



# Performance Evaluation of Crossbred Cattle Fed Treated Leftover Feed

Dhawal Kant Yadav<sup>1</sup>, P.K. Bharti<sup>2</sup>, Amit Kumar Singh<sup>2</sup>, Sandeep<sup>3</sup>, G.K. Gaur<sup>1</sup>, Putan Singh<sup>1</sup>

10.18805/ajdfr.DR-1726

## ABSTRACT

**Background:** Left over feed is still an unnoticed problem at organized dairy farms which often leads to considerable economic losses. This study was done to assess the feasibility of treated left over feed and performance of crossbred dairy cattle for a period of 150 days during winter and spring seasons.

**Methods:** 24 healthy crossbred (Vrindavani) animals (8-12 months of age) were randomly selected to four different groups viz. Group-1 (Gr-1): 100% treated leftover feed; Group-2(Gr-2): 75% treated feed; Group-3 (Gr-3): 50% treated feed and Group-4(Gr-4) or Control: 100% green fodder. The leftover feed F-1, F-2, F-3, F-4, F-5 and F-6 were treated with combination of 1% urea+5% molasses+0.5% salt, 1% urea+5% molasses+1% salt, 1% urea+10% molasses+0.5% salt, 1% urea+10% molasses+1% salt, 5% molasses+0.5% salt and 10% molasses+0.5% salt, respectively. Each feed was offered for a period of one month to each group and animals were rearranged after every trial. Adjustment period of one week was given after every treatment.

**Result:** The palatability score was found significantly ( $P<0.05$ ) higher in Gr-1 than other treatment groups. The Gr-3 animals had equivalent palatability and weight gain in compared with control group. The average feeding cost per animal at farm was 80Rs. under normal circumstances. Analyzed data revealed that feeding cost was reduced significantly in Gr-1, Gr-2 and Gr-3 respectively. It can be concluded that the leftover feed can efficiently and economically be utilized for feeding to various classes of dairy animals under farm conditions and provide a better option during the scarcity period.

**Key words:** Cattle cost, Leftover feed, Palatability, Treatments.

## INTRODUCTION

India being a tropical south Asian developing nation has a large deficit of cereal grains, dry and green fodder. At present there is a shortage of 11.24% green fodder, 23.4% dry crop residues and 28.9% concentrate feed ingredients (IGFRI-2020). This gap can be filled either by increasing crop productivity, utilizing untapped feed resources, increasing land area, or through imports. The bovine are the largest dairy animals which mainly subsist on green fodder followed by dry roughage and concentrate mixture. The feeding cost in dairy animals accounts for the highest input factor of the total cost of rearing and production (60-70%). The net cultivated area is around 142 million hectare in addition to forests and their associated grasslands and fodder sources (Singh *et al.*, 2014). There is high pressure on land for crop production in order to meet the growing demands of food grains for human consumption and hence farmers cannot spare land for fodder production to feed the cattle (Singh *et al.*, 2014; Singh *et al.*, 2020a). At many organized farm in India, leftover feed constitute bulk roughage which is generally considered as waste material and discarded in crop-fields. The composition of leftover varies depending upon the fodder variety however by and large the leftover consist mainly of maize, jowar, bajra, berseem and napier grass in northern plain region of India (Bithal and Jha, 2005). It has been reported that if molasses and urea mixture is supplied to the animals with straw then intake, digestibility and palatability of feed increases (Sahoo *et al.*, 2004; Verma *et al.*, 2006). Various studies have been conducted for this

<sup>1</sup>Indian Veterinary Research Institute, Bareilly-243 122, Uttar Pradesh, India.

<sup>2</sup>National Dairy Research Institute, Karnal-132 001, Haryana, India.

<sup>3</sup>Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 001, Haryana, India.

