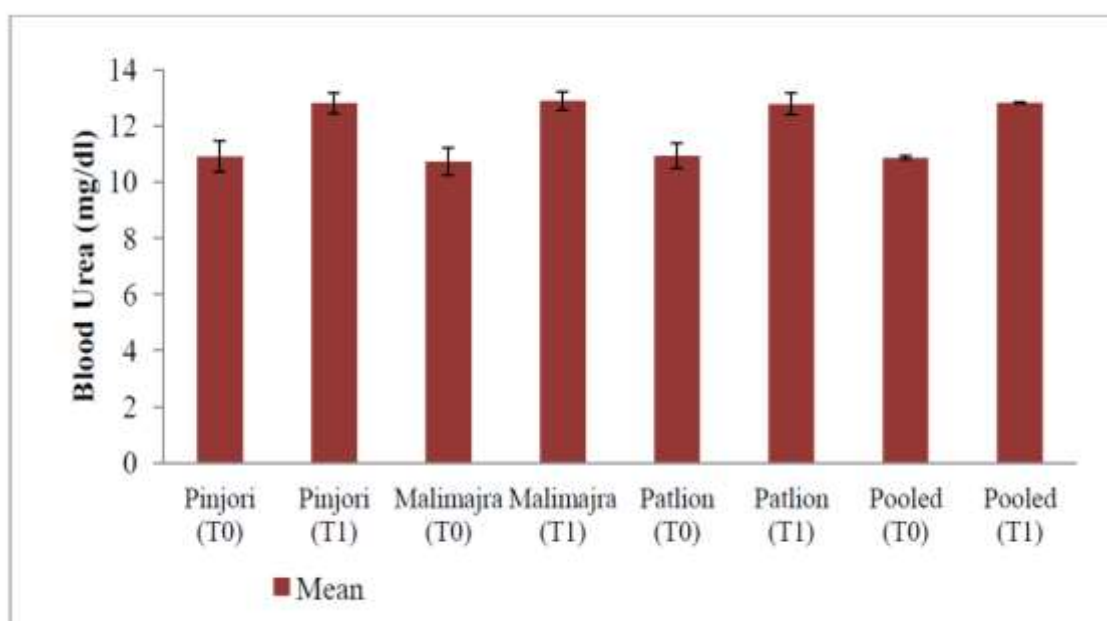


Figure 4.25 Blood urea (mg/dl) in lactating crossbred cattle

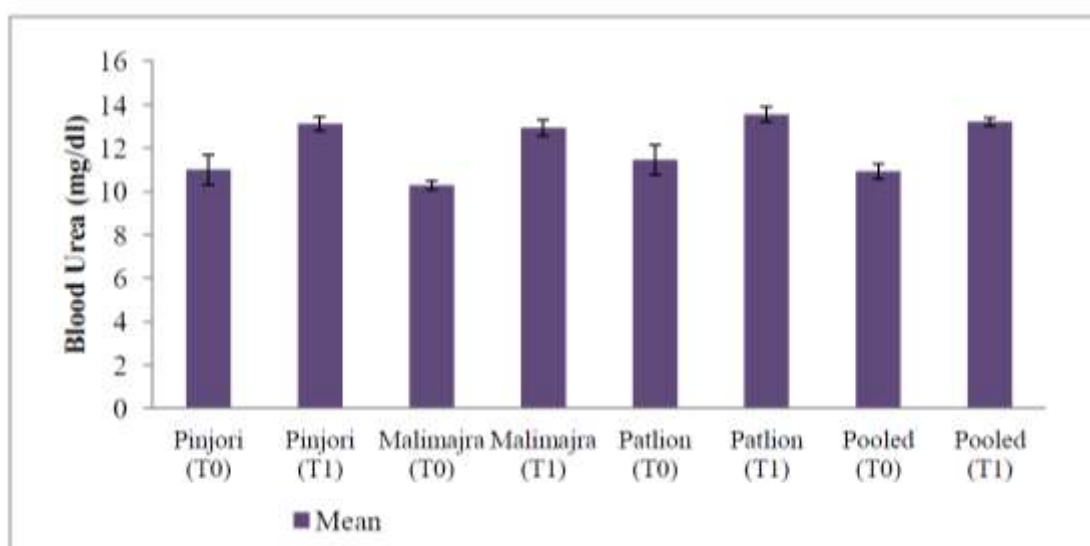


Figure 4.26 Blood urea (mg/dl) in lactating buffaloes

4.16 Partial budget analysis of feeding of MNB supplementation to lactating animals

The economics of MNB in different groups of crossbred cattle were calculated and presented in Table 4.26. Economic analysis showed that the supplementation of MNB was cost effective and net return per crossbred cattle per day in control group was ₹ 240.02, 200.32, 384.88 and 276.39 and in treatment group, net return was ₹ 288.94, 251.25, 441.99 and 319.86 in Pinjori, Malmajra and Patlioni and pooled values, respectively. Benefit cost ratio of crossbred cattle in Pinjori, Malmajra, Patlioni and pooled values of control group was 1.40, 1.16, 2.11, and 1.58 and in treatment group it was 1.56, 1.31, 2.25 and 1.68, respectively.

The economics of MNB in different groups of buffaloes were calculated and presented in Table 4.27. Economic analysis showed that the supplementation of MNB was cost effective and net return per buffaloes per day in control group were ₹ 306.25, 415, 516 and 413.60 and in treatment group was ₹ 383.85, 498.56, 594.88 and 491.28 in Pinjori, Malmajra and Patlioni and overall pooled values, respectively. Benefit cost ratio of buffaloes in Pinjori, Malmajra, Patlioni and overall pooled values of control group was 1.52, 2.12, 2.50 and 2.06 and the treatment group it was 1.79, 2.39, 2.67 and 2.26, respectively.

Similar findings were reported by Misra *et al.* (2006) in crossbred cattle, where cash return improved over Rs. 10 per day per cow due to UMMB supplementation under small holder mixed farming system. Similarly Meel *et al.* (2015) reported higher net profit in UMMB supplemented group (Rs. 1935.81) as compared to control group (Rs.1641) of Jersey crossbred cattle. Kumar *et al.* (2018) reported significantly ($p < 0.05$) higher gross return (Rs.) over control (T_1 : 22.40; T_2 : 6.65) and return over feed cost (Rs.) (T_1 : 10.40; T_2 : 4.65) in UMMB supplemented group compared to non-supplemented crossbred cattle group. Kour *et al.* (2022) reported similar kind of findings in dairy buffaloes. He also reported that UMMB feeding increased milk yield per animal per day upto 1.5 litre with benefit cost ratio of 1:2.73. Similar result were reported by Patidar *et al.* (2014) and Lawania *et al.* (2017) in dairy cattle, Garg *et al.* (2016) in crossbred cattle and buffaloes, Tanwar *et al.* (2013) in buffaloes.

Table 4.26: Economic evaluation of MNB supplementation in lactating crossbred cattle

Village	Pinjori		Malimajra		Patlioni		Pooled	
N	6	6	6	6	7	7	19	19
Feed intake (kg/h/d)	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Concentrate	3.03	2.92	3.2	3.13	3.25	3.16	3.16	3.07
Green fodder	24.9	26.58	24.15	27.63	26.9	28.27	25.31	27.5
Wheat straw	5.28	5.42	5.03	5.15	5.32	5.55	5.18	5.37
MNB intake (g/h/day)	0	384.24	0	382.82	0	382.75	0	383.27
Feed cost								
Concentrate (₹28/kg)	84.84	81.76	89.6	87.64	91	88.48	88.48	85.96
Green fodder (₹ 2/kg)	49.8	53.16	48.3	55.26	53.8	56.54	50.62	55
Wheat straw (₹ 7/kg)	36.96	37.94	35.21	36.05	37.24	38.85	36.26	37.59
MNB (₹ 32/kg)	0	12.30	0	12.25	0	12.248	0	12.26
Milk yield (kg/h/d)	10.21	11.43	9.48	10.94	13.69	15.06	11.13	12.47
4% fat corrected milk yield	10.29	11.85	9.34	11.06	14.17	15.95	11.29	12.77
Increase in milk yield (kg)		1.56	-	1.73	-	1.78	-	1.47
Total variable cost (₹)	171.6	185.16	173.11	191.20	182.04	196.11	175.36	190.86
Change in variable cost (₹)	-	13.55	-	18.09	-	14.078	-	15.45
Return from sale of milk (₹40/kg)	411.61	474.10	373.44	442.45	566.92	638.11	451.75	510.67
Change in total return (₹)	-	62.48	-	69.01	-	71.19	-	58.92
Net return (₹)	240.02	288.94	200.32	251.25	384.88	441.99	276.39	319.86
B:C ratio	1.40	1.56	1.16	1.31	2.11	2.25	1.58	1.68

Table 4.27: Economic evaluation of MNB supplementation in lactating buffaloes

	Pinjori		Malimajra		Patlioni		Pooled	
Feed intake (kg/h/d)	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Concentrate	3.57	3.34	3.43	3.22	3.55	3.46	3.52	3.34
Green fodder	29.57	31.65	28.26	30.82	31.13	33.33	29.65	31.93
Wheat straw	6.06	6.22	6.14	6.2	6.35	6.46	6.19	6.69
MNB intake (g/h/day)	0	423.76	0	427.13	0	426.45	0	425.78
Feed cost (₹)								
Concentrate (₹28/kg)	99.96	93.52	96.04	90.16	99.4	96.88	98.47	93.52
Green fodder (₹2/kg)	59.14	63.3	56.52	61.64	62.26	66.66	59.3	63.86
Wheat straw (₹7/kg)	42.42	43.54	42.98	43.40	44.45	45.22	43.33	46.83
MNB (₹32/kg)	0	13.56	0	13.67	0	13.65	0	13.62
Milk yield (kg/h/d)	7.98	9.06	9.44	10.63	11.58	12.73	9.67	10.81
6% Fat corrected milk	9.23	10.86	11.11	12.86	13.13	14.86	11.18	12.89
Increase in milk yield (kg)	-	1.63	-	1.76	-	1.73	-	1.72
Total variable cost (₹)	201.52	213.92	195.54	208.87	206.11	222.41	201.10	217.84
Change in variable cost (₹)	-	12.40	-	13.33	-	16.30	-	16.74
Return from sale of milk (₹ 55/kg)	507.77	597.77	610.86	707.43	722.15	817.29	614.69	709.12
Change in total return (₹)	-	89.99	-	96.57	-	95.14	-	94.42
Net return (₹)	306.25	383.85	415.31	498.56	516.04	594.88	413.60	491.28
B:C ratio	1.52	1.79	2.12	2.39	2.50	2.67	2.06	2.26

4.17 Economics of reproductive efficiency of crossbred cattle and buffaloes

The economics of reproductive efficiency of crossbred cattle and buffaloes are presented in Table 4.28. The total cost of artificial insemination in Pinjori, Malimajra, Patlion and pooled were ₹ 325.5, 343.5, 337.5 and 336 in control and ₹ 199.5, 214.5, 195 and 202.5 respectively in treatment group of crossbred cattle. Total cost per cow per successful service in Malimajra, Patlion and pooled were ₹ 23491.5, 29277.11, 27364.98 and 26675.07 for control and ₹ 19177.95, 22611.69, 25268.69 and 22304.56 respectively for treatment group of buffaloes. Reduction in total cost per animal per successful service in Pinjori, Malimajra, Patlion and pooled were ₹ 4313.54, 6665.41, 2096.29 and 4370.51 respectively as compared to control group. Per cent reduction in total cost per animal per successful service in Pinjori, Malimajra, Patlion and pooled were ₹ 18.36, 22.77, 7.66 and 16.38, respectively as compared to control group.

In buffaloes, the total cost of artificial insemination in Pinjori, Malimajra, Patlion and pooled for control it was ₹ 375, 351, 363 and 363 whereas, for treatment group it was ₹ 250.5, 225, 235.5 and 237. Total cost per buffalo per successful service in Malimajra, Patlion and pooled for control it was ₹ 26909.13, 25608.9, 25980.41 and 26177.78 whereas, for treatment group it was ₹ 20750.48, 21113.90, 25970.14 and 22859.16 in treatment group. Reduction in total cost per animal per successful service as compared to control group was ₹ 6158.65, 4494.99, 10.27 and 3318.62 in Pinjori, Malimajra, Patlion and pooled, respectively. Per cent reduction in total cost per animal per successful service as compared with control group was 22.89, 17.55, 0.04 and 12.67 in Pinjori, Malimajra, Patlion and pooled, respectively.

The similar findings were reported by Nkya et al. (2002). They obtained increase in net profit (0.34 USD) due to shorten day open period in treatment group of dairy animal compared to control. Sahu (2022) also reported that per cent reduction in total cost per animal per successful service were 15.77 and 0.33 in *Moringa oligofera* leaf meal and herbal galactogogues feeding groups, respectively.

