Bundelkhand region is spread over 71618 km² area and bounded by the Yamuna in the north, ranges of Vindhyan Plateau in the south, the Sind in the northwest and Bhandar ranges in the south-west. Undulating rugged topography, lack of underground water source, unfavorable climatic conditions especially high temperate and low & erratic rainfall and infertile soil are not very much conducive for agricultural development but having the possibility and potential of livestock based farming. To explore the possibility, the present study was designed with selected objectives mainly as to compare the Free Range Grazing (FRG) system verses Managed Feeding (MF) system and requirement, availability and quality of feed resources from all the available sources. Efforts have also been made to estimate the cost benefit balance sheet of livestock farming. The study is primarily based on intensive field survey, observations and personal interview with farmers through a set of questionnaire. For this purpose 10 villages from different parts of the region were
selected and from each village fifteen farmers from different categories were selected for the study. Animals under Free Range Grazing (FRG) system were allowed for grazing on crop harvested lands, wastelands or forest lands without any restriction during summer and part of the monsoon season. Such animals were fed limited amount of supplemental feed at home. The Managed Feeding (MF) system included stall-feeding, cut and carry system for rangeland grasses, rotational grazing and feeding fair amount of concentrates. Farmers adopted MF system for the lactating animals specially for milking buffaloes. The salient findings of this investigation may be summarized as follow:

The analysis of data related to feed resource availability and requirement showed that about 20 percent fodder was deficit in the sample villages. The major deficit was found from concentrate (44.9%) whereas in the case of roughage it was only 7.19 percent on dry matter basis. Large farmers possessed surplus amount of fodder roughage (+40%) and concentrate (+9.3%), whereas small farmers faced acute deficit of fodder roughage (-37.6%) and concentrate (89.8%) for their livestock in the region. Crop residues were the major source of roughage supply and lowest amount of roughage received from cultivated fodder in the region.

The locally available feed resources as crop residues, cultivated fodder, concentrate and naturally grown grasses were evaluated for their nutritive values. The CP content in crop residues varied from 3.42 to 14.86 percent. The straws of cereal crops like wheat, paddy, barley and lentil contained the CP in the range of 3.42 to 4.37 percent. However the CP content was found higher in residues of leguminous crop
viz., moongbean straw (12.8%), chickpea straw (10.2%) and soyabean straw (14.8%).

The anti-nutritional factor lignin content was ranged from 5.98 to 9.93 percent and
IVDMD from 36.54 to 61.92 percent in different crop residues.

The main cultivated fodder crops were sorghum and maize in kharif and
berseem and oat in Rabi season. The sorghum and maize fodder contained fair amount
of CP 7.70 and 8.40 percent, respectively. Berseem was the rich source of CP
(16.75%) and grown as major fodder crop by the dairy farmers. The oil cakes and
cereal grains were the main concentrate available with the farmers. The high CP
content was observed in oil cakes ranges from 26.8 to 39.1 percent. Cell wall fraction
was lower in all the concentrates. IVDMD of concentrate were very high and ranged
from 78.56 to 84.38 percent on DM basis. All the species of naturally grown grasses
contained the CP in the range of 3.92 to 7.60 percent, minimum in Chrysopogon
fulvus and maximum in Cynodon dactylon, respectively. The lignin content was in the
range of 5.92 to 7.6 percent and IVDMD varied from 48 to 60 percent.

Shrubs and tree leaves possessed high CP throughout the year (9.65 to
18.75%). Season wise analyses showed that CP content was higher in monsoon and
summer season and moderately decline in winter season in all the shrubs and tree
species. NDF and ADF increased with the maturity of leave and varied with the
season. All the shrub species invariably exhibited lower content of NDF and ADF in
summer or monsoon, at the time of emergence of new leaves. The lignin (ADL)
content in the leaves of all the shrubs species ranged from 4.8 to 14.5 percent, which
was comparatively lower in monsoon and increased in the winter season with the
maturity of leaves. Similarly, IVDMD values of tree leaves were higher in monsoon than summer and lowest in winter season. The mean IVDMD of shrubs and tree leaves was varied from 43.68 to 71.90 percent. Higher cell wall fraction and lower IVDMD was observed in winter season, when leaves matured.