**Corresponding Author:** Dhawal Kant Yadav, Indian Veterinary Research Institute, Bareilly-243 122, Uttar Pradesh, India. Email: dhawalyadav777@gmail.com

**How to cite this article:** Yadav, D.K., Bharti, P.K., Singh, A.K., Sandeep, Gaur, G.K. and Singh, P. (2022). Performance Evaluation of Crossbred Cattle Fed Treated Leftover Feed. Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-1726. ():

**Submitted:** 19-05-2021 **Accepted:** 01-02-2022 **Online:**

purpose by treating the inferior quality feed with urea, ammonia and molasses with different inclusion levels which provided positive results. It was observed that urea treatment could increase nutritive value of straw by 46% (Wanapat *et al.*, 2009) due to breakage of bonds between the lignin, hemi-cellulose and cellulose. The feeding practices using these feed have also improved the productivity of dairy animals (Singh *et al.*, 2014). From the perusal of literature, it is found that the most of earlier research works have been targeted on treatment of dry crop residues (wheat straw or rice straw) using supplementation of urea as nitrogen or molasses as energy sources but no study has been conducted on treatment of the fresh leftover feed having high moisture contents (more than 50 per cent). The

treatment of leftover feed using different combinations of urea, molasses and salt may enhance its nutritive value as well as its palatability. The treated leftover feed can also serve as better feed during the scarcity or lean period. It is also expected that feeding of these treated feed may reduce the feeding cost without affecting the performance of animals.

## MATERIALS AND METHODS

### Place of study

The study was conducted at Cattle and Buffalo Farm, ICAR-Indian Veterinary Research Institute, Izatnagar, India during 2018-19 which is located at latitude of 28° 22' north, longitude of 79° 24' East and altitude of 169.2 meter above the mean sea level. The location comes under upper gangetic plain region and has sub-tropical climatic condition with high humidity.

### Design of experiment

The experiment was conducted in two phase's viz. 1) Feasibility assessment of treated leftover feed and 2) Palatability and performance evaluation of dairy cattle using different combinations of treated leftover feed with fresh fodder. The leftover feed consisted of chaffed fodder sorghum, millets, maize, napier grass and berseem (clover) as raw material. Six combinations of urea, molasses and salt were used for treating the leftover feed (Table 1) to increase its nutritive value and palatability. The feasibility of the treatment during the months of December to April was tested and weight gain of animals in different treatment groups was compared.

### Selection of experimental animals

A total of 24 crossbred cattle (8-12 months of age) were selected and randomly allocated to four different groups (6 animals per group) viz. Group-1 (Gr-1): 100% treated leftover feed; Group-2 (Gr-2): 75% treated feed; Group-3 (Gr-3): 50% treated feed and Group-4 (Gr-4) or Control: 100% green fodder, without use of treated feed. Feeding was done by providing each feed for one week subsequent to each other and one week was given between each treatment as adjustment period (Table 2).

Palatability score was used to test the palatability of the treatment; all the 24 animals were weighed before and after each feeding trail and their weight gains were compared after the end of each trial.

### Chemical analysis of feed

Leftover feed was analysed before and after treatment to find out changes in the the chemical composition. The presence of fungal toxins viz. mycotoxin and ochratoxin were also tested in the treated feed. Testing was done using automatic chromatographic technique and methanol was used as solvent.

### Feasibility testing

Leftover feed was mixed with urea, molasses and salt and packed in polybag of 25 kg capacity in airtight condition for

incubation period of 21 days, thereafter polybags were opened and feed were valued physically for smell, colour and texture. Moisture content was sufficient in the leftover feed so there was no requirement of water sprinkling.

### Palatability testing

Palatability scores were given based on acceptance and time taken by animals to start feeding as mentioned in Table 3.

### Performance of the animals

Performance of the animals was evaluated based on weight gain before and after each feeding trail.

### Statistical analysis

The data obtained from the experiments were analysed using the SPSS 20.0 software package.

## RESULTS AND DISCUSSION

The chemical composition of leftover feed before and after treatment with urea, molasses and salt has been presented in Table 4.