4.18 Effect of rubber mat on daily milk yield (kg/h/d) of lactating dairy animals

The milk yield (kg/h/d) of lactating crossbred cattle and buffaloes are presented in Table 4.29 and Figure 4.27 and 4.28. The result revealed that, rubber mat bedding had non-significant ($p < 0.05$) effect on milk production in crossbred cattle and buffaloes in all selected villages. The pooled values were also similar in crossbred cattle (9.53 ± 0.39 vs. 9.86 ± 0.17) and in buffaloes (8.86 ± 0.43 vs. 9.85 ± 0.11) for control and treatment group, respectively. Similar findings were reported by Kremer et al. (2006) and Ruud et al. (2010). They found non-significant difference in milk yield between cows on rubber mat bedding and concrete floor.

Table 4.28 Economics of reproductive efficiency of crossbred cattle and buffaloes

Economics of reproductive efficiency of crossbred cattle								
	Pinjori		Malimajra		Patlion		Pooled	
N	6	6	6	6	7	7	19	19
Groups	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Total feed cost /cow /successful service (₹)	171.6	185.16	173.11	191.20	182.04	196.12	175.36	190.81
Number of A.I. /cow / conception	2.17	1.33	2.29	1.43	2.25	1.3	2.24	1.35
Total cost of A.I. (₹150/A.I.)	325.5	199.5	343.5	214.5	337.5	195	336	202.5
Service period (days)	135	102.5	167.14	117.14	148.47	127.85	150.2	115.83
Total feed cost/ cow/successful service (₹)	23166	18978.45	28933.61	22397.19	27027.48	25073.69	26339.07	22102.06
Total cost per cow / successful service (₹)	23491.5	19177.95	29277.11	22611.69	27364.98	25268.69	26675.07	22304.56
Reduction in total cost / cow /successful service in comparison to control (₹)	-	4313.54	-	6665.41	-	2096.29	-	4370.51
Reduction in total cost / cow /successful service in comparison to control (%)	-	18.36	-	22.77	-	7.66	-	16.38
Economics of reproductive efficiency of buffaloes								
Total feed cost/ buffaloes/ successful service (₹)	201.52	213.92	195.54	208.87	206.11	222.40	201.10	217.83
Number of A.I. / buffaloes / conception	2.5	1.67	2.34	1.5	2.42	1.57	2.42	1.58
Total cost of A.I. (₹150/A.I.)	375	250.5	351	225	363	235.5	363	237
Service period (days)	131.67	95.83	129.17	100.01	124.29	115.71	128.37	103.85
Total feed cost/ buffalo/ successful service (₹)	26534.13	20499.98	25257.9	20888.90	25617.41	25734.64	25814.78	22622.16
Total cost / buffalo/ successful service (₹)	26909.13	20750.48	25608.9	21113.90	25980.41	25970.14	26177.78	22859.16
Reduction in total cost / buffalo /successful service in comparison to control (₹)	-	6158.65	-	4494.99	-	10.27	-	3318.62
Reduction in total cost / buffalo / successful service in comparison to control (%)	-	22.89	-	17.55	-	0.04	-	12.67

Table 4.29: Mean $\pm$ S.E. of milk yield (kg/h/d) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffaloes	
Pinjori	N	6	6	6	6
	Day	T ₀	T ₁	T ₀	T ₁
	0-15	9.55 $\pm$ 1.17	9.39 $\pm$ 0.59	8.28 $\pm$ 0.47	8.12 $\pm$ 0.92
	15-30	9.58 $\pm$ 1.12	9.83 $\pm$ 0.66	8.42 $\pm$ 0.66	8.97 $\pm$ 0.97
	30-45	9.78 $\pm$ 0.76	10.26 $\pm$ 0.70	8.79 $\pm$ 0.67	9.53 $\pm$ 0.76
	45-60	9.27 $\pm$ 0.66	10.68 $\pm$ 0.65	8.98 $\pm$ 0.55	9.96 $\pm$ 0.82
	60-75	10.35 $\pm$ 0.59	10.61 $\pm$ 0.74	9.16 $\pm$ 0.45	10.66 $\pm$ 0.59
	75-90	10.13 $\pm$ 0.57	10.35 $\pm$ 0.68	8.87 $\pm$ 0.71	10.41 $\pm$ 0.57
	90-105	9.95 $\pm$ 0.55	10.16 $\pm$ 0.74	8.45 $\pm$ 0.48	10.28 $\pm$ 0.55
	105-120	9.65 $\pm$ 0.59	9.99 $\pm$ 0.65	8.18 $\pm$ 0.56	9.83 $\pm$ 0.59
Mean $\pm$ S.E.		9.91$\pm$0.39	10.16$\pm$0.17	8.64$\pm$0.10	9.72$\pm$0.56
Malimajra	N	6	6	6	6
	0-15	8.59 $\pm$ 1.66	8.71 $\pm$ 0.57	8.66 $\pm$ 0.41	8.92 $\pm$ 0.94
	15-30	8.98 $\pm$ 1.53	9.11 $\pm$ 0.74	8.79 $\pm$ 0.51	8.47 $\pm$ 0.95
	30-45	9.21 $\pm$ 1.40	9.68 $\pm$ 0.73	8.84 $\pm$ 0.48	9.96 $\pm$ 0.88
	45-60	9.47 $\pm$ 1.42	9.76 $\pm$ 0.72	9.19 $\pm$ 0.49	10.66 $\pm$ 0.91
	60-75	9.55 $\pm$ 1.37	10.02 $\pm$ 0.71	9.68 $\pm$ 0.44	10.61 $\pm$ 1.44
	75-90	9.43 $\pm$ 1.34	9.98 $\pm$ 0.66	9.53 $\pm$ 0.34	10.45 $\pm$ 0.99
	90-105	9.14 $\pm$ 1.33	9.75 $\pm$ 0.66	9.12 $\pm$ 0.36	9.93 $\pm$ 1.01
	105-120	8.88 $\pm$ 1.28	9.53 $\pm$ 0.68	8.86 $\pm$ 0.57	9.85 $\pm$ 1.66
Mean $\pm$ S.E		9.16$\pm$0.43	9.57$\pm$0.11	9.08$\pm$0.16	9.98$\pm$0.45
Pooled (Mean $\pm$ S.E.)	N	12	12	12	12
	0-15	9.07 $\pm$ 1.17	9.05 $\pm$ 0.59	8.47 $\pm$ 1.66	8.52 $\pm$ 0.57
	15-30	9.28 $\pm$ 1.12	9.47 $\pm$ 0.66	8.61 $\pm$ 1.53	9.22 $\pm$ 0.74
	30-45	9.50 $\pm$ 0.76	9.97 $\pm$ 0.70	8.82 $\pm$ 1.40	9.75 $\pm$ 0.73
	45-60	9.87 $\pm$ 0.66	10.22 $\pm$ 0.65	9.08 $\pm$ 1.42	10.31 $\pm$ 0.72
	60-75	9.95 $\pm$ 0.59	10.32 $\pm$ 0.65	9.42 $\pm$ 1.37	10.64 $\pm$ 0.71
	75-90	9.78 $\pm$ 0.57	10.17 $\pm$ 0.74	9.20 $\pm$ 1.34	10.43 $\pm$ 0.66
	90-105	9.55 $\pm$ 0.55	9.96 $\pm$ 0.68	8.78 $\pm$ 1.33	10.11 $\pm$ 0.66
	105-120	9.27 $\pm$ 0.59	9.76 $\pm$ 0.74	8.53 $\pm$ 1.28	9.84 $\pm$ 0.68
Mean $\pm$ S.E		9.53$\pm$0.39	9.86$\pm$0.17	8.86$\pm$0.43	9.85$\pm$0.11

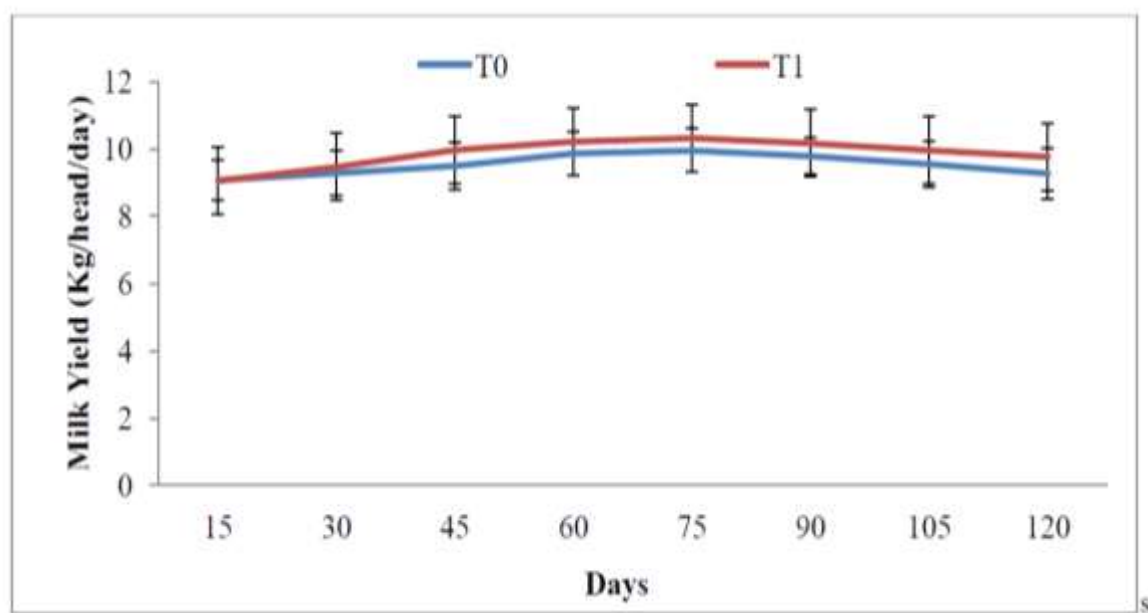


Figure 4.27 Milk yield (kg/h/d) of lactating crossbred cattle (Pooled)

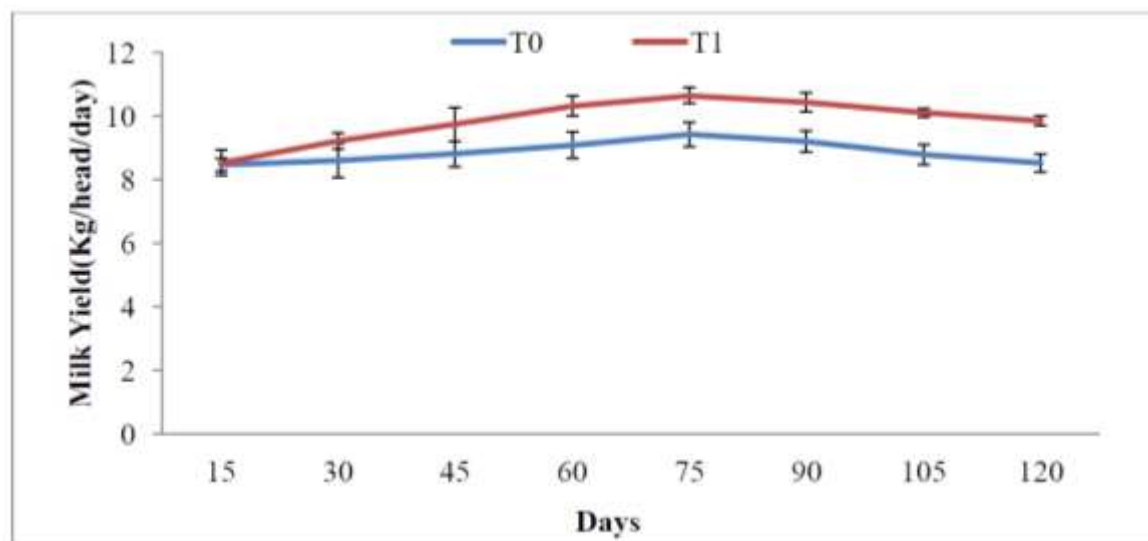


Figure 4.28 Milk yield (kg/h/d) of lactating buffaloes (Pooled)

4.19 Effect of rubber mat bedding on per cent milk composition of lactating dairy animals

4.19.1 Effect of rubber mat bedding on milk fat per cent

The milk fat (%) in crossbred cows and buffaloes are presented in Table 4.30. There was non-significant difference ($P>0.05$) observed in mean $\pm$ S.E. of milk fat (%) of rubber mat bedding between control group and treatment group of crossbred cattle and buffaloes. Pooled milk fat per cent in control and treatment group was 3.75 ± 0.24 and 3.83 ± 0.24 per cent in crossbred cattle, whereas in buffaloes it was 7.05 ± 0.06 and 6.98 ± 0.20 per cent, respectively.