The annual average of dry matter intake (DMI) of milch cows was higher in MF system (6.81 kg/h/d) as compared to FRG system (5.70 kg/h/d), in the region. The feed intake was similar among animals of different landholders in FRG system, however in MF system large farmers fed their animals with higher amount of feed compared to small and medium landholders. Cows with large farmers received significantly higher green fodder as compared to small and medium landholders. In summer season green fodder was not available to the animal in FRG system and cows of small farmers in MF system. The intake of crop residues in MF system by the milch cows (4.83 kg) was significantly higher as compared to FRG system (3.96 kg) in summer season. The amount of concentrate fed through out the year by the dairy farmers to the lactating cows, was 1.48 and 1.07 kg/h/d in MF and FRG system, respectively. The study also revealed that large farmers supplied significantly higher amount of nutrients to milch cows as compared to medium and small farmers. Milch cows under MF system was fed round the year with higher DCP and TDN (0.354 and 4.116 kg/h/d) as compared to cows under FRG system (0.315 and 3.959) kg/h/d). However, cows under FRG system were faced deficit of 20.7% DCP and 14.7 %TDN as compared to standard requirement of ICAR, 1985. Acute nutrient deficit (46% DCP and 36% TDN) in FRG cows during summer season.
The year wise, dry matter intake of milch buffaloes was significantly higher (8.75 kg/h/d), in MF system as compared to FRG system (7.75 kg/h/d). In winter season DMI of buffaloes did not differ significantly in both the feeding systems (9.01 and 9.06 kg/h/d). But large and medium categories of farmers offered significantly higher quantity of green fodder in MF system during winter season. The maximum dry fodder (6.24 kg/h/d) was offered to the buffaloes in MF system during summer season and lowest (4.43 kg/h/d) during monsoon by the farmers who have adopted FRG system. The DMI of milch buffaloes was observed significantly higher in MF system (8.39 kg/h/d) compared to FRG system (6.52 kg/h/d) during summer season. Large farmers of MF system fed their milch buffaloes higher amount of DM (9.11 kg) as compared to medium (8.43 kg) and small landholders (7.61 kg/h/d) in summer season. However DM intake was significantly lower during summer in buffaloes under FRG system in all the categories of farmers.

The concentrate feeding to milch buffaloes was higher in summer season due to remunerative price of milk. Buffaloes under MF system were fed higher amount of concentrate (2.18 kg/h/d) than FRG system (1.81 kg/h/d). The large and medium farmers fed significantly higher amount (2.55 and 2.30 kg/h/d) of concentrates as compared to small landholders (1.70 kg/h/d) in MF system. Medium and large farmers have taken care of buffaloes feeding, in all the season while only large farmers fed milch cows better in both the feeding systems.

The buffaloes under MF system received recommended level of DCP and TDN, even surplus amount of DCP (+ 5.90%) and TDN (+ 2.74%) in case of large
farmers. But the buffaloes under FRG system received deficit amount of DCP (-16.50%) and TDN (-11.99%). Maximum deficit of DCP and TDN was observed in summer season for the buffaloes under FRG system. In monsoon and summer season DCP and TDN supply to milch buffaloes were significantly (P >0.05) higher in MF system compared to FRG system.

The average milk yield of cows fed under MF system was 3.42 litre/day against 2.39 litre/day in FRG system. The milk yield of FRG cows in winter season was similar to cows in MF system (3.41 and 3.72 litre/day), whereas FRG cows were low producer for rest of the seasons. The cows of large farmers in MF system produced highest quantity of milk (3.87 litre/day) throughout the year, due to constant supply of DCP and TDN.