The treatment of leftover feed was feasible during the winter and spring months of the year. The nutritional quality of the leftover feed increased after each treatment and there were no traces of mycotoxin and ochratoxin in any of the treated feed. Crude protein content increased due to increased nitrogen content following urea treatment where as crude fibre content increased which might be due to break

**Table 1:** Six different combinations of urea, molasses and salt used for treatment of leftover feed.

| Basal feed material (on fresh matter basis) | Chemical substance (on dry matter basis of basal feed) |          |      | Treated feed (end product) |
|---------------------------------------------|--------------------------------------------------------|----------|------|----------------------------|
|                                             | Urea                                                   | Molasses | Salt |                            |
| Leftover feed                               | 1%                                                     | 5%       | 0.5% | F1                         |
|                                             | 1%                                                     | 5%       | 1%   | F2                         |
|                                             | 1%                                                     | 10%      | 0.5% | F3                         |
|                                             | 1%                                                     | 10%      | 1%   | F4                         |
|                                             | Nil                                                    | 5%       | 0.5% | F5                         |
|                                             | Nil                                                    | 10%      | 0.5% | F6                         |

**Table 2:** Feeding trial using different combination treated leftover feed and green fodder.

| Feeds                        | T1 group                                                            | T2 group | T3 group | T4 control |
|------------------------------|---------------------------------------------------------------------|----------|----------|------------|
| Green: Treated leftover feed | 0: 100                                                              | 25:75    | 50:50    | 100:0      |
| Concentrate feed             | Provided equally in all groups (As per institute feeding protocol). |          |          |            |

**Table 3:** Palatability score based on time to start feed intake.

| Palatability score | Criteria                                  |
|--------------------|-------------------------------------------|
| 1                  | If feed intake starts within 10 minutes   |
| 2                  | If feed intake starts in 10-20 minutes    |
| 3                  | If feed intake takes more than 20 minutes |
| 4                  | No feed intake                            |

down of ester bonds between the lignin, hemi-cellulose and cellulose. Ash content increased because of addition of salt and other impurities.

### Palatability of the feed

Palatability of the treated feed in different groups were measured by using palatability scored as mentioned in Table 5.

Palatability scores show identical trends in all the treatment groups. The high value of palatability score indicated that feed acceptability was poor in treatment than control. From the results as shown in Table 3, it is evident that animals fed on 100 percent fresh feed in Gr-4 had better acceptability whereas Gr-1 with 100 per cent treated leftover feed had the lowest acceptability. Among the treatments, the combinations of treated and fresh feed (in ratio of 50:50 and 75:25) gave better results in terms of feed acceptability without any adverse effect on performance of the growing animals (Table 2).

### Performance of the animals

Performance of the experimental animals in terms of changes in their body weights are shown in Table 6.

The difference of initial body weights (IW) was non-significant in all the groups. The final body (FW) and weight gain (WG) of animals for F3 and F5 were found significant in Gr-1 compared with control, however Gr-3 and Gr-4 were non-significant with control. Among the proportion of treated and fresh feed, the weight gain in Gr-2 was found superior even than control, however the difference was non-significant. The equivalent performance in Gr-2 than control might be due increased nutritive values of feed and better acceptability than other groups. In 3<sup>rd</sup> and 5<sup>th</sup> group the initial body weight of animals in control, Gr-1, Gr-2 and Gr-3 was non-significant among each other. The final body of animals

in different groups were also found non-significant. The weight gain was significantly ( $p < 0.5$ ) lower in Gr-1 where 100 percent treated feed was offered to animals than control, Gr-2 but non-significant from Gr-3. The equivalent performance in Gr-2 might be due increased nutritive values of feed along with acceptability and better palatability in control group.

### Economics of the feed

Economic feasibility of the treated feed in different groups were measured by using scorecards as mentioned in Table 7.

Feeding cost chart shows that there was reduction in feeding cost up to almost half in 1<sup>st</sup> and 2<sup>nd</sup> treatment groups feeding cost was somewhat higher in 3<sup>rd</sup> treatment group due to higher cost of molasses but even though it was lower than the control group. Among the treatments, the combinations of treated and fresh feed (in ratio of 50:50 and 75:25) gave better results in terms of feed acceptability without any adverse effect on performance of the growing animals.