Table 4.30 Mean $\pm$ S.E. of milk fat (%) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	3.21 $\pm$ 0.13	3.94 $\pm$ 0.96	6.57 $\pm$ 0.96	6.95 $\pm$ 0.42
	60	3.44 $\pm$ 0.38	3.5 $\pm$ 0.40	6.70 $\pm$ 1.22	7.03 $\pm$ 0.35
	90	3.75 $\pm$ 0.34	4.41 $\pm$ 0.99	7.23 $\pm$ 1.52	6.87 $\pm$ 0.39
	120	3.63 $\pm$ 0.27	3.91 $\pm$ 0.75	7.66 $\pm$ 1.73	6.25 $\pm$ 0.23
Mean $\pm$ S.E.		3.51$\pm$0.18	3.94$\pm$0.19	7.04$\pm$0.24	6.78$\pm$0.34
Malimajra	N	6	6	6	6
	30	3.96 $\pm$ 0.60	4.14 $\pm$ 0.61	6.58 $\pm$ 0.46	6.89 $\pm$ 0.58
	60	3.04 $\pm$ 0.71	3.11 $\pm$ 0.48	7.05 $\pm$ 0.59	7.23 $\pm$ 0.69
	90	4.58 $\pm$ 0.82	4.04 $\pm$ 0.63	6.82 $\pm$ 0.48	7.16 $\pm$ 0.59
	120	4.37 $\pm$ 0.72	3.66 $\pm$ 0.65	7.26 $\pm$ 0.43	7.42 $\pm$ 0.68
Mean $\pm$ S.E.		3.98$\pm$0.34	3.74$\pm$0.47	6.93$\pm$0.16	7.18$\pm$0.10
Pooled	N	12	12	12	12
	30	3.58 $\pm$ 0.37	4.04 $\pm$ 0.10	6.68 $\pm$ 0.01	6.92 $\pm$ 0.03
	60	3.24 $\pm$ 0.20	3.30 $\pm$ 0.20	6.87 $\pm$ 0.17	7.13 $\pm$ 0.10
	90	4.17 $\pm$ 0.42	4.23 $\pm$ 0.41	7.03 $\pm$ 0.21	7.02 $\pm$ 0.15
	120	4.00 $\pm$ 0.7	3.66 $\pm$ 0.37	7.46 $\pm$ 0.20	6.84 $\pm$ 0.58
Mean $\pm$ S.E.		3.75$\pm$0.24	3.83$\pm$0.24	7.05$\pm$0.06	6.98$\pm$0.20

4.19.2 Effect of rubber mat bedding on SNF per cent

The SNF (%) in crossbred cows and buffaloes are presented in Table 4.31. There was non-significant difference ($P>0.05$) between treatment and control group of crossbred cattle and buffaloes of Pinjori and Malimajra village as well as pooled values. Overall, SNF per cent of control and treatment group of crossbred cattle was 8.56 ± 0.03 and 8.48 ± 0.02 per cent. Whereas, in buffaloes, it was 9.61 ± 0.28 and 9.65 ± 0.09 per cent, respectively.

Table 4.31 Mean $\pm$ S.E. of SNF (%) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	8.56 ± 0.21	8.42 ± 0.34	10.165 ± 0.43	9.70 ± 0.69
	60	8.44 ± 0.37	8.39 ± 0.29	9.78 ± 0.44	9.75 ± 0.69
	90	8.62 ± 0.39	8.45 ± 0.29	9.26 ± 0.54	9.72 ± 0.64
	120	8.71 ± 0.19	8.44 ± 0.26	10.02 ± 0.57	9.68 ± 0.61
Mean $\pm$ S.E.		8.57 ± 0.06	8.43 ± 0.02	9.81 ± 0.09	9.72 ± 0.13
Malimajra	N	6	6	6	6
	30	8.50 ± 0.28	8.81 ± 0.60	9.31 ± 0.48	9.49 ± 0.50
	60	8.80 ± 0.52	8.46 ± 0.57	9.62 ± 0.65	9.72 ± 0.57
	90	8.72 ± 0.14	8.40 ± 0.66	9.18 ± 0.48	9.54 ± 0.53
	120	8.26 ± 0.20	8.49 ± 0.42	9.53 ± 0.49	9.59 ± 0.52
Mean $\pm$ S.E.		8.57 ± 0.15	8.54 ± 0.12	9.41 ± 0.11	9.59 ± 0.07
Pooled	N	12	12	12	12
	30	8.50 ± 0.02	8.62 ± 0.04	9.74 ± 0.60	9.60 ± 0.14
	60	8.62 ± 0.03	8.42 ± 0.14	9.70 ± 0.11	9.74 ± 0.02
	90	8.67 ± 0.14	8.42 ± 0.12	9.22 ± 0.06	9.63 ± 0.13
	120	8.49 ± 0.10	8.46 ± 0.20	9.78 ± 0.35	9.64 ± 0.06
Mean $\pm$ S.E.		8.56 ± 0.03	8.48 ± 0.02	9.61 ± 0.28	9.65 ± 0.09

4.19.3 Effect of rubber mat bedding on milk protein per cent

The milk protein (%) in crossbred cows and buffaloes are presented in Table 4.32. The pooled values of control and treatment group of crossbred cattle were 3.21 ± 0.12 and 3.27 ± 0.17 per cent, whereas for buffaloes it was 3.48 ± 0.07 and 3.60 ± 0.01 per cent, respectively. There was non-significant difference found between control and treatment group of crossbred cattle and buffaloes.

Table 4.32 Mean $\pm$ S.E. of protein (%) in crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	3.47 ± 0.06	3.21 ± 0.12	3.40 ± 0.16	3.60 ± 0.29
	60	2.61 ± 0.15	2.35 ± 0.06	3.21 ± 0.19	3.55 ± 0.28
	90	3.89 ± 0.13	3.61 ± 0.13	3.56 ± 0.16	3.54 ± 0.29
	120	3.35 ± 0.04	3.63 ± 0.11	3.49 ± 0.13	3.69 ± 0.22
Mean $\pm$ S.E.		3.33 ± 0.07	3.45 ± 0.01	3.42 ± 0.20	3.60 ± 0.05
Malimajra	N	6	6	6	6
	30	3.46 ± 0.10	3.17 ± 0.32	3.68 ± 0.17	3.31 ± 0.19
	60	2.98 ± 0.17	2.96 ± 0.22	3.47 ± 0.20	3.75 ± 0.19
	90	3.33 ± 0.11	3.15 ± 0.19	3.49 ± 0.15	3.69 ± 0.19
	120	2.62 ± 0.16	3.14 ± 0.26	3.57 ± 0.18	3.64 ± 0.19
Mean $\pm$ S.E.		3.10 ± 0.06	3.11 ± 0.26	3.55 ± 0.12	3.60 ± 0.13
Pooled	N	12	12	12	12
	30	3.47 ± 0.05	3.29 ± 0.02	3.54 ± 0.14	3.46 ± 0.15
	60	2.79 ± 0.19	3.15 ± 0.19	2.34 ± 0.13	3.65 ± 0.10
	90	3.61 ± 0.28	3.38 ± 0.23	3.53 ± 0.04	3.62 ± 0.08
	120	2.99 ± 0.36	3.39 ± 0.25	3.53 ± 0.04	3.67 ± 0.03
Mean $\pm$ S.E.		3.21 ± 0.12	3.27 ± 0.17	3.48 ± 0.07	3.60 ± 0.01

4.20 Reproductive performance of dairy animals due to rubber mat bedding

The first observed post partum estrus (days), service period (days) and number of service per conception and conception rate of crossbred cows and buffaloes are presented in Table 4.33 and Figure 4.29 to Figure 4.34. It was observed non-significant difference between treatment and control group of crossbred cattle for first observed post partum estrus (88.50 ± 4.50 vs. 79.50 ± 4.45 days), service period (120 ± 7.00 vs. 110 ± 2.10 days) and number of services per conception (2.53 ± 0.27 vs. 2.08 ± 0.08). Similarly, non-significant difference was found between treatment and control group of buffaloes for first observed post partum estrus (108 ± 20.98 vs. T_1 : 93 ± 12.01 days) service period (146 ± 21.00 vs. 127 ± 8.50 days) and number of services per conception (T_0 : 2.33 ± 0.03 ; T_1 : 2.15 ± 0.07). First service conception rate was 33.33 per cent in control group and 41.67 per cent in treatment group of crossbred cattle, whereas, in control and treatment group of buffaloes was 25 per cent and 33.33, respectively. Similarly Kremer *et al.* (2012) observed non-significant differences between rubber and concrete floor for service per conception (rubber floor: 1.5; concrete: 1.7; $p=0.267$) and 100 days in milk yield were recorded in dairy cows.

Table 4.33: Mean $\pm$ S.E. of reproductive parameters of lactating crossbred cows and buffaloes

Reproduction parameters	Pinjori		Malimajra		Pooled (Mean $\pm$ S.E.)	
N	6	6	6	6	12	12
Group	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Days of first observed post partum estrus (days)						
Crossbred cattle	84 $\pm$ 8.80	84 $\pm$ 10.17	93 $\pm$ 11.02	75 $\pm$ 8.21	88.50 $\pm$ 4.50	79.50 $\pm$ 4.45
Buffalo	87 $\pm$ 5.61	81 $\pm$ 12.18	129 $\pm$ 6.01	105 $\pm$ 15.73	108 $\pm$ 20.98	93 $\pm$ 12.01
Service period (days)						
Crossbred cattle	113 $\pm$ 8.46	112 $\pm$ 11.89	127 $\pm$ 12.10	108 $\pm$ 14.45	120 $\pm$ 7.00	110 $\pm$ 2.10
Buffalo	125 $\pm$ 4.74	119 $\pm$ 13.82	167 $\pm$ 6.04	136 $\pm$ 18.73	146 $\pm$ 21.00	127 $\pm$ 8.50
No. of services per conception						
Crossbred cattle	2.40 $\pm$ 0.24	2.15 $\pm$ 0.20	2.25 $\pm$ 0.37	2.00 $\pm$ 0.24	2.53 $\pm$ 0.27	2.08 $\pm$ 0.08
Buffalo	2.30 $\pm$ 0.37	2.10 $\pm$ 0.24	2.35 $\pm$ 0.31	2.20 $\pm$ 0.25	2.33 $\pm$ 0.03	2.15 $\pm$ 0.07
First service conception rate (%)						
Crossbred cattle	33.33 (2)	50 (3)	33.33 (2)	33.33 (2)	33.33 (4)	41.67 (5)
Buffalo	16.67 (1)	33.33 (2)	33.33 (2)	33.33 (2)	25 (3)	33.33(4)

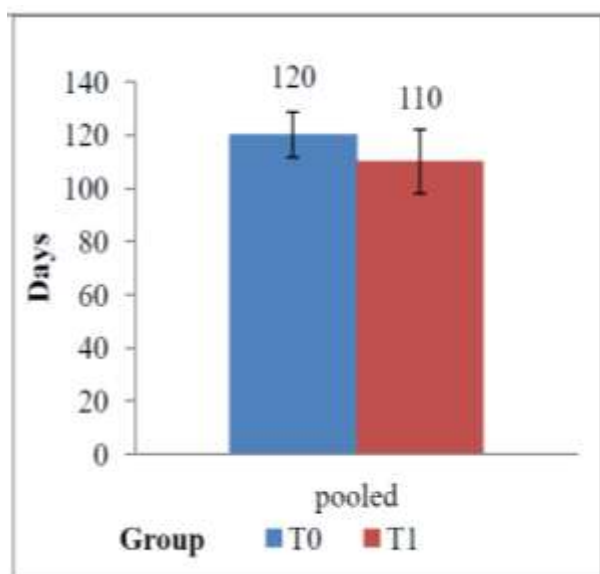


Figure 4.29 Service period (days) in lactating crossbred cattle (Pooled)

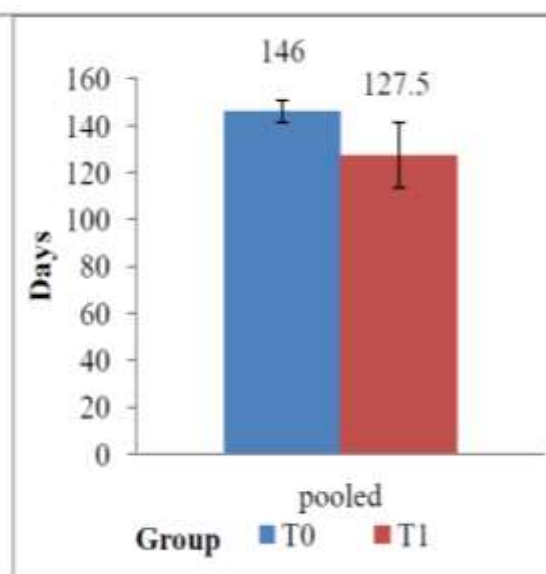


Figure 4.30 Service period (days) in lactating buffaloes (Pooled)

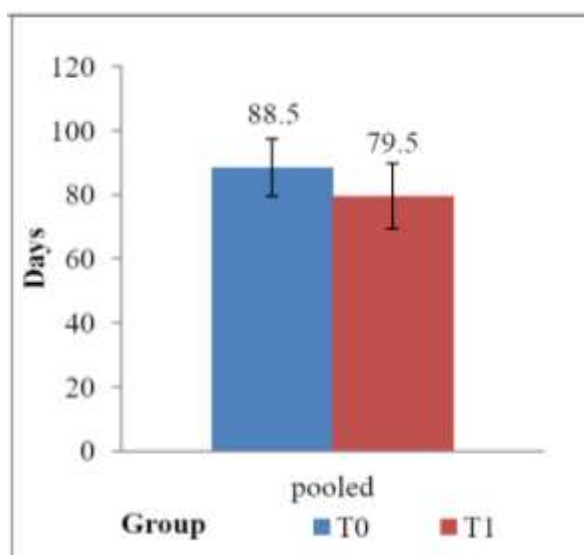


Figure 4.31 First post partum estrus (days) in lactating crossbred cattle (Pooled)

