



## **Crop Residue Based Complete Feed for Enhancing Livestock Performance- A Review**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/AJAEES/2021/v39i1230799

### **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/77993>

**Review Article**

**Received 06 October 2021**  
**Accepted 12 December 2021**  
**Published 14 December 2021**

### **ABSTRACT**

The estimated projected data regarding demand and supply of feed and fodder shows 13.20% and 18.43% deficit between demand and supply of dry and green fodder to livestock, respectively. Shortage of land for cultivation of fodders and increased human as well as livestock population has led to heavy competition for food grains that necessitates using the crop residues for the feeding of livestock. These crop residues are rich in fibre and low in other nutrients; they also have low palatability and digestibility. The best way to efficiently utilize the crop residues is to prepare complete feeds from pretreated crop residues + concentrates mixture. Pretreatment of crop residues increases digestibility by increasing rate of delignification, increasing enzymatic hydrolysis of cellulose, hemicelluloses and thus increasing the glucose yield. The complete feed is a quantitative mixture of all dietary ingredients to provide the specific nutrient requirement for various physiological functions of livestock. Crop residue-based complete feed could be prepared in mash, block and pellet (Expander and extruder) form. In this system, all feed ingredients including roughages are proportioned, processed and mixed into a uniform blend. Different researchers undertook feeding trials of complete animal feed and conventional animal feed and reported better performance in terms of weight gain, milk yield and reproductive performance on feeding complete feed pellets or

complete feed blocks to ruminants as compared to conventional ration. In conclusion, crop residue based complete feed could improve ruminant performance and reduces cost of feeding per kg gain or yield and thereby improving livestock based rural economy in developing countries like India.

*Keywords: Complete feed; crop residue; livestock; performance.*

## 1. INTRODUCTION

Total livestock population as per 20<sup>th</sup> livestock census in India is 535.78 million, showing rise of 4.6% over the previous census. Therefore, increased livestock population requires more feed and fodder. Feed cost accounts about 60 to 70% of total livestock production cost. Increased competition for grains between human being and livestock necessitates consideration of economical feed resources, treatment methods besides technologies for production of high valued livestock feed using them.

In India, different crop residues are produced every year. Some of them are utilized as fodder for the animals and most of them are burned as such to remove waste in land or used as fuel and for composting. Day by day the feed and fodder requirement is increasing due to increased livestock population, farm mechanization etc. but, feed and fodder supply is deficit due to less availability of land for fodder cultivation, heavy competition for grains between human beings and animals. About 3, 62,793 million tonnes of crop residues are generated each year in India and large quantities of crop residues produced are burnt, contributing grossly to environmental pollution. Hence, it's proper utilization and disposal.

To overcome the fodder shortage due to increase in livestock population, use of crop residues in the animal ration is must. The best way to efficiently utilize the crop residues is to prepare complete feeds from crop residues + concentrates mixture.

Major crop residues produced from different crops are Maize Stover, Maize husk, Sorghum Straw, Groundnut Straw, Wheat Straw, Rice Straw, Arhar Straw, Gram Straw, Sugarcane Bagasse, Sugarcane tops, Molasses, Millet Straw, Soybean Straw etc. The inclusion level of these crop residues in different complete livestock feed varies from 17.5 to 75 percent as per the physiological status of the animal and nutritive value of different crop residues.

## 2. CONSTRAINTS IN SOLE FEEDING OF CROP RESIDUES [2]

- Crop residues are rich in fibre and low in nitrogen, minerals and vitamins.
- The palatability, digestibility of different crop residues is low and therefore, crop residues cannot form a sole ration for livestock.
- Crop residues are seasonally produced & have year-to-year variation in their production, hence need to be conserved.
- The crop residues are bulky in nature. Hence, they are expensive to transport, even for short distances.
- Some of the residues contains anti-nutritional factors e.g. Sorghum and maize stover contains tannin and paddy straw contains oxalate

It is possible to bridge the gap between availability and requirement of roughages by processing of crop residues by using suitable method to improve the palatability and digestibility and nutrient availability of crop residues.