### Chemical composition of feed

The nutritive value of the feed increased after every treatment which was due to urea ammoniation of leftover feed and increased content of carbohydrate, molasses, ash was due to minerals present in salt and other impurities present in premix. The increase in crude protein and crude fibre content is in agreement with Hamad *et al.* (2010) and Sarwar *et al.* (2010) who found higher crude protein and total protein content of barley or wheat straw being treated with 4% urea. Reduction of energy intake during far off period provided positive results in crossbred animals (Singh *et al.*, 2020a; Singh *et al.*, 2020b). Results are also in line with Oji *et al.* (2007) who reported increase in crude protein content and crude fibre content of maize residues from 2.9 to 5.9%

**Table 4:** Nutritive values of leftover feed before and after treatment.

| Leftover feed | Treatment status | Moisture | Dry matter | Crude protein | Crude fibre | Ash   |
|---------------|------------------|----------|------------|---------------|-------------|-------|
| F1            | Pre-treatment    | 65.45    | 34.55      | 4.32          | 8.54        | 6.58  |
|               | Post-treatment   | 61.67    | 38.33      | 6.70          | 11.37       | 11.65 |
| F2            | Pre-treatment    | 74.46    | 25.54      | 3.78          | 9.76        | 7.80  |
|               | Post-treatment   | 71.75    | 28.25      | 6.30          | 10.70       | 12.56 |
| F3            | Pre-treatment    | 69.93    | 30.07      | 4.20          | 14.20       | 11.00 |
|               | Post-treatment   | 63.98    | 36.07      | 6.70          | 14.60       | 13.60 |
| F4            | Pre-treatment    | 74.78    | 25.22      | 3.78          | 9.76        | 8.00  |
|               | Post-treatment   | 70.89    | 29.11      | 5.40          | 12.90       | 11.89 |
| F5            | Pre-treatment    | 62.78    | 37.22      | 5.50          | 14.20       | 11.00 |
|               | Post-treatment   | 67.56    | 32.44      | 6.10          | 16.50       | 13.60 |
| F6            | Pre-treatment    | 65.78    | 34.22      | 4.90          | 17.20       | 10.78 |
|               | Post-treatment   | 62.23    | 37.77      | 5.20          | 17.50       | 12.06 |

**Table 5:** Average palatability scores of all the treatment groups.

| Groups  | F1 feed | F2 feed | F3 feed | F4 feed | F5 feed | F6 feed |
|---------|---------|---------|---------|---------|---------|---------|
| Group 1 | 3.43    | 2.79    | 2.66    | 3.06    | 3.7     | 3.1     |
| Group 2 | 1.56    | 1.52    | 1.43    | 2.36    | 1.76    | 1.96    |
| Group 3 | 1.53    | 1.50    | 1.40    | 2.06    | 1.66    | 1.83    |
| Group 4 | 1       | 1       | 1       | 1       | 1       | 1       |