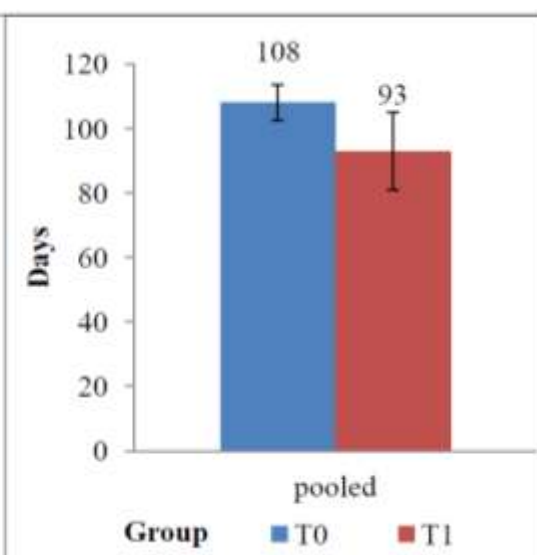


Figure 4.32 First post partum estrus (days) in lactating buffaloes (Pooled)

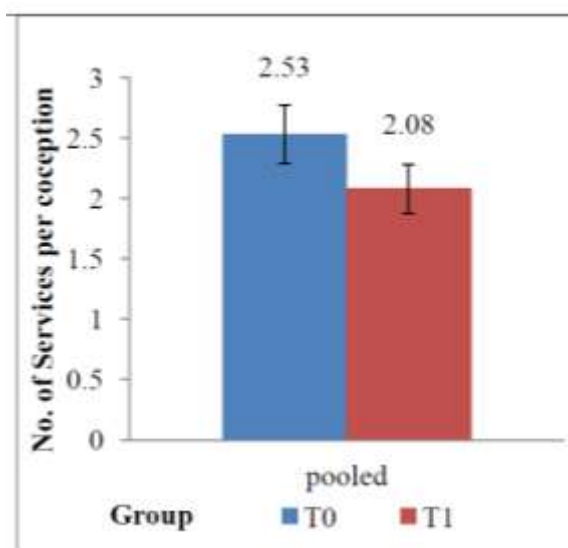


Figure 4.33 Number of service per conception in lactating crossbred cattle (Pooled)

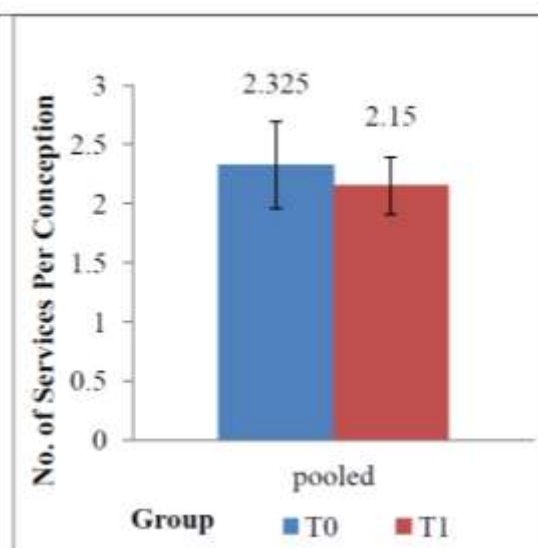


Figure 4.34 Number of service per conception in lactating buffaloes (Pooled)

4.21 Effect of rubber mat bedding on subclinical mastitis of lactating dairy animals

4.21.1 Effect of rubber mat bedding on California mastitis test score

The CMT score in lactating crossbred cattle and buffaloes are presented in Table 4.34 and Figure 4.35 and 4.36. CMT score was significantly ($P < 0.05$) different between control (1.57 ± 0.10 and 1.66 ± 0.17) and treatment group (1.12 ± 0.08 and 1.19 ± 0.10) of crossbred cattle in Pinjori and Malimajra village. Similarly, in buffaloes, there was significant ($P < 0.05$) difference observed between control (1.78 ± 0.05 and 1.58 ± 0.11) and treatment group (1.35 ± 0.15 and 1.02 ± 0.11) of Pinjori and Malimajra, respectively. Overall pooled values of CMT score in crossbred cattle and buffaloes were significantly ($P < 0.05$) different between control (1.61 ± 0.10 and 1.68 ± 0.16) and treatment group (1.15 ± 0.10 and 1.18 ± 0.17), respectively.

Our findings are in accordance with the result of Valde *et al.* (1997). They reported that Norwegian cattle housed on concrete floor had 14 per cent higher clinical mastitis than cattle housed with rubber mat flooring. Similarly, other researchers also reported significant ($p < 0.05$) reduction in mastitis incidences due to rubber mat bedding to dairy animals (Norrington *et al.*, 2010; Bradley *et al.*, 2018; Singh *et al.*, 2020). Lower cases of sub-clinical mastitis in dairy animals on rubber mat bedding might be due to improved level of cleanliness of dairy animals on rubber mat floor (Valde *et al.* 1997)

Table 4.34: Mean $\pm$ S.E. of CMT score in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	1.54 $\pm$ 0.20	1.30 $\pm$ 0.20	1.77 $\pm$ 0.24	1.80 $\pm$ 0.20
	60	1.35 $\pm$ 0.01	1.10 $\pm$ 0.01	1.67 $\pm$ 0.24	1.40 $\pm$ 0.01
	90	1.70 $\pm$ 0.24	1.15 $\pm$ 0.32	1.73 $\pm$ 0.20	1.20 $\pm$ 0.24
	120	1.70 ^a $\pm$ 0.24	0.92 ^b $\pm$ 0.24	1.96 ^a $\pm$ 0.25	1.00 ^b $\pm$ 0.25
Mean $\pm$ S.E.		1.57^a$\pm$0.10	1.12$\pm$0.08	1.78^a$\pm$0.05	1.35^b$\pm$0.15
Malimajra	N	6	6	6	6
	30	1.75 $\pm$ 0.24	1.60 $\pm$ 0.20	1.43 $\pm$ 0.17	1.27 $\pm$ 0.21
	60	1.55 $\pm$ 0.22	1.25 $\pm$ 0.22	1.60 $\pm$ 0.26	1.10 $\pm$ 0.22
	90	1.70 ^a $\pm$ 0.20	0.93 ^b $\pm$ 0.24	1.77 ^a $\pm$ 0.17	0.93 ^b $\pm$ 0.21
	120	1.65 ^a $\pm$ 0.25	0.98 ^b $\pm$ 0.25	1.53 ^a $\pm$ 0.21	0.77 ^b $\pm$ 0.30
Mean $\pm$ S.E.		1.66^a$\pm$0.17	1.19^b$\pm$0.10	1.58^a$\pm$0.11	1.02^b$\pm$0.11
Pooled	N	12	12	12	12
	30	1.64 $\pm$ 0.10	1.45 $\pm$ 0.10	1.60 $\pm$ 0.17	1.54 $\pm$ 0.27
	60	1.45 $\pm$ 0.10	1.17 $\pm$ 0.10	1.64 $\pm$ 0.29	1.25 $\pm$ 0.15
	90	1.70 ^a $\pm$ 0.01	1.04 ^b $\pm$ 0.10	1.75 ^a $\pm$ 0.08	1.07 ^b $\pm$ 0.14
	120	1.67 ^a $\pm$ 0.01	0.95 ^b $\pm$ 0.01	1.75 ^a $\pm$ 0.12	0.88 ^b $\pm$ 0.12
Mean $\pm$ S.E.		1.61^a$\pm$0.10	1.15^b$\pm$0.10	1.68^a$\pm$0.16	1.18^b$\pm$0.17

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

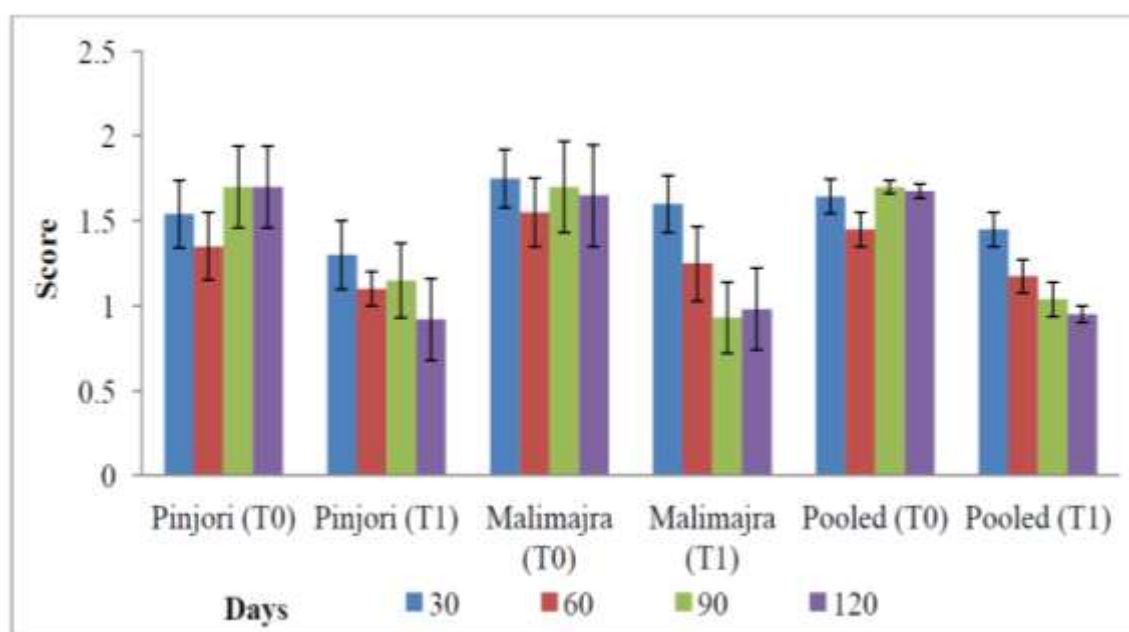


Figure 4.35 California mastitis test score in lactating crossbred cattle

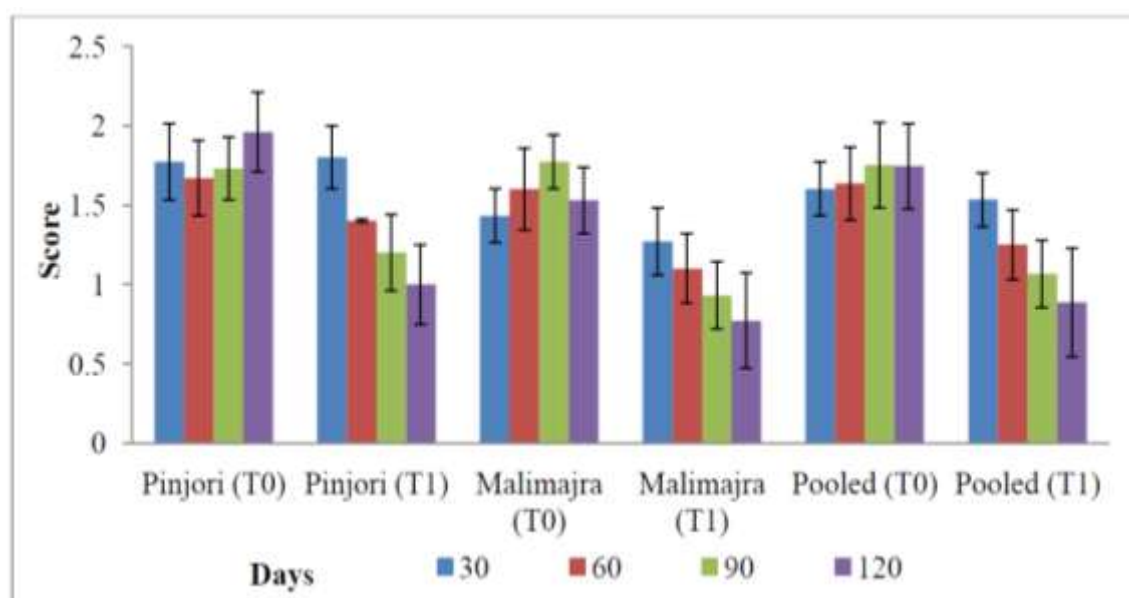


Figure 4.36 California mastitis test score in lactating buffaloes

4.21.2 Effect of rubber mat bedding on somatic cell count

The somatic cell count ($\times 10^3$ /ml) in lactating crossbred cattle and buffaloes are presented in Table 4.35 and Figure 4.37 and 4.38. Somatic cell count was significantly ($P < 0.05$) lower in treatment group of crossbred cattle (192.08 ± 1.13 and 206.22 ± 4.30) as compared control group (219.85 ± 5.11 , 218.95 ± 6.01). In buffaloes also, there was significant ($P < 0.05$) difference between treatment group (87.80 ± 5.20 , 98.13 ± 4.29) and control group (97.23 ± 4.46 , 112.95 ± 5.31) of Pinjori and Malimajra villages, respectively. The pooled value of somatic cell count was significantly ($P < 0.05$) lower in treatment group ($199.66^b \pm 1.08$ and 92.96 ± 4.41) as compared to control (219.40 ± 3.76 and 105.09 ± 13.73) in crossbred cattle and buffaloes, respectively.

