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Crop Residues for Sustainable Livestock Production

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Abstract

Global livestock production is constrained by the inadequate supply of feeds and forages for optimum production. At the same time land devoted for forage production does not likely to increase in the near future due to urbanization, industrialization etc. In this respect, abundantly available crop residues possess immense potential as ruminant feed resource, whose prospects are outlined briefly in this paper.

Keywords: Crop residues; Digestibility; Feeding; Straw

Description

Global demand for animal derived foods [milk, meat and eggs] is increasing tremendously in the recent years and will continue to increase in the near future. More so in the Asia, where the demand for livestock products are anticipated to outstrip the current production levels, and the demands are projected to grow by two to three folds by 2050 [1]. To achieve these targeted levels of production, efficient feeding of livestock is necessary as feed is the major driver of livestock production accounting for more than 0.65 of recurring expenditure. Furthermore, prices of conventional feed ingredients as well as grains are constantly escalating globally. In this context, crop residues, comprising mainly of straw (from fine grains such as wheat, oat, rice etc.) and stover (from coarse grains such as maize, sorghum, millets etc.) obtained after harvesting the crops, form an abundantly available feedstock (~4 billion metric tons globally) for ruminant feeding. For example, in India annual availability is >100 million metric tons each of rice straw, wheat straw and sugarcane bagasse, which are otherwise unfit for human consumption. Despite the fact that cereal crop residues are of low feeding value [i.e., poorly available nitrogen, low digestibility with lack of useful minerals] and have low voluntary intakes [around 1.5-2 kg/100 kg mature body weight], they constitute and continue to be an important feed resource for sustainable dairy production in the developing world, as energy-protein malnutrition among livestock is a serious problem in these countries [2-4].

Crop residues are used as ruminant feed since millennia [2]. Straws of legume crops have generally better nutritive value, forage quality and thus are nutritionally superior to cereal straws. Stovers have better nutritional quality than straws with respect to intake and organic matter digestibility [>50% vs. <50%] [5]. Straws and stovers are generally used to feed low producing animals or can be used as a source of bulk in the high producers' ration to fulfill their appetite, can help correct physically effective fibre shortage for milk fat synthesis in high concentrate feeding systems and may beneficially provide additional heat increment during cold stress conditions [5].

Major constraint to utilize the straws by ruminants is the interlocking of cell wall polysaccharides with the resistant biopolymer lignin [up to 15%], which prevents their microbial biodegradation in the rumen [6] and thereby decreasing the overall nutritive worth for ruminants. In addition, rice straw is unique in that it has very high content of silica [13-15%]. Several physical, chemical, physico-chemical and biological methods have been tried to maximize the utilization of energy from these straws, as better quality straw can result in at least 10% increase in productivity [7]. Among the many methods, chopping [2-3 cm], soaking in water before feeding, alkali treatment in industrial systems and urea ammoniation [4% urea at 40% moisture level for 1-2 weeks] in the tropics have been tried extensively by both researchers as well as farmers with the latter being enriching the nitrogen level of straw. A noteworthy finding here is that a growing calf may lose body weight of 150 g per day if fed straw alone; while similar calf fed urea treated straw alone can gain about 150 g per day [5]. Biological treatments (e.g., Karnal process) aiming at the deconstruction of lignocelluloses employ selective ligninolytic white-rot basidiomycetes under solid-state fermentation. Although improvements in digestibility and nitrogen level have been evident, inherent organic matter losses (up to 40%) can't be eliminated and the technology is not economical [6]. Another approach is supplementation of critical nutrients [catalytic] like in the form of urea molasses mineral blocks [8], slowly degradable proteins [moderate] and green forage supplementation (substitutional) to improve the performance [2]. Catalytic and moderate supplementations can also be done by use of 'protein banks' through tree leaves at the farm level [2].

A considerable variation in the quality of straws in terms of digestibility as well as metabolizable energy exists among different cultivars of rice, wheat, barley and stovers of sorghum, pearl millet as well as groundnut haulms [9,10]. Cultivar with superior stover quality without affecting grain yield [i.e., general ratio of straw: grain is 1:1 to 1:3] must be popularized under 'food-feed crops research', which have the additional advantage of lowering methane emission by ruminant enteric fermentation [2] similar to catalytic supplements [5].

Management of crop residues linked with burning of straws is a real 'burning issue' in country like India, although this has been banned in the UK in the 1980s [2,7]. Annually >20 million tons of straw biomass is being burnt in the field due to various reasons which is causing serious environmental pollution via carbon dioxide, smoke, methane etc. and human health hazards, besides diminishing soil organic matter content and fertility. It is advisable to feed straw rather than burning it at least from the point of methane emission, which is much higher in the former than through enteric fermentation. Alternatively, these can be processed by compressing into 'densified feed blocks' for future usage [7].

In summary, as the land devoted for green forage production is not expected to expand beyond its present level (i.e., 4% in India), and the crop residues are produced without additional allocation of land and water [11], there is an urgent need for the efficient utilization of nutrients through further studies on crop residues, as these are predicted to contribute nearly 0.7 to the Indian feed budget by 2020 [12]. Furthermore, grain redesigning with duly incorporating forage quality traits in plant breeding under 'food-feed crops research' has the potential to sustain the future livestock production to meet the growing global demand for animal products as well as to partially mitigate feed scarcity problem.

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