**Table 6:** Change in body weight of animals upon feeding on different leftover feed.

| Feed | Parameter | Gr- 1 Treated:<br>fresh feed (100:0) | Gr-2 Treated:<br>fresh feed (75:25) | Gr-3 Treated:<br>fresh feed (50:50) | Control treated:<br>fresh feed (0:100) |
|------|-----------|--------------------------------------|-------------------------------------|-------------------------------------|----------------------------------------|
| F1   | IW (Kg.)  | 227.33±9.05                          | 237.83±11.81                        | 230.16±11.37                        | 234.33±15.80                           |
|      | FW (Kg.)  | 229.00±9.54                          | 241.33±11.89                        | 232.83±11.89                        | 237.66±15.52                           |
|      | WG(Kg.)   | 1.66±1.60                            | 3.50±1.56                           | 2.66±0.0.66                         | 3.33±0.61                              |
| F2   | IW (Kg.)  | 226.83±11.41                         | 240.16±10.47                        | 228.55±13.57                        | 233.83±16.68                           |
|      | FW (Kg.)  | 227.66±11.41                         | 244.16±9.22                         | 230.83±13.83                        | 237.54±16.50                           |
|      | WG(Kg.)   | 0.33±0.61                            | 4.00±1.84                           | 2.33±0.67                           | 3.66±0.67                              |
| F3   | IW (Kg.)  | 237.00±10.06                         | 242.66±8.81                         | 237.5±12.56                         | 243.55±18.65                           |
|      | FW (Kg.)  | 237.50±9.83                          | 246.00±8.69                         | 240.33±13.04                        | 247.16±18.45                           |
|      | WG(Kg.)   | 0.50±0.56 <sup>a</sup>               | 3.33±0.55 <sup>b</sup>              | 2.83±0.70 <sup>ab</sup>             | 3.66±0.80 <sup>b</sup>                 |
| F4   | IW (Kg.)  | 246.66±9.54                          | 258.83±8.23                         | 250.00±10.58                        | 253.33±14.70                           |
|      | FW (Kg.)  | 248.33±8.54                          | 265.00±7.83                         | 256.46±10.93                        | 261.50±15.34                           |
|      | WG(Kg.)   | 1.66±1.49                            | 6.66±1.60                           | 6.16±0.49                           | 6.5±0.70                               |
| F5   | IW (Kg.)  | 255.33±8.81                          | 271±6.96                            | 260.00±9.12                         | 267.5±15.47                            |
|      | FW (Kg.)  | 256.83±9.19                          | 278.16±7.07                         | 266.00±9.68                         | 273±15.40                              |
|      | WG(Kg.)   | 1.50±0.67 <sup>a</sup>               | 7.00±0.70 <sup>b</sup>              | 6.00±1.12 <sup>ab</sup>             | 5.5±0.62 <sup>b</sup>                  |
| F6   | IW (Kg.)  | 258.33±12.73                         | 283.66±9.29                         | 276.16±10.90                        | 284.84±18.50                           |
|      | FW (Kg.)  | 260±13.57                            | 289.16±9.09                         | 281±10.82                           | 289.16±18.32                           |
|      | WG(Kg.)   | 1.66±0.98                            | 5.55±1.52                           | 4.83±0.83                           | 5.33±0.49                              |

Where, IW- Initial weight, FW= Final Weight, WG= Weight gain.

**Table 7:** Average daily feeding cost per animal (in Rupees) of all the treatment groups.

| Groups  | F1 feed | F2 feed | F3 feed | F4 feed | F5 feed | F6 feed |
|---------|---------|---------|---------|---------|---------|---------|
| Group 1 | 36      | 37      | 70      | 70      | 35      | 69      |
| Group 2 | 50      | 51      | 70      | 71      | 50      | 70      |
| Group 3 | 60      | 61      | 75      | 75      | 60      | 75      |
| Group 4 | 80      | 80      | 80      | 80      | 80      | 80      |

when treated with 3% urea and CP content increased to 6.7% when treated with 5% urea. Hassan *et al.* (2011) reported high ruminal  $\text{NH}_3\text{-N}$  in bulls fed urea treated straw. Dutta *et al.* (2004) and Dass *et al.* (2000) reported increase in crude protein by urea ammoniation of wheat straw whereas higher digestible protein and digestible nutrients were recorded by Prasad *et al.* (1998) in rations containing either stacked or baled urea treated rice straw. Treatments fifth and sixth contained only molasses and salt and they had sweet smell and golden brown colour so their palatability was comparatively better. Sahoo *et al.* (2002) reported that organic matter, neutral detergent fibre and hemicellulose digestibility were highest in urea treated wheat straw. Similarly, many reports say that urea treated wheat straw increased the ruminal  $\text{NH}_3$  concentration (Manyuchi *et al.*, 1992; Nisa *et al.*, 2004; Sarwar *et al.*, 2004; Jabbar *et al.*, 2008). Ramirez *et al.* (2007) reported decrease in acid detergent fibre on treatment of *Zea mays* with urea.