Various researchers reported that subclinical mastitis significantly ($P < 0.05$) reduced in dairy cows due to implementation of rubber mat bedding (Kremer *et al.*, 2006; Ruud *et al.*, 2010 and Singh *et al.*, 2020). Somatic cell count in milk is closely associated with the cleanliness of the udder and lower hind leg of dairy animals. Reduced somatic cell count in treatment group may be due to improvement in cleanliness score of dairy animals (Reneau *et al.* 2005)

4.22 Effect of rubber mat bedding on body condition score (BCS) and body weight of lactating animals

4.22.1 Body condition score (BCS) of lactating crossbred cattle and buffaloes

The BCS score in lactating crossbred cattle and buffaloes are presented in Table 4.36 and Figure 4.39 and 4.40. There was non-significant difference observed between control and treatment group of crossbred cattle and buffaloes in study area. The pooled BCS score for control and treatment group of crossbred cattle were 2.86 ± 0.15 and 3.03 ± 0.09 , whereas in buffaloes it was 2.90 ± 0.29 and 3.02 ± 0.12 , respectively.

Table 4.35: Mean $\pm$ S.E. of somatic cell count ($\times 10^3$ /ml) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	212.40 $\pm$ 15.47	206.10 $\pm$ 39.34	95.83 $\pm$ 8.83	90.80 $\pm$ 6.35
	60	213.50 $\pm$ 15.97	202.20 $\pm$ 36.09	92.67 $\pm$ 4.24	86.80 $\pm$ 6.42
	90	228.2 $\pm$ 25.47	184.2 $\pm$ 19.22	102.75 $\pm$ 7.04	85.60 $\pm$ 5.25
	120	225.30 $\pm$ 18.76	175.80 $\pm$ 28.53	97.67 $\pm$ 7.93	88.00 $\pm$ 5.22
Mean $\pm$ S.E.		219.85^a$\pm$5.11	192.08^b$\pm$1.13	97.23^a$\pm$4.46	87.80^b$\pm$5.20
Malimajra	N	6	6	6	6
	30	216.30 $\pm$ 20.26	213.50 $\pm$ 8.53	106.50 $\pm$ 3.48	98.17 $\pm$ 4.89
	60	218.60 $\pm$ 13.18	189.46 $\pm$ 8.45	113.83 $\pm$ 3.16	98.50 $\pm$ 5.75
	90	220.08 ^a $\pm$ 9.27	208.30 ^b $\pm$ 10.22	115.00 $\pm$ 9.85	98.33 $\pm$ 3.27
	120	220.40 $\pm$ 18.93	213.60 $\pm$ 11.02	116.50 $\pm$ 5.25	97.50 $\pm$ 5.02
Mean $\pm$ S.E.		218.95^a$\pm$6.01	206.22^b$\pm$4.30	112.95^a$\pm$5.31	98.13^b$\pm$4.29
Pooled	N	12	12	12	12
	30	214.20 $\pm$ 2.80	209.55 $\pm$ 1.45	101.17 $\pm$ 10.33	94.48 $\pm$ 3.68
	60	216.05 $\pm$ 5.55	195.83 $\pm$ 9.30	103.25 $\pm$ 14.08	92.65 $\pm$ 5.85
	90	224.25 $\pm$ 5.05	196.25 $\pm$ 6.90	108.87 $\pm$ 11.13	91.97 $\pm$ 3.36
	120	222.95 $\pm$ 6.65	194.70 $\pm$ 5.30	107.08 $\pm$ 19.41	92.75 $\pm$ 4.75
Mean $\pm$ S.E.		219.40^a$\pm$3.76	199.66^b$\pm$1.08	105.09$\pm$13.73	92.96$\pm$4.41

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

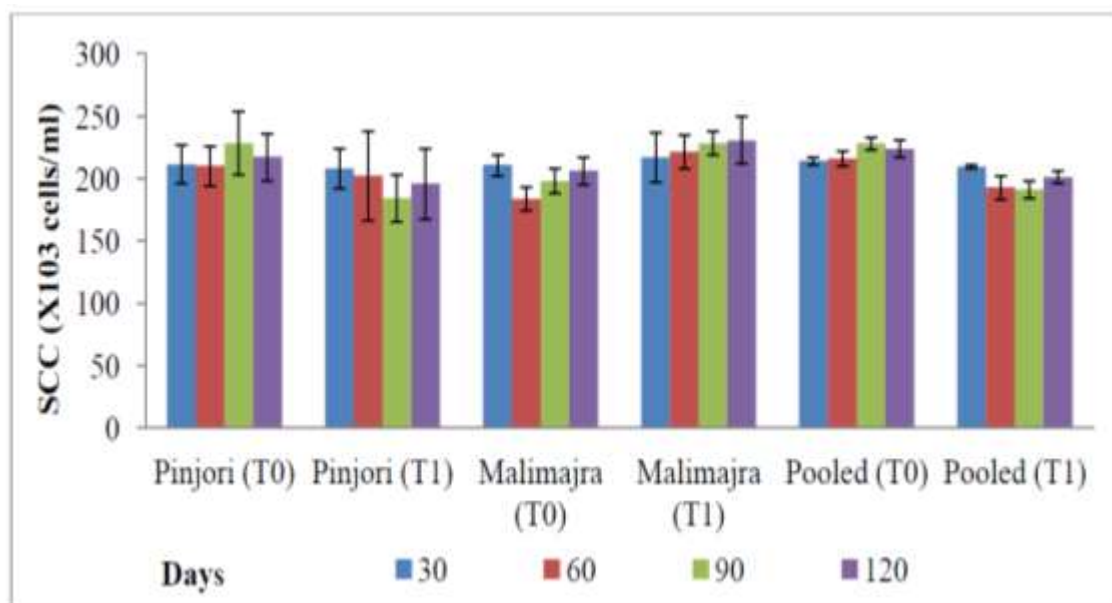


Figure 4.37 Somatic cell count ($\times 10^3$ cells/ml) in lactating crossbred cattle

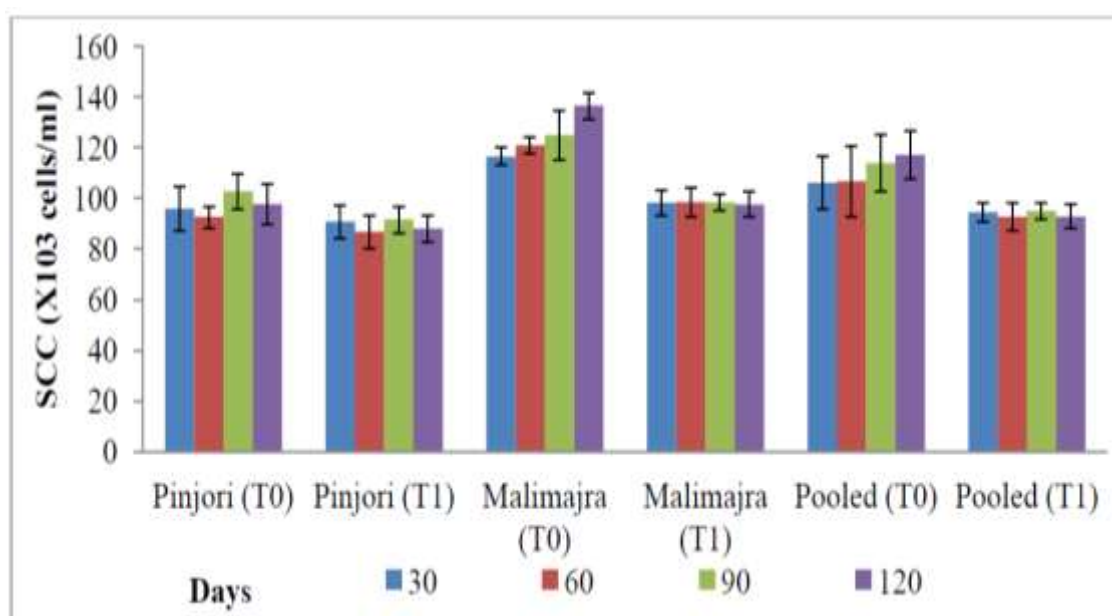


Figure 4.38 Somatic cell count ($\times 10^3$ cells/ml) in lactating buffaloes

Table 4.36: Mean $\pm$ S.E. of BCS in crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	0	2.95 $\pm$ 0.11	3.10 $\pm$ 0.12	2.90 $\pm$ 0.18	3.19 $\pm$ 0.10
	30	2.77 $\pm$ 0.08	2.88 $\pm$ 0.14	2.58 $\pm$ 0.04	2.92 $\pm$ 0.08
	60	2.70 $\pm$ 0.07	2.84 $\pm$ 0.17	2.47 $\pm$ 0.12	2.86 $\pm$ 0.09
	90	2.51 $\pm$ 0.20	2.93 $\pm$ 0.27	2.48 $\pm$ 0.26	2.90 $\pm$ 0.15
	120	2.63 $\pm$ 0.16	3.07 $\pm$ 0.17	2.61 $\pm$ 0.08	2.95 $\pm$ 0.27
Mean $\pm$ S.E.		2.71$\pm$0.05	2.98$\pm$0.08	2.61$\pm$0.10	2.96$\pm$0.04
Malimajra	N	6	6	6	6
	0	3.26 $\pm$ 0.07	3.20 $\pm$ 0.43	3.29 $\pm$ 0.04	3.08 $\pm$ 0.03
	30	3.04 $\pm$ 0.03	3.13 $\pm$ 0.03	3.25 $\pm$ 0.03	3.08 $\pm$ 0.04
	60	2.90 $\pm$ 0.10	3.05 $\pm$ 0.02	3.21 $\pm$ 0.07	2.96 $\pm$ 0.09
	90	2.92 $\pm$ 0.06	3.09 $\pm$ 0.08	3.06 $\pm$ 0.06	3.07 $\pm$ 0.12
	120	2.98 $\pm$ 0.18	3.11 $\pm$ 0.10	3.10 $\pm$ 0.11	3.09 $\pm$ 0.13
Mean $\pm$ S.E.		3.02$\pm$0.06	3.12$\pm$0.03	3.18$\pm$0.05	3.05$\pm$0.04
Pooled	N	12	12	12	12
	0	3.10 $\pm$ 0.11	3.15 $\pm$ 0.05	3.09 $\pm$ 0.19	3.13 $\pm$ 0.14
	30	2.91 $\pm$ 0.17	3.01 $\pm$ 0.15	2.92 $\pm$ 0.34	3.01 $\pm$ 0.13
	60	2.80 $\pm$ 0.07	2.95 $\pm$ 0.11	2.84 $\pm$ 0.29	2.92 $\pm$ 0.01
	90	2.70 $\pm$ 0.17	3.01 $\pm$ 0.13	2.77 $\pm$ 0.31	2.99 $\pm$ 0.17
	120	2.81 $\pm$ 0.20	3.09 $\pm$ 0.03	2.86 $\pm$ 0.30	3.02 $\pm$ 0.14
Mean $\pm$ S.E.		2.86$\pm$0.15	3.03$\pm$0.09	2.90$\pm$0.29	3.02$\pm$0.12