The average milk yield of buffaloes was also higher in MF system (4.66 litre/day). The highest milk yielded by the buffaloes of large farmers (5.94 litre/day) in MF system during winter and lowest in FRG buffaloes of small farmers (1.5 litre/day) during summer. Buffaloes of large and medium farmers in MF system yielded significantly higher quantity of milk (5.11 and 4.91 litre/day) as compared to buffaloes of small landholders (4.09 litre/day).

The mean dry matter intake of cattle heifers was 4.05 kg/h/d throughout the year. The DMI was highest in winter (4.57 kg) than monsoon (4.22 kg) and lowest in summer season (3.36 kg/h/d). In monsoon and summer season, the DMI of cattle and buffalo heifers was lower than standard feeding due to free range grazing by all the animals. Animals with small landholders received lowest DMI due to limited
supplementary feeding by their owners. The average DCP and TDN supply to growing cattle were 0.190 and 2.259 kg/h/day in the region, which was deficit by 35.5 and 13.3 percent, respectively compared to standard requirements however, acute deficit of DCP (-58.3%) was observed in summer season. Buffaloes were fed better than cow heifers in the region. The average DCP and TDN supply of growing buffaloes were deficit only 16.8 and 3.4 percent as composed to standard requirements. The maximum deficit of DCP and TDN was observed in summer season with all the categories of the farmers because most of the green fodder and concentrate available with the farmers were usually field to lactating animals.

The growth rate of cattle heifers was highest in winter season (231 g/day) than in monsoon (219 g/day) but in summer reason average growth was negative (-11 g/day). Cattle lost their body weight in small (-25 g/day) and medium categories of the farmers (-17 g/day) during summer season. The average growth of buffaloes heifers was similar in monsoon and winter season (314 g/day) whereas, lower growth rate of buffaloes observed in summer season (53 g/day). The growth rate of buffaloes for large and medium categories was 250 and 241 g/day, which was higher than buffaloes of small farmers (189 g/day). Highest live weight gain was recorded in the buffaloes of large farmers (342 g/day) in winter season and lowest in the heifers of small farmers (17 g/day) during summer season. The growth rate of buffalo heifers was better than cows in the region but lower than standard growth.

Feed intake of sheep and goat was recorded in different seasons for the animals of all categories of the farmers. The large farmers were not rearing sheep in the region.
due to some social reasons. The average supplementary feeding to sheep was similar in small (0.50 kg DM/h/d) and medium (0.52 kg DM/h/d) landholders. However, medium categories of farmers supplemented moderately higher amount of concentrate to their sheep. The average dry matter supplemented to goat by small, medium and large farmers was 0.55, 0.54 and 0.60 kg/h/d, respectively. The concentrate was maximum supplemented to goat in summer season by large farmers (0.27 kg/h/d) and higher amount of crop residues was also supplemented in summer (0.41 kg/h/d) by all the categories of the farmers.

Economics of the milk production was worked out for cattle land buffaloes on the basis of present rates of input and output prevailing in the region. The total input cost of rearing a milch cow was lower in FRG system (Rs. 6560/year) as compared to MF system (Rs. 10591/year). Similarly, the total income from sale of products was also lower in FRG system (Rs. 10125 /cow/year) than MF system (Rs. 14550/cow/year). But the net income from a cow under FRG and MF system was Rs. 3565 and 3959/year, respectively. However milk productivity of cows was higher in MF system (1252 litre/day) than FRF system (872 litre/day). This indicates that FRG cows requires feed supplementation to support their production potential.

The cost of rearing a buffalo was lower in FRG system (Rs. 10750/year) than MF system (Rs. 14739/year) in the region. The total income was also lower in FRG system (Rs. 17842/buffaloe/year) than MF system (23159 /buffalo/year) and net income from FRG and MF system was Rs. 8420 and 7092 /buffaloes/year. Similar to the cows, milk productivity of buffaloes was higher in MF system (1717
litre/buffaloe/year) than FRG system (1335 litre/buffalo/year) due to feeding of required amount of nutrients in MF system. The cost of milk production in FRG and MF system was Rs. 7.52 and 8.46/litre for cows and Rs. 8.05 and 8.58/litre milk for buffaloes in the region.