#### Performance of animals

Significant difference in weight gain of the animals in treatment groups for F3 and F5 feed where lower weight gain in Gr1 were observed which might be due less palatability of treated feed than that of fresh green fodder. The equivalent performance in Gr-2 might be due increased nutritive values

of feed along with acceptability and better palatability (Garg *et al.*, 2006). Kilic and Emre (2017) reported that digestibility of wheat and soybean straw could be improved upon some additives however in present study feed palatability was taken in account for performance evaluation along with weight gain. Mishra *et al.* (2012) found that supplementation of urea molasses block significantly increased the milk yield, live weight and body score of cows. Similarly, the enhanced acceptability of feed upon treatment with molasses was observed in crossbred heifers and lambs (Rath *et al.*, 2001).

#### CONCLUSION

Treatment of left over feed using different combinations of urea, molasses and salt was feasible and increased nutritive values in terms of crude protein without production of fungal toxins. The animals fed on 50 per cent treated feed and 50 percent fresh green fodder had equivalent palatability and weight gain in comparison to control group. The leftover feed can efficiently be utilized for feeding to various classes of dairy animals under farm conditions to minimize the rearing cost and could also serve a better option during the scarcity period of fodder production. Body weight gains were not diminished when the treated feed is given even upto the levels of 75 per cent but it was not higher than the group fed with green fodder.

## Declarations of interest

The authors report no conflict of interest over the content of this paper.

## ACKNOWLEDGEMENT

The authors are thankful to the Director, ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar for providing all the necessary facilities during the study.