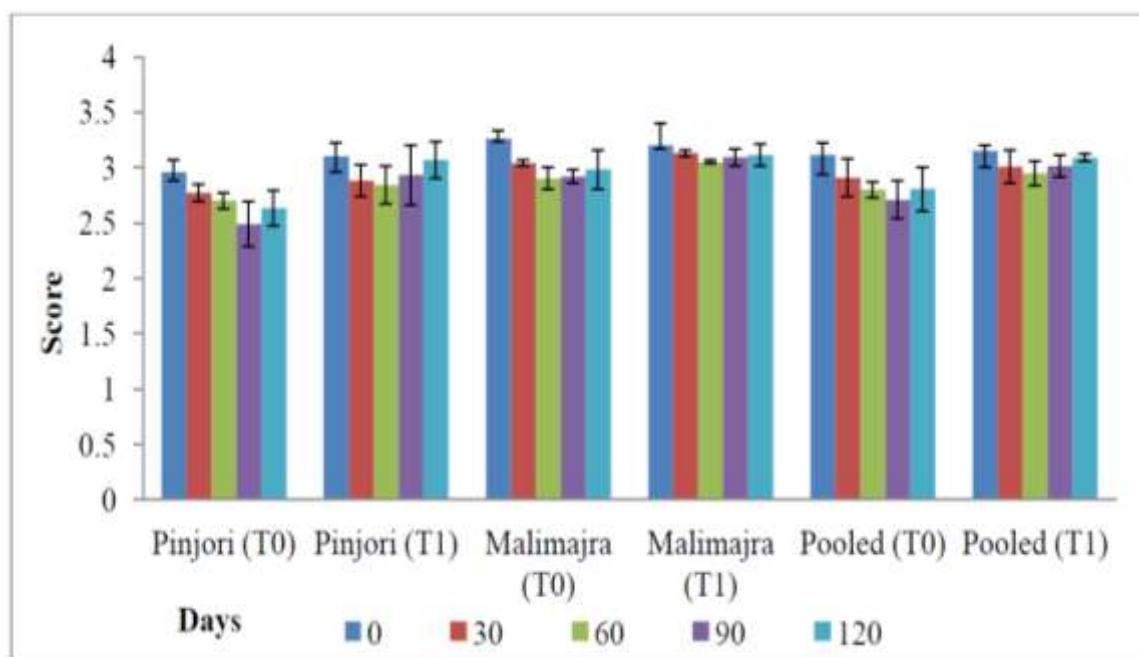


Figure 4.39 Body condition score in lactating crossbred cattle

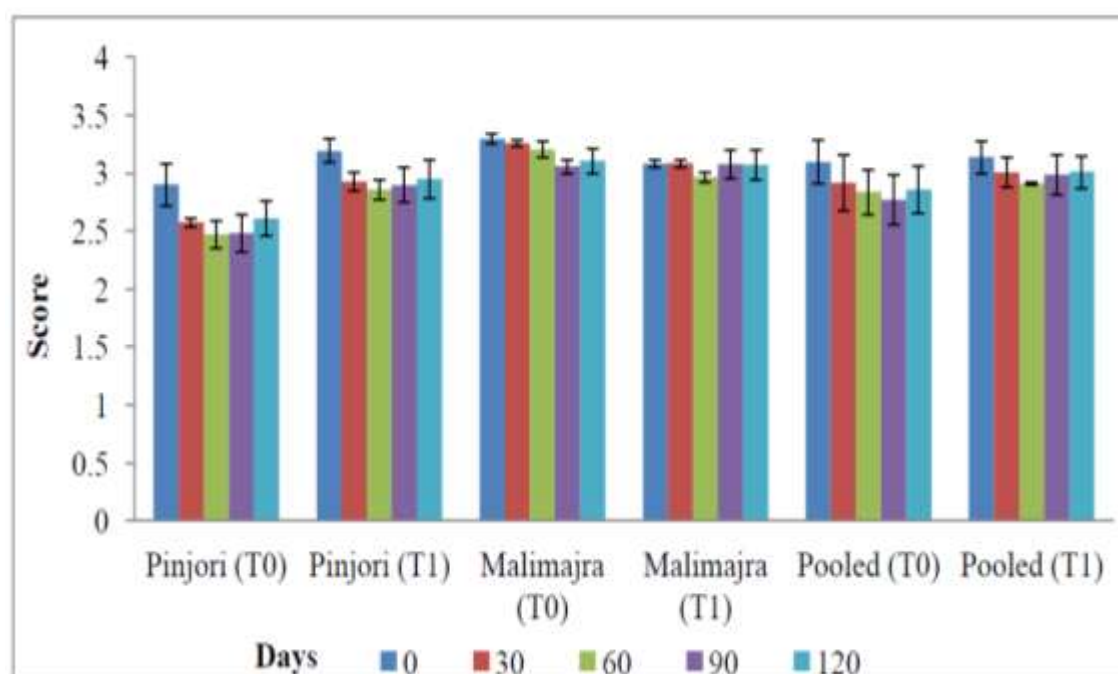


Figure 4.40 Body condition score in lactating buffaloes

4.22.2 Body weight of lactating crossbred cattle and buffaloes

The body weight (Kg) of lactating crossbred cattle and buffaloes are presented in Table 4.37. Mean body weight (kg) of crossbred cattle and buffaloes were found to be non-significant in Pinjori and Malimajra village. The pooled value of body weight of control and treatment group of crossbred cattle was 418.43 ± 4.38 kg and 421.49 ± 2.28 kg, whereas for buffaloes it was 563.20 ± 18.02 kg and 560.52 ± 19.87 kg in control and treatment, respectively.

Table 4.37: Mean $\pm$ S.E. of body weight (kg) in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	0	425.54 $\pm$ 10.43	423.40 $\pm$ 21.30	571.38 $\pm$ 19.42	565.42 $\pm$ 12.36
	30	424.17 $\pm$ 11.94	419.16 $\pm$ 22.01	563.91 $\pm$ 22.04	562.04 $\pm$ 13.73
	60	423.01 $\pm$ 11.36	422.01 $\pm$ 22.16	557.25 $\pm$ 21.84	557.43 $\pm$ 14.78
	90	423.11 $\pm$ 9.79	425.50 $\pm$ 21.46	556.85 $\pm$ 20.64	556.97 $\pm$ 14.82
	120	419.20 $\pm$ 8.25	424.20 $\pm$ 20.79	555.45 $\pm$ 19.54	559.52 $\pm$ 14.91
Mean $\pm$ S.E.		423.35$\pm$1.03	422.85$\pm$5.63	560.97$\pm$3.29	560.27$\pm$1.98
Malimajra	N	6	6	6	6
	0	418.35 $\pm$ 15.21	426.09 $\pm$ 17.76	570.25 $\pm$ 21.18	568.54 $\pm$ 24.40
	30	415.95 $\pm$ 14.44	421.64 $\pm$ 19.17	566.05 $\pm$ 22.36	561.12 $\pm$ 23.23
	60	412.10 $\pm$ 16.85	416.68 $\pm$ 18.50	567.43 $\pm$ 18.58	559.32 $\pm$ 24.05
	90	415.68 $\pm$ 16.81	417.95 $\pm$ 19.93	561.22 $\pm$ 16.78	558.07 $\pm$ 23.77
	120	412.45 $\pm$ 17.18	418.32 $\pm$ 21.50	562.23 $\pm$ 15.16	556.82 $\pm$ 23.51
Mean $\pm$ S.E.		414.91$\pm$1.02	420.14$\pm$2.02	565.64$\pm$3.59	560.77$\pm$3.19
Pooled	N	12	12	12	12
	0	421.94 $\pm$ 4.14	424.74 $\pm$ 4.33	570.91 $\pm$ 18.16	566.98 $\pm$ 19.48
	30	420.11 $\pm$ 4.14	420.40 $\pm$ 3.23	564.99 $\pm$ 17.12	561.58 $\pm$ 23.53
	60	417.61 $\pm$ 5.50	419.35 $\pm$ 2.66	562.23 $\pm$ 19.50	558.38 $\pm$ 23.13
	90	419.88 $\pm$ 4.19	421.73 $\pm$ 5.27	559.03 $\pm$ 17.61	557.52 $\pm$ 14.42
	120	416.14 $\pm$ 3.68	421.27 $\pm$ 4.43	558.84 $\pm$ 17.86	558.17 $\pm$ 18.15
Mean $\pm$ S.E.		418.43$\pm$4.38	421.49$\pm$2.28	563.20$\pm$18.02	560.52$\pm$19.87

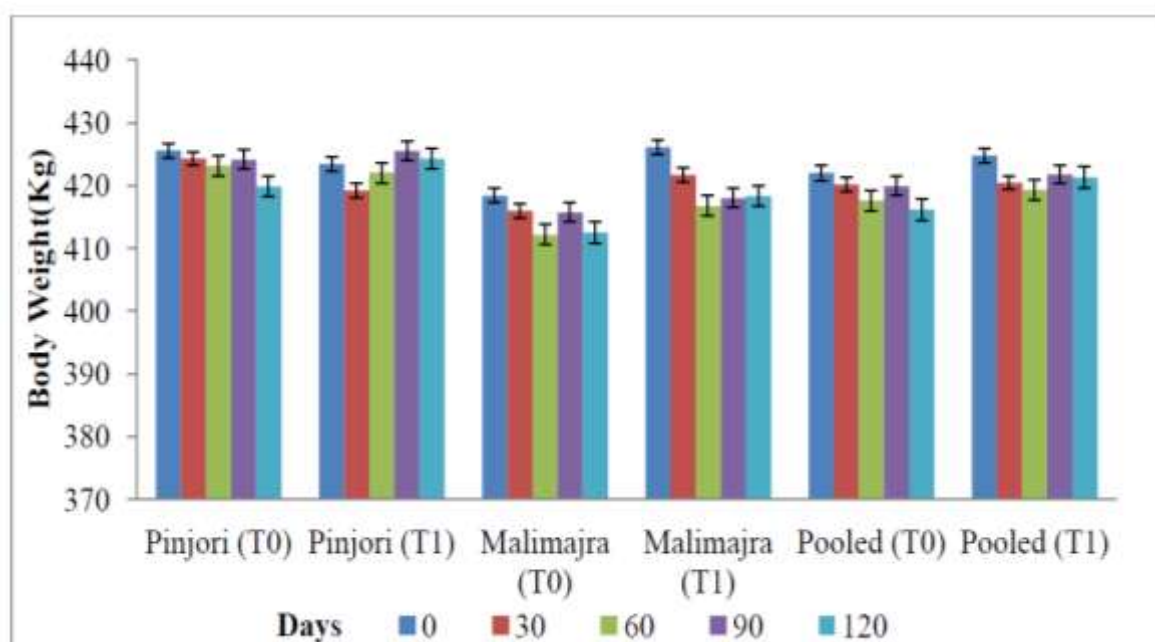


Figure 4.41 Body weight (kg) of lactating crossbred cattle

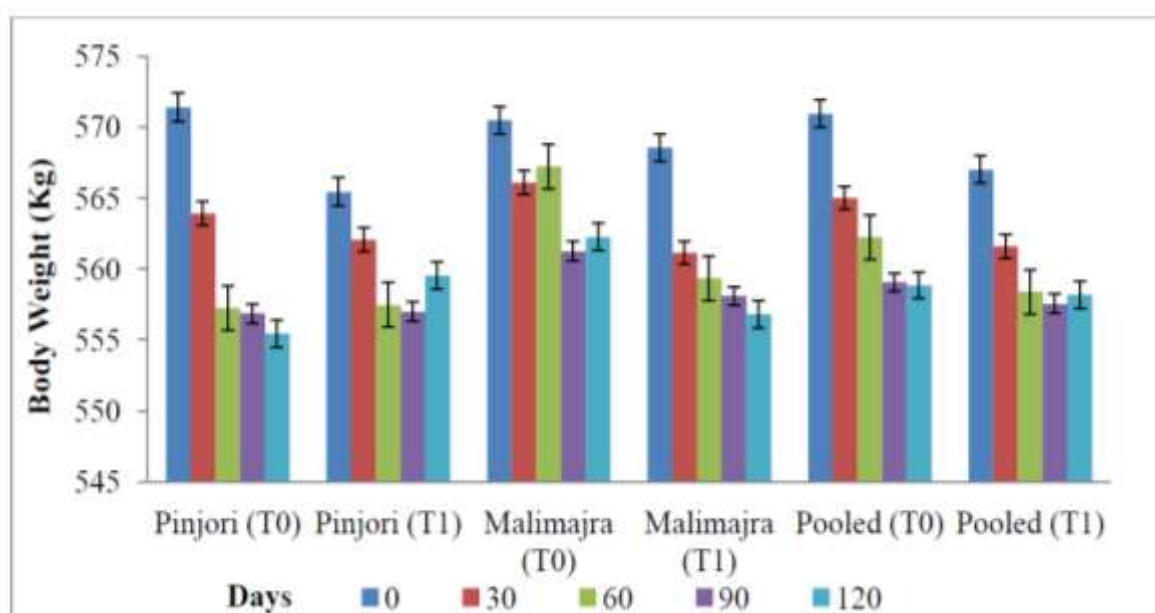


Figure 4.42 Body weight (kg) of lactating buffaloes

4.23 Effect of rubber mat bedding on hock and knee injury score in crossbred cattle and buffaloes.

The hock and knee injury score (HIS) in lactating crossbred cattle and buffaloes are presented in Table 4.38 and Figure 4.43 and 4.44. Injury of hock and knee is indicator for type of bedding in animal housing. In present study, hock and knee injury score was significantly ($P<0.05$) reduced in treatment group in Pinjori village of crossbred cattle at 60, 90, 120 days (1.60 ± 0.29 , 1.51 ± 0.28 and 1.48 ± 0.26) as compared to control group (2.50 ± 0.50 , 2.63 ± 0.25 and 2.55 ± 0.26), whereas HIS of treatment group in Malimajra village was significantly ($P<0.05$) lower at 120 days (1.22 ± 0.20) as compared with control group (2.02 ± 0.40). Similarly in buffaloes, treatment group HIS of Pinjori village was significantly ($P<0.05$) lower at 60, 90 and 120 days (1.20 ± 0.32 , 1.50 ± 0.20 and 1.40 ± 0.25) in treatment group as compared to control group (2.00 ± 0.32 , 2.20 ± 0.25 and 2.50 ± 0.20), whereas treatment group of Malimajra village at 90 and 120 days (1.20 ± 0.21 and 1.60 ± 0.20) it was significantly ($p<0.05$) lower as compared to control group (1.40 ± 0.25 and 1.20 ± 0.20).