## 3. CONCEPT OF COMPLETE FEED FROM CROP RESIDUE

- The complete feed is a quantitative mixture of all dietary ingredients to provide the specific nutrients requirement [3].
- In this system, all feed ingredients including roughages are proportioned, processed and mixed into a uniform blend.
- The product is used for feeding of livestock as a sole source of nutrients.
- The complete feeds can provide an adequate supply of balanced nutrients to the animal by controlling the concentrate to roughage ratio.
- It helps in improving utilization of low-quality fibrous crop residues.
- The system avoids feed wastage by promoting feed intake and by preventing refusal of the unpalatable feedstuff portions with reduction in feeding cost.

**Table 1. Demand and supply estimates of dry and green forages (million tonnes) [1]**

Year	Demand		Supply		Deficient		Deficit as %	
	Dry	Green	Dry	Green	Dry	Green	Dry	Green
2010	508.9	816.8	453.2	525.5	55.72	291.3	10.95	35.66
2020	530.5	851.3	467.6	590.4	62.85	260.9	11.85	30.65
2030	568.1	911.6	500.0	687.4	68.07	224.2	11.98	24.59
2040	594.9	954.8	524.4	761.7	70.57	193.0	11.86	20.22
2050	631.0	1012.7	547.7	826.0	83.27	186.6	13.20	18.43

- Eating and rumination time can also reduce due to feeding crop residue based complete feeds to animals.
- In complete rations the proportion of other ingredients varies as per physiological status of animal and nutritive value of ingredients.
- These complete diets can be processed into mash or pellets or feed block.
- Mash feed can be pelleted by adopting either traditional steam pelleting or recently developed expander-extruder technology.

Crop residue-based complete feed could be prepared in mash, pellet, block or expander extruder pellet form.

#### 4. PRETREATMENT METHODS OF ON CROP RESIDUE [4]

Commonly used pretreatment methods are alkali treatment, urea treatment, steam explosion, ozonolysis and enzyme treatment.

Following are the pre-treatment methods mainly used for crop residues,

1. Physical method- It includes mechanical, thermal, ultrasound, electrokinetic and microwave method of pretreatment.
2. Chemical treatment includes treatment of acid, alkali, oxidative and organosolv treatment on crop residues.
3. Biological pretreatment method includes fungal, enzymatic and bacterial treatment on different crop residues.
4. Combined pretreatment includes steam explosion, extrusion and thermochemical methods of treatment.

#### 5. ADVANTAGES OF PRETREATMENT ON CROP RESIDUES

1. It improves palatability of crop residues and thereby intake.

2. It breaks lingo-cellulosic bond improves digestibility of crop residues.
3. It enhances enzymatic hydrolysis and thereby conversion of cellulose into fermentable sugars.
4. It enhances delignification of crop residues and thereby improves quality of crop residues. Melted lignin acts as a binding material in complete feed pellet or block making.
5. It increases glucose yield leads to improvement in animal production.

#### 6. COMPLETE FEED IMPROVES ANIMAL PERFORMANCE BY FOLLOWING WAYS

1. Stabilize rumen environment & improves nutrient utilization
2. Less fluctuation in release of ammonia and efficient utilization of ruminal NPN
3. Improves fibre digestion hence acetate production
4. Due to maintained Roughage: Concentrate ratio it maintains milk quality
5. Increase in energy density in feed
6. Increased digestibility of protein and improves nitrogen balance
7. Improves total volatile fatty acid production (Propionate and acetate)

#### 7. PROPORTION OF STRAWS IN COMPLETE FEEDS

- 30 to 70 percent roughages can be included in complete rations depending upon the physiological status of animals to be fed.
- The roughage content of complete diets can be as follows,

Whereas, Protein content in complete ration will be varies from 11 to 13 percent.