## REFERENCES

- Birthal, P.S. and Jha, A.K. (2005). Various economic losses due to various constraints in dairy production in India. *Indian Journal of Animal Science*. 75(12): 1470-1475.
- Dass, R.S., Mehra, U.R. and Verma, A.K. (2000). Nitrogen Fixation and In-situ dry matter and fibre constituents' disappearance of wheat straw treated with urea and Boric Acid in Murrah buffaloes. *Asian-Australasian Journal of Animal Science*. 13(8): 1133-1136.
- Dutta, N., Sharma, K., and Naulia, U. (2004). Nutritional evaluation of lentil (*Lens culinaris*) straw and urea treated wheat straw in goats and lactating buffaloes. *Asian-australasian Journal of Animal Sciences*. 17(11): 1529-1534.
- Garg, M.R., Mehla, A.K. and Singh, D.K. (2006). Advances in the production and use of urea molasses mineral blocks in India. A technical manual of NDDB, Anand. 4: 22-27.
- Hamad, M.R., Abed-Elazeem, S.N., Aiad, A.M., Mohamed, A., and Soliman, A.M. (2010). Replacement value of urea treated corn with cobs for concentrate feed mixture in pregnant ewes rations. *J. Am. Sci*. 6(6): 166-178.
- Hassan, Z., Shahzad, M.A., Nisa, M. and Sarwar, M. (2011). Replacing concentrate with wheat straw treated with urea molasses and ensiled with manure. *Asian-Australasian Journal of Animal Science*. 24(8): 1092-1099.
- Jabbar, M.A., Muzafar, H., Khattak, F.M., Pasha, T.N. and Khaliq, A. (2008). Simplification of urea treatment method of wheat straw for its better adoption by farmers. *South African Journal of Animal Science*. 39(5): 58-61.
- Kilic, U. and Emre, G. (2017). Effects of some additives on *In vitro* true digestibility of wheat and soybean straw pellets. *Open Life Science*. 12: 206-213.
- Manyuchi, B., Orskov, E.R. and Kay, R.N.B. (1992). Effect of feeding small amounts of ammonia treated straw on degradation rate and intake of untreated straw. *Animal Feed Science and Technology*. 38:293-304.
- Mishra, A.K., Reddy, G.S. and Ramakrishna, Y.S. (2012). Participatory on-farm evaluation of urea molasses mineral block as a supplement to crossbred cows for dry season feeding in rain-fed agro-ecosystem in India. *Livestock Research for Rural Development*. 18(2).
- Nisa, M., Sarwar, M. and Khan, M.A. (2004). Influence of ad libitum feeding of urea treated Wheat straw with or without corn steep liquor on intake, in situ digestion kinetics, Nitrogen Metabolism and nutrient digestion in Nili-ravi buffalo bulls. *Australian Journal of Agricultural Research*. 55: 229-236.
- Oji, U.I., Etim, H.E., and Okoye, F.C. (2007). Effects of urea and aqueous ammonia treatment on the composition and nutritive value of maize residues. *Small Ruminant Research*. 69(1-3): 232-236.
- Pathak R, Jaiswal, R.S., Thakur, T.C., Joshi, Y.P. and Paudyal, H. (2005). Effect of feeding ammonia treated baled wheat straw with different levels of concentrate on nutrient utilization and growth of cross bred heifers. *Indian Journal of Animal Science*. 5: 252-255.
- Prasad, R.D.D., Reddy, M.R. and Reddy, G.V.N. (1998). Effect of feeding baled and stacked urea treated rice straw on the performance of crossbred cows. *Animal Feed Science and Technology*. 73: 347-352.
- Ramírez, G.R., Aguilera-Gonzalez, J.C., Garcia-Diaz, G., and Núñez-González, A.M. (2007). Effect of urea treatment on chemical composition and digestion of *Cenchrus ciliaris* and *Cynodon dactylon* hays and *Zea mays* residues. *Cellulose*. 38(42.5): 39-6.
- Rath, S., Verma, A.K., Singh, P., Dass, R.S. and Mehra, U.R. (2001). Performance of growing lambs fed urea ammoniated and urea supplemented wheat straw based diets. *Asian Australian Journal of Animal Science*. 14(8): 1078-1084.
- Sahoo, A., Elangovan, A.V., Mehra, U.R. and Singh, U.B. (2004). Catalytic supplementation of urea-molasses on nutritional performance of male buffaloes. *Asian Australian Journal of Animal Science*. 17(5): 621-628.
- Sahoo, B., Saraswat, M.L., Haque, N. and Khan, M.Y. (2002). Chemical treatment of wheat straw on intake and nutrient utilization in sheep. *Indian Journal of Animal Science*. 72(12): 1162-1165.
- Sarwar, M., Khan, M.A. and Nisa, M. (2004). Effect of organic acids or fermentable Carbohydrates on digestibility and nitrogen utilisation of urea-treated wheat straw in buffalo bulls. *Australian Journal of Agricultural Research*. 55: 223-228.
- Sarwar, M., Shahzad, M.A., Nisa, M., Afzal, D., Sharif, M. and Saddiqi, H.A. (2010). Feeding value of urea molasses treated wheat straw ensiled with fresh cattle manure for growing crossbred cattle calves. *Tropical Animal Health and Production*. DOI: 10.1007/s11250-010-9745-5.
- Singh, A.K., Bhakat, C., Mandal, D.K., Mandal, A., Rai, S., Chatterjee, A. and Ghosh, M.K. (2020a). Effect of reducing energy intake during dry period on milk production, udder health and body condition score of Jersey crossbred cows at tropical lower Gangetic region. *Tropical Animal Health and Production*. 52: 1759-1767.
- Singh, A.K., Bhakat, C., Kumari, T., Mandal, D.K., Chatterjee, A. and Dutta, T.K. (2020b). Influence of alteration of dry period feeding management on body weight and body measurements of jersey crossbred cows at lower gangetic region. *Journal of Animal Research*. 10(1): 137-141.
- Singh, S., Mishra, A.K., Singh, J.B., Rai, S.K., Baig, M.J., Biradar, N., Kumar, A. and Verma, O.P.S. (2014). Water requirement estimates of feed and fodder production for Indian livestock vis a vis livestock water productivity. *Indian Journal of Animal Science*. 84(10): 1090-1094.
- Verma, A.K., Singh, P., Dass, R.S. and Mehra, U.R. (2006). Impact of feeding urea ammoniated and urea supplemented wheat straw on intake and utilization of nutrients in crossbred cattle. *Indian Journal of Animal Science*. 76(6): 46-470.
- Wanapat, M. and Cherdthong, A. (2009). Effects of treating rice straw with urea or urea calcium hydroxide upon intake, digestibility, rumen fermentation and milk yield of dairy cows. *Asian Australian Journal of Animal Science*. 12: 294-299.