Overall mean value of hock and knee injury cases were significantly ($P<0.05$) lower in treatment group of crossbred cattle (1.58 ± 0.06) and buffaloes (1.53 ± 0.17) as compared to control group of crossbred cattle (2.43 ± 0.16) and buffaloes (2.23 ± 0.10) in Pinjori village. Similarly in Malimajra village, hock and knee injury score were significantly ($P<0.05$) lower in treatment group of crossbred cattle (1.46 ± 0.09) and buffaloes (1.47 ± 0.14) as compared to control group of crossbred cattle (1.95 ± 0.05) and buffaloes (2.04 ± 0.12). Pooled hock and knee injury score were significantly ($P<0.05$) different between control (2.19 ± 0.16) and treatment group (1.52 ± 0.06) of crossbred cattle. Similarly in buffaloes also, significant ($P<0.05$) difference was observed between control (2.13 ± 0.09) and treatment group (1.50 ± 0.03).

In accordance with our findings, Jha *et al.* (2019) reported that the dairy cow's housed on muddy floor (1.02 ± 0.57) and rubber mat floor (1.34 ± 0.48) had lower hock injury lesion compared to housed on cemented floor (1.63 ± 0.489) and brick paved floor (1.83 ± 0.44). Weerasinghe *et al.* (2021) reported significant ($p<0.05$) reduction in swelling and wound severity of hocks in Friesian dairy cows on rubber mat bedding as compared to concrete floor. Sadharakiya *et al.* (2019) reported that overall hock and knee injury score were significantly ($p<0.01$) different in cows on rubber mat and concrete floor. Similar results were reported by Gurung *et al.* (2020), Schutz and Cox (2014),

Bergsten *et al.* (2015) Jha *et al.* (2019), Islam *et al.* (2020). Reduced incidences of hock and knee injury may be due to softness of rubber mat bedding along with reducing friction between floor and hock and knee due longer time of standing and sitting of animals on rubber mat bedding (Rushen *et al.* 2007; Sadharakiya *et al.* 2019; Weerasinghe *et al.* 2021)

Table 4.38: Mean± S.E. of hock and knee injury score in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	2.00±0.58	1.76±0.48	2.20±0.20	2.00±0.20
	60	2.50 ^a ±0.50	1.60 ^b ±0.29	2.00 ^a ±0.32	1.20 ^b ±0.32
	90	2.63 ^a ±0.25	1.51 ^b ±0.28	2.20 ^a ±0.25	1.50 ^b ±0.20
	120	2.55 ^a ±0.26	1.48 ^b ±0.26	2.50 ^a ±0.20	1.40 ^b ±0.25
Mean ± S.E.		2.43^a±0.16	1.58^b±0.06	2.23^a±0.10	1.53^b±0.17
Malimajra	N	6	6	6	6
	30	1.80±0.37	1.62±0.20	1.60±0.40	1.60±0.32
	60	2.01±0.32	1.50±0.24	1.60±0.40	1.50±0.25
	90	2.00±0.44	1.51±0.20	1.40 ^a ±0.25	1.20 ^b ±0.21
	120	2.02 ^a ±0.40	1.22 ^b ±0.20	1.20 ^a ±0.20	1.60 ^b ±0.20
Mean ± S.E.		1.95^a±0.05	1.46^b±0.09	2.04^a±0.12	1.47^b±0.14
Pooled	N	12	12	12	12
	30	1.90 ^a ±0.58	1.68 ^b ±0.48	1.95±0.25	1.80±0.20
	60	2.25 ^a ±0.50	1.55 ^b ±0.29	2.00 ^a ±0.01	1.35 ^b ±0.15
	90	2.33 ^a ±0.25	1.50 ^b ±0.28	2.20 ^a ±0.01	1.35 ^b ±0.15
	120	2.28 ^a ±0.26	1.35 ^b ±0.26	2.38 ^a ±0.12	1.50 ^b ±0.10
Mean ± S.E.		2.19^a±0.16	1.52^b±0.06	2.13^a±0.09	1.50^b±0.03

^{ab}Mean values with different superscript within a row differ significantly (P<0.05)

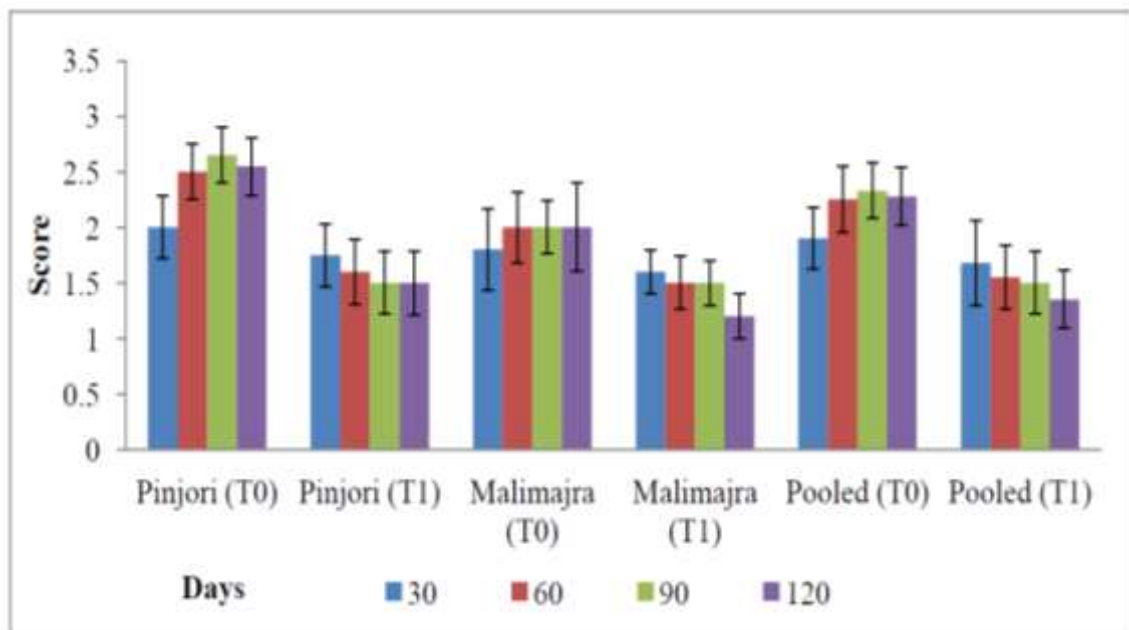


Figure 4.43 Hock and knee injury score in lactating crossbred cattle

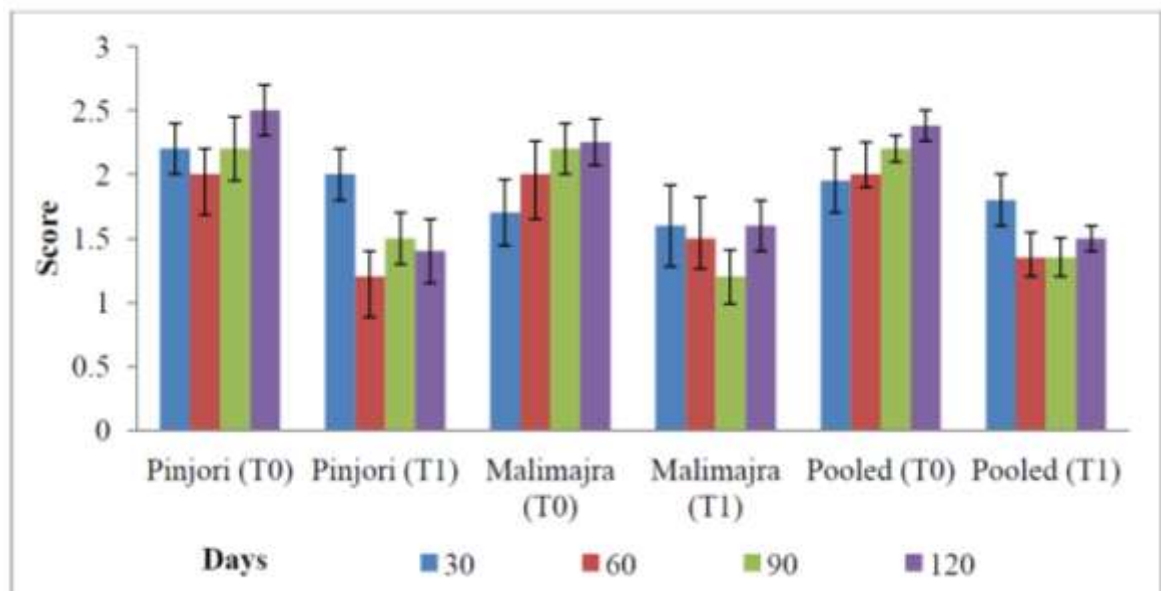


Figure 4.44 Hock and knee injury score in lactating buffaloes

4.24 Effect of rubber mat bedding on cow cleanliness score of lactating crossbred cattle and buffaloes

The cow cleanliness score (CCS) in lactating crossbred cattle and buffaloes are presented in Table 4.39 and Figure 4.45 and 4.46. Cow cleanliness score of crossbred cattle of T₁ were significantly ($P<0.05$) higher (3.06 ± 0.20 , 3.28 ± 0.08 and 3.22 ± 0.11) at 60, 90 and 120 day as compared to T₀ (2.48 ± 0.18 , 2.64 ± 0.11 and 2.54 ± 0.06) in Pinjori village, whereas, in Malimajra village, cow cleanliness score of crossbred cattle of treatment group were (3.18 ± 0.13 , 3.12 ± 0.12 , 3.32 ± 0.12 and 3.44 ± 0.07) at 30, 60, 90, 120 day and were significantly ($P<0.05$) higher as compared to control (2.64 ± 0.12 , 2.48 ± 0.08 , 2.52 ± 0.08 and 2.58 ± 0.05). Cow cleanliness score in T₁ of buffaloes (3.08 ± 0.17 and 3.38 ± 0.05) were significant ($P<0.05$) higher at 30 and 120 days as compared to control group (2.54 ± 0.15 and 2.60 ± 0.06) in Pinjori village.

Mean cow cleanliness score of treatment group of crossbred cattle in Pinjori and Malimajra villages was (3.18 ± 0.12 and 3.27 ± 0.13) were significantly ($P<0.05$) higher as compared to control group (2.53 ± 0.06 and 2.55 ± 0.05). Similarly in buffaloes, significant ($P<0.05$) differences were found between mean values of cow cleanliness score of treatment (3.13 ± 0.1 and 3.15 ± 0.09) and control group (2.57 ± 0.03 and 2.62 ± 0.08) in Pinjori and Malimajra villages. It shows that crossbred cattle and buffaloes were cleaner on rubber mat bedding rather than on concrete floor and katcha floor. Significant ($P<0.05$) differences of pooled value of cow cleanliness score were observed between control and treatment group of crossbred cattle (T₀: 2.54 ± 0.01 ; T₁: 3.22 ± 0.042) and buffaloes (T₀: 2.59 ± 0.02 ; T₁: 3.14 ± 0.01) in the study area.

In accordance with our finding, Sadharakiya *et al.* (2019) reported that cow cleanliness score were significantly ($p<0.05$) increased due to implementation of rubber mat in dairy animal house. Along with that overall hygiene score was found significantly ($p<0.01$) different for the cow kept on rubber mat (1.66 ± 0.09) compared to cows kept on concrete floor (2.00 ± 0.08). Similarly Hultgren and Bergsten (2001) reported overall per cent of cow dirty on foot, leg and body on rubber mat floor and solid stall floor were 61 and 91, 43 and 80, and 35 and 59 per cent, respectively in dairy cows. Significant ($p<0.05$) improvement in cleanliness score in treatment group of dairy animals may be due to better drainage of waste from rubber mat as compared to rough concrete floor and katcha floor (Hultgren and Bergsten 2001).