Buffaloes were better maintained in MF system by large as well as medium farmers, while cows by large farmers only. The cattle and buffalo heifers were maintained in managed feeding system during winter season and in free range grazing during summer and part of monsoon season by all categories of the farmers. Buffaloes were fed better than cow heifers in the region. The milk productivity and net income from cows as well as buffaloes was higher in MF system.

Conclusion

The Region is facing deficit of feed resources mainly green fodder and concentrate. Feed intake, nutrient supply and milk production of lactating cattle and buffaloes were lower in FRG system. The acute deficit of nutrient and poor growth of heifers observed during summer season. Milk productivity and net income from cattle and buffaloes were higher in MF system. Milk production and net income increased with the increase in the investment by the farmers in both the feeding systems. Production potential of the animals have not been fully utilized in FRG system. There is an urgent need to supplement the nutrients through green fodder, concentrate and crop residues to support their production potential.
SUGGESTIONS

➢ Enrichment of poor quality crop residues

The crop residues may be treated with urea for enhancing its nutritional quality and palatability. Such value addition of crop residues will be appropriate technique for the small landholders because they have no option for green fodder cultivation. Conservation of surplus green fodder as silage or good quality hay may provide nutrients to livestock during summer season.

➢ Development of food/fodder crop farming system

Farmers have limited irrigation facilities in the region, and they utilize their irrigation resources for food crops. Technology of inter-cropping of food and fodder crops is required, without affecting the yield of main crops. The dual purpose food/fodder varieties may also be introduced in the region to increase the fodder availability. Economic viability of fodder crops need to be examined at village level through on farm trials.
➤ Soil-water conservation and Irrigation facilities

The increase in irrigation facilities through micro watershed development, check dams, bunding and other water conservation measures may positively affect the production of crop as well as fodder in the region. That will also enhance the economic conditions of the farmer and investment capacity for the livestock in the region.

➤ Grassland management, Agroforestry and Silvipasture

The high pressure of livestock population on the grazing land resulted in decline in the production and availability of natural grassland, wastelands and forest. The potential of these grazing land to provide the required feed is further limited by the short monsoon period in the region. Proper management of these natural grasslands, wasteland is essentially required through participation of farmers of the region. Techniques of agroforestry and silvipasture may be the good option that will provide fuel as well as fodder through cut and carry system.

➤ Marketing infrastructure for fodder and livestock products

There is no proper marketing infrastructure for sale of surplus fodder, milk, and other livestock products in the region. Farmers are not aware about recent processing technique of milk and other dairy products. A lot of middleman involved in the marketing of milk from village to consumers in cities and getting major share from consumer price. The region has full potential of livestock development. Establishment of Gujrat pattern dairy cooperatives may provide the infrastructure for marketing and
processing of milk. The producers will get better price of their products and it will stimulate dairy activities in the region.

- **Increase the number of improved bulls**

  Efforts were made earlier also on breed up-gradation in the region. But, most of the cows were covered by local bulls during free range grazing in summer season. The cumulative efforts on controlling the free range grazing and increasing the number of graded bulls in each village may be the option for breed improvement.

- **Conversion of FRG to managed feeding system**

  The region suffers from a shortage of livestock feed for most of the year. In the village where stall feeding practices are mainly followed, the resource poor farmers may still dependent on free rage grazing, as they can not afford to purchase the feeds for stall feeding. Even, within the heard held by a farmer, the cattle might be allowed for free grazing while buffaloes are stall fed. These factors are dependent on availability of feed resources to the individual farmer. This practices of free range grazing has additional social consequence as it discourage farmers from growing crop in the summer. Most of the suggestions given are directly or indirectly related to increase the feed resources in the region. Active participation of farmers required to convert the system from free range grazing to stall feeding with controlled grazing or managed feeding system.