Sr. No.	Status of animal	Proportion of roughage in complete feed
1	high-yielding animals	30-40 percent
2	Growing animals	40-50percent
3	Dry animals	60-70 percent

## 8. THE PROPORTION OF STRAWS IN COMPLETE FEEDS FOR MILKING ANIMALS

**Table 2. Complete feed block is composed of forage, concentrate and other supplementary nutrients in desired proportions capable of fulfilling an animal's nutrient requirement [5]**

Sr. No.	Milk yield of animal	Proportion of straw
1	5-10 liters/day	60%
2	10-15 liters/day	50%
3	15-20 liters/day	40%

## 9. INGREDIENTS OF THE CONCENTRATE MIXTURE [5]

Ingredients includes-

- Oil cakes/ meals as a protein source
- Molasses, grains, grain byproducts as an energy source
- Bypass fat and protein for the preparation of complete diet for high yielders
- Micro minerals, vitamins
- Feed additives- probiotics, bentonite, enzymes, antioxidants, herbal extracts, etc.

## 10. ADVANTAGES OF COMPLETE FEED [5]

- Complete feed has potential to fulfill the nutrient requirement of animals.
- It is possible to exploit locally available animal feed resources in complete feed to overcome the deficit of feed/fodder.
- There is scope for incorporation of tree leaves/shrubs in routine diets.
- Due to preparation of complete feeds quality feed is available round the year and is cost-effective.
- Complete feed prepared from bulky roughage sources is cheaper in storage and transportation.
- Complete ration feeding saves time and labour.
- Complete feed can correct multi-nutrient deficiencies in animals.
- Enhances utilization & palatability of poor quality/unconventional feeds through complete feeds.
- Reduces feed wastage
- It prevents selective feeding by animal.
- Complete feed facilitates farm management by allowing complete mechanization and more flexibility to include a wide range of alternative feeds.
- Low methane emission is possible by feeding complete feeds from animals.

- Feeding of complete feeds leads to improvement in productive & reproductive performance of animals.

## 11. COMPARATIVE STUDY OF THE EFFECT OF FEEDING THE COMPLETE FEED IN VARIOUS FORMS

Comparative growth performance study in goats and lambs on feeding crop residue-based complete mash Vs complete pellet feed was studied by Li *et al.*, [6]. Final body weight (Kg), ADG(g/d) and daily feed intake (Kg DM) was significantly higher and feed to gain ratio was better in goats and lambs fed pelleted crop residue based complete feed than complete mash feed.

Afzal *et al.*, [7] reported significant ( $p < 0.05$ ) improvement in feed conversion efficiency with marked reduction in cost of production by feeding complete feed block than complete mash feed to Corriedale lambs, while DM and digestibility of gross nutrients, nutritive value and retention of major minerals did not change between the groups.

The higher average milk yield in complete feed block fed than in mash fed lactating buffaloes during an on-farm trial. Farmers were of opinion that complete feed blocks enhanced milk yield and were also easy at feeding and storage [8].

Effect of feeding processed sweet sorghum crushed residue-based complete rations in Murrah buffalo calves was studied by Seshaiyah *et al.*, [9]. They found higher final body weight (224.70 kg), ADG (585.33 g/d), Feed intake (4.56 kg), better FCR (7.80) and low cost/Kg gain (Rs. 52.44) in Murrah buffalo calves fed Sweet sorghum crushed residue based complete expander extruder pellets than in Murrah buffalo calves fed either Sorghum straw based complete mash feed or Sweet sorghum crushed residue based complete mash feed.