Table 4.39: Mean± S.E. of cow cleanliness score in lactating crossbred cows and buffaloes

Village		Crossbred cattle		Buffalo	
Pinjori	Days	T ₀	T ₁	T ₀	T ₁
	N	6	6	6	6
	30	2.46±0.15	3.16±0.19	2.54 ^a ±0.15	3.08 ^b ±0.17
	60	2.48 ^a ±0.18	3.06 ^b ±0.20	2.52±0.21	2.92±0.16
	90	2.64 ^a ±0.11	3.28 ^b ±0.08	2.62±0.20	3.12±0.16
	120	2.54 ^a ±0.06	3.22 ^b ±0.11	2.60 ^a ±0.06	3.38 ^b ±0.05
Mean ± S.E.		2.53^a±0.04	3.18^b±0.12	2.57^a±0.03	3.13^b±0.10
Malimajra	N	6	6	6	6
	30	2.64 ^a ±0.12	3.18 ^b ±0.13	2.7±0.19	2.88±0.24
	60	2.48 ^a ±0.08	3.12 ^b ±0.12	2.63±0.13	3.12±0.18
	90	2.52 ^a ±0.08	3.32 ^b ±0.12	2.38±0.09	3.30±0.16b
	120	2.58 ^a ±0.05	3.44 ^b ±0.07	2.75±0.06	3.28±0.05
Mean ± S.E.		2.55^a±0.05	3.27^b±0.13	2.62^a±0.08	3.15^b±0.09
Pooled	N	12	12	12	12
	30	2.55 ^a ±0.09	3.17 ^b ±0.01	2.62±0.08	2.98±0.10
	60	2.45 ^a ±0.03	3.09 ^b ±0.03	2.57±0.05	3.02±0.11
	90	2.58 ^a ±0.06	3.30 ^b ±0.02	2.50 ^a ±0.12	3.21 ^b ±0.09
	120	2.56 ^a ±0.02	3.33 ^b ±0.11	2.68 ^a ±0.08	3.33 ^b ±0.05
Mean ± S.E.		2.54^a±0.01	3.22^b±0.042	2.59^a±0.02	3.14^b±0.01

^{a,b}Mean values with different superscript within a row differ significantly (P<0.05)

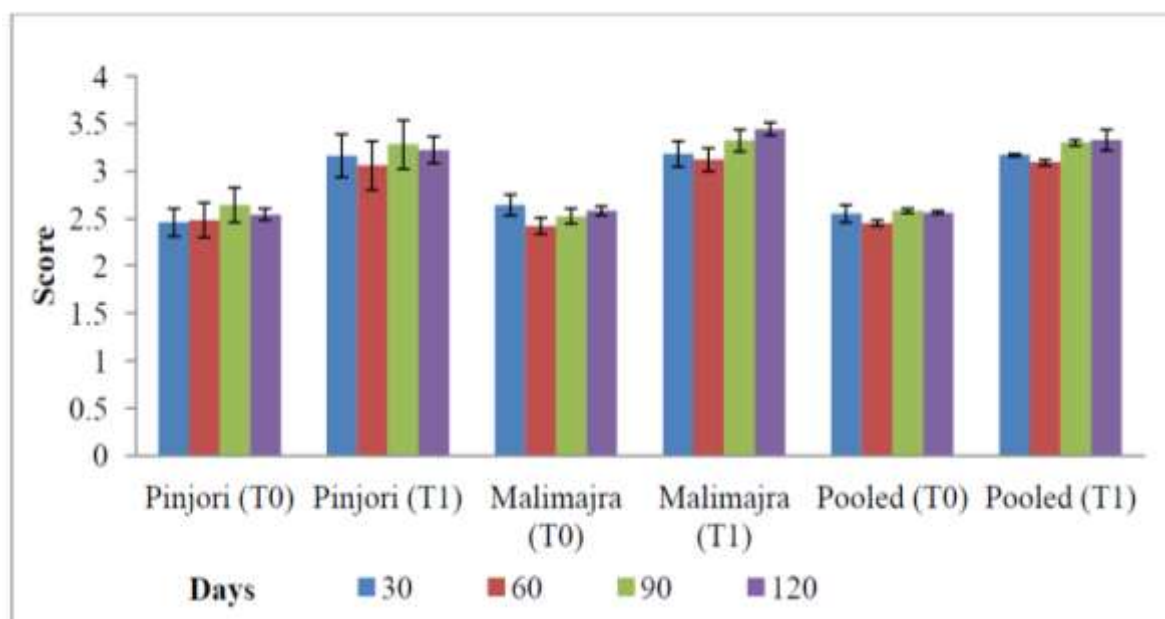


Figure 4.45 Cow cleanliness score of lactating crossbred cattle

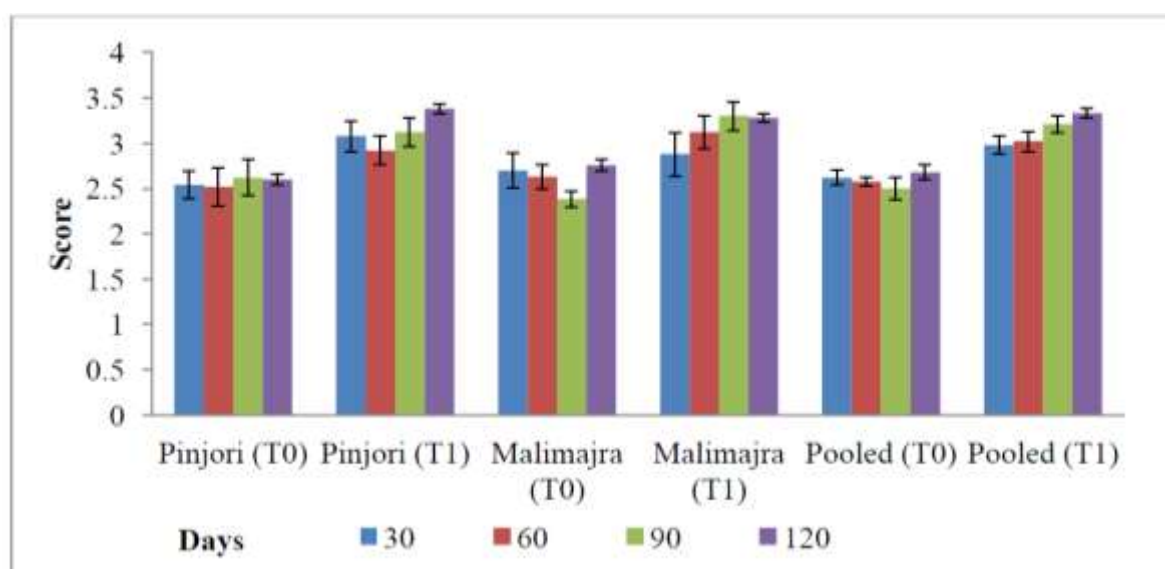


Figure 4.46 Cow cleanliness score of lactating buffaloes

4.25 Effect of rubber mat bedding on hematological parameter of lactating crossbred cattle and buffaloes

The hematological parameter of lactating crossbred cattle and buffaloes are presented in Table 4.40. No effect of rubber mat bedding was observed in hematological parameters such as RBC ($\times 10^6$ cell / μ L), TLC ($\times 10^3$ cells/ μ L), PCV (%) and Hb (g/dl) between control and treatment group of crossbred cattle and buffaloes.

Table 4.40: Hematological parameter of lactating crossbred cows and buffaloes (Mean± S.E.)

Village		Pinjori		Malimajra		Pooled (Mean ± S.E.)	
	N	6	6	6	6	12	12
	Parameters	T ₀	T ₁	T ₀	T ₁	T ₀	T ₁
Crossbred cattle	RBC (x10 ⁶ cell /μL)	7.14±0.50	6.90±0.41	8.06±0.22	6.35±0.43	7.60±0.42	6.63±0.41
	TLC (x 10 ³ cells/ μL)	14.00±0.22	13.50±0.94	13.67±0.70	13.84±0.59	13.83±0.45	13.67±0.54
	PCV (%)	33.00±1.47	36.75±1.49	37.75±2.50	39.00±1.22	35.37±1.85	37.87±1.62
	Hb (g/dl)	13.71±0.61	13.11±0.57	12.69±0.40	12.51±0.37	13.20±0.44	12.81±0.35
Buffalo	RBC (x10 ⁶ cell /μL)	7.30±0.37	7.21±0.38	6.88±0.50	7.31±0.55	7.15±0.29	7.26±0.43
	TLC (x 10 ³ cells/ μL)	13.15±0.43	13.79±0.36	13.51±0.30	13.55±0.22	13.33±0.46	13.66±0.59
	PCV (%)	37.75±2.35	39.25±2.56	37.50±2.10	32.75±1.03	37.63±1.63	36.00±1.82
	Hb (g/dl)	12.98±0.43	13.35±0.59	13.25±0.46	13.32±0.24	12.82±0.32	13.22±0.44

CHAPTER –5

Summary and Conclusions

SUMMARY AND CONCLUSIONS

Better nutritional management and welfare of the dairy animals influences the productive and reproductive performance of dairy animals. Therefore, the present study entitled ‘Assessment of multi-nutrient block supplementation and rubber mat on the production performance of dairy animals under field condition’ was undertaken with following objectives:

1. To assess the effect of multi-nutrient block supplementation on productive and reproductive performance of dairy animals
2. To evaluate the effect of rubber mat bedding on production and welfare of dairy animals in the study area

The study was carried out in Yamunanagar district of Haryana and Sirmaur district of Himachal Pradesh to assess the effect of Multinutrient block (MNB) supplementation and rubber mat bedding on the milk production, milk quality, reproduction, health and welfare of dairy animals. Thirty eight early lactating crossbred cattle and 38 early lactating buffaloes were selected for first objective (12 from Pinjori, 12 from Malimajra and 14 from Patlioni) whereas, for second objective, 24 crossbred cattle and 24 buffaloes (12 from Pinjori and 12 from Malimajra) were selected. The animals were divided into two groups as: control (T₀) and treatment (T₁) based on milk yield, body weight and parity of animals. Data were collected for 4 month duration on feeding, milk production welfare and management practices by personal observation and interview schedule. The collected data analyzed using descriptive statistics and propensity score matching. The results are summarized below:

1. In study area, majority of dairy farmers were marginal and small farmers with less than two hectares of land.
2. MNB supplementation to lactating crossbred cattle significantly ($P < 0.05$) increased dry matter intake (T₀: 12.46±0.03; T₁: 12.73±0.04 kg/head/day), average daily milk yield (T₀: 11.13±1.35; T₁: 12.47±1.89 kg/ head/day), fat percent (T₀: 4.12±0.14; T₁: 4.31±0.14) and SNF percent (T₀: 8.60±0.03; T₁: 8.70±0.02).

Summary and Conclusions

3. Similarly, in lactating buffaloes MNB supplementation significantly ($P<0.05$) increased milk yield (T_0 : 9.67 ± 1.19 ; T_1 : 10.81 ± 0.99 Kg/head/day) and fat percent (T_0 : 7.49 ± 0.05 ; T_1 : 7.59 ± 0.09).
4. Supplementation of MNB was significantly ($P<0.05$) reduced the days of first post partum estrus (T_0 : 94.76 ± 1.46 ; T_1 : 74.22 ± 3.62 days), service period (T_0 : 128.37 ± 2.16 ; T_1 : 103.85 ± 6.05 days), and number of service per successful conception (T_0 : 2.24 ± 0.06 ; T_1 : 1.35 ± 0.07) in crossbred cattle and service period (T_0 : 150.20 ± 9.31 ; T_1 : 115.83 ± 7.34 days) and number of service per successful conception (T_0 : 2.42 ± 0.08 ; T_1 : 1.58 ± 0.09) in buffaloes.
5. The MNB supplementation significantly ($P<0.05$) increased blood urea (mg/dl) in crossbred cattle (T_0 : 10.86 ± 0.06 ; T_1 : 12.82 ± 0.03) and buffaloes (T_0 : 10.93 ± 0.34 ; T_1 : 13.21 ± 0.18).
6. Non-significant ($P>0.05$) effect of MNB on reducing subclinical mastitis incidences (CMT and somatic cell count), body weight (kg), DMI (percent body weight and total DMI) and hematological parameters were observed in crossbred cattle and buffaloes.
7. Significant ($P<0.05$) increase in cow cleanliness score was observed due to rubber mat bedding in crossbred cattle (T_0 : 2.54 ± 0.01 ; T_1 : 3.22 ± 0.042) and buffaloes (T_0 : 2.59 ± 0.02 ; T_1 : 3.14 ± 0.01).
8. Rubber mat bedding also significantly reduces the incidence of hock and knee injury in treatment group of crossbred cattle (T_0 : 2.19 ± 0.16 ; T_1 : 1.52 ± 0.06) and buffaloes (T_0 : 2.13 ± 0.09 ; T_1 : 1.50 ± 0.03). Somatic cell count was also reduced in crossbred cattle (T_0 : 219.40 ± 3.76 ; T_1 : 199.66 ± 1.08) and buffaloes (T_0 : 105.09 ± 13.73 ; T_1 : 92.96 ± 4.41) as compared to control group. CMT score was reduced in treatment group of crossbred cattle (T_0 : 1.61 ± 0.10 ; T_1 : 1.15 ± 0.10) and buffaloes (T_0 : 1.68 ± 0.1 ; T_1 : 1.18 ± 0.17) as compared to control.
9. Rubber mat bedding had non-significant ($P>0.05$) effect on milk yield, milk fat, SNF, milk protein, body weight, BCS, reproductive performance and hematological parameters of crossbred cattle and buffaloes.

Conclusions

From the present study following conclusions can be drawn:

- The supplementation of multi-nutrient block has significantly improved milk yield, milk fat percentage and reproductive performance of crossbred cattle and buffaloes.
- The use of rubber mat bedding significantly decreased incidences of sub-clinical mastitis, hock and knee injury, and significantly increased cow cleanliness score of crossbred cattle and buffaloes.

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