## 12. MILK PRODUCTION STUDIES BASED ON CROP RESIDUE-BASED COMPLETE FEED

Dry matter intake was 28.2, 26.7 and 15.0 percent less on complete diets containing cotton stalks, maize cobs and sunflower heads, respectively, compared with the conventional diet. Average milk yield increased by 11.3, 11.5, 23.5 percent and cost of feed/kg milk yield reduced by 21.5, 23.4 and 25.2 percent on feeding complete diets containing cotton stalks, maize cobs and sunflower heads, respectively, compared with the conventional diets. The diets maintained 6–8 litres/day of milk yield in lactating Murrah buffalo. The results indicated that cotton stalks, maize cobs and sunflower heads could be incorporated in complete diets as sole roughage sources without any adverse effect on milk production in lactating Murrah buffalo [10]. The milk yield was 16.7 and 11.4 litres/day on feed blocks produced from premium and lower-quality sorghum Stover, respectively[11], indicating the feasibility of medium levels of milk production on crop-residue-based complete feeds.

Rao *et al.*, [12] reported increase in milk yield by 15.2% and FCM by 17.5% after feeding complete feed based on sunflower heads. They also reported higher fat and SNF by 19.7 % and 15.9%, respectively.

Thakur and Tomar, [13] found an increase in milk yield was reported by 16.23 % in buffaloes fed a complete diet containing concentrate+ sorghum fodder+ wheat straw in 50:35:15 proportions.

Gafer *et al.*, [14] observed that the milk fat, lactose, SNF and total solids were highest in cow fed with TMR with 30% concentrates, 35% fresh berseem, 20% corn silage and 15% rice straw (TMR1) and 35% fresh berseem, 30% corn silage, 14% rice straw, 10% corn grain, 5% soybean meal, 5% wheat bran and 1% premix (TMR2) than the conventional feed.

## 13. MEAT PRODUCTION STUDIES BASED ON CROP RESIDUE-BASED COMPLETE FEED

Reddy and Reddy [10] reported that the complete diets supported 87–108 g average daily gains (ADG) in Nellore ram lambs and 71 to 81 g ADG in local male kids in the intensive-feeding system. The ADG was significantly ( $P < 0.05$ ) higher on complete diets compared with the

respective conventional diet in both species. The dry matter intake/kg gain decreased by about 20 percent in sheep and 15 percent in goats, while the cost of feed/kg gain decreased by 13 to 32 percent in lambs and 13–22 percent in kids compared with the conventional diet. Dressing percentage and meat: bone ratio was optimum and almost similar for complete and conventional diets in sheep and goats.

Jadhav and Deshmukh [15] fed complete rations containing wheat straw and black gram straw at 60% level in crossbred sheep and reported the ADG (g/d) was 60 and 62.5, respectively. Whereas [16] found significantly higher ADG in Bharat Merino lambs fed complete diets containing 50% roughage and 50% concentrate than Bharat merino lambs fed conventional diet.

Bhadane *et al.*, [17] Formulated Arhar based pelleted complete feed with roughage: Concentrate ratio, 60:40 with two different protein levels and fed to 12 non-descript goats (divided into two groups) for 140 days. The ADG found in the two groups were 75.7 and 72.9 g/d, respectively with no significant difference.

## 14. EFFECT OF CROP RESIDUE BASED COMPLETE FEED ON ANIMAL REPRODUCTION

Walli [18] reported early maturity and age at first calving by 4-6 months in heifers. However, reduction in problems like anoestrus and repeat breeding with overall improvement in reproductive performance was also reported on feeding crop residue based complete feed.

## 15. CONCLUSION

Higher demand of milk and meat in the country requires newer feed resources with lower input cost for economical livestock rearing. Higher production of food grains i.e., cereals, pulses, oilseeds and agro-industrial products generates larger source of crop residues. Demand and supply gap of roughages and concentrates can be bridged through effective utilization of crop residues. Feed processing technology provides better opportunity for converting poor quality crop residues with proper supplementation into high valued feed. Crop residue based complete feed increases digestibility by increasing rate of delignification, increasing enzymatic hydrolysis of cellulose, hemicelluloses and thus increasing the livestock performance. Strategic use of crop residues for complete feed production can

support sustainable livestock production system and can further prevent environmental pollution. It also helps to decrease the methane production through enteric fermentation which will help to reduce the overall effect of climate change.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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