

Challenges and opportunities

in utilization of paddy straw as animal feed

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Paddy straw is one of the important by-products of rice production. Immediately after harvesting the crop, farmers are practicing residue burning for easy and early sowing of the next crop. This results in the vast emission of greenhouse gases and a lot of pollutants into the atmosphere. The residue can be used as a source of animal feed along or by combining with other rations as high lignin and silica content in straw reduces the intake in animals. Some economical treatments like chopping, soaking with water, urea treatment etc, enhance the digestibility and voluntary intake in the animals. This aids in the fight against the fodder crisis with poor quality fodders and environmental pollution.

Keywords: Animal feed, Digestibility, Paddy straw, Quality, Treatment

INDIA holds 1st position in livestock population as well as milk production. As per the 20th livestock census (2019), the population of cattle, buffalo, goat and sheep in India was about 192.49, 109.85, 148.88 and 74.26 million, respectively. The scarcity of green and dry fodder is the major constraint in realizing the production potential of crossbred and indigenous cows because of its negative impact on the body weight, overall growth, fertility, lactation period, milk productivity and digestive system of animals. Unavailability of green and dry fodder respectively accounts for 12.3% and 11.6% losses in dairy milk production in India. In different zones of India, ruminants depend on year-round grazing on natural pastures or cut grass and crop residues. Some areas face seasonal dry periods in which the availability of green fodder and pasture decreases in quality by reduction in the content of digestible energy and nitrogen. At present, cultivated fodder crops occupy only 5.4% (8.4 mha) of the total cultivated area which stagnates over the last two decades resulting

in the country facing a net deficit of green fodder (35.6%) and dry crop residues (10.95%). Besides, the increasing human population leads to increasing demand of food grains for consumption. Thus, the option for increasing the land area under cultivated fodder crops is limited.

India is a major rice (*Oryza sativa* L.) producer and exporter in the world, reportedly producing around 152.60 million tonnes (MT) of rice per year. Rice straw is the by-product of rice production. It is the

leftover material after the rice plant is harvested for its grains. Typically rice straw is abundantly available in India. West Bengal generates the maximum straw (22.95 MT) followed by Uttar Pradesh (20.63 MT) and Punjab (17.38 MT). Despite its abundant availability, the nutritive value of rice straw is considered to be low, particularly characterized by the high lignocellulose fraction and low protein content. Such characteristics contribute to the low amount of nutrients that



Burning of rice crop residues by the farmers

can be utilized by livestock and therefore, lead to a low production performance of the livestock. Furthermore, from the point of view of environmental conservation, the low nutritive value of rice straw may result in the high emission of methane, a major greenhouse gas contributing to the global warming problem and climate change. Pre-treatment of rice straw is a key to enhance its nutritive value as well as to improve the productivity of livestock.

Nutritional quality of paddy straw

It has a high dry matter (DM) content of 92–96% but, a low crude protein (CP) content ranging from 3–7%. It has high cell wall components, neutral detergent fibre (NDF) and acid detergent fibre (ADF), which consisted of degradable carbohydrate fractions such as starch, cellulose and hemicellulose (Table 1). It also contains a complex phenolic substance called lignin. This contains 80% of potentially degradable substances and is a source of energy.

Intake of rice straw by ruminants

Generally, the quantity of rice straw that the animal can eat each day is limited to less than 2% of its body weight. Ruminants can consume up to 1.2 kg of rice straw on DM basis per 100 kg live weight per day. The intake of rice straw varies greatly among animals, influenced

by the proportion of the rice straw present in the ration and how it is prepared, processed and fed to the animals.

Challenges in feeding paddy straw

- Rice straw has higher lignin and silica content (8–14%), which limit voluntary intake and reduces digestibility by ruminal microorganisms.
- High selenium content in paddy straw also limits its use as fodder in animals as compared to wheat straw. However, if given in moderate quantities (up to 5 kg per animal per day), selenium poses no health hazard to the animal.
- Paddy straw also contains oxalates (2–2.5%) which lead to calcium deficiency. So, the mineral mixture should always be fed along with the straw.

Utilization of paddy straw as animal feed

Paddy straw can be utilized as animal feed by:

- Reducing the size of the straw by chopping or grinding.
- Mixing with other rations like green fodders, oil cake and mineral mixtures.
- Physical treatment methods: water soaking.
- Biological treatment method: fungi and enzymes are used to metabolize lignocelluloses to improve the nutritional value of straw by selective

delignification.

- Straw fortification or value addition.

Value addition of paddy straw

Feeding only rice straw is unable to supply all the nutrients required for the maintenance of ruminants due to the low nutritive value of the highly lignified material. Paddy straw is a good feed component if pre-treated properly. The nutritive quality of paddy straw can be improved with physical, chemical and biological treatments. Supplementation of paddy straw along with some edible oilseed cakes or rapeseed meals and with mulberry shrubs as a protein source was found to improve animal performance. Also, many species of effective lignin-degrading white-rot fungi have been used to assess their ability to improve the nutritive quality of fodder for ruminant nutrition.

Physical treatment

Physical treatment of rice straw aims to improve palatability and increase intake as well as improve the potential digestibility of ruminants. Physical processes include soaking, grinding or chopping, pelleting, steaming pressure and gamma irradiation. These processes promote physical changes in rice straw such as reducing particle size, breakdown of the cell wall contents of rice straw which reduce rumination time for the animal and enrich the softness of the straw fibrous components to make it more palatable to the animal and hastening nutrient digestion. These physical processes are practical and inexpensive methods to enhance the utilization and recycling of nutrients from paddy straw and promote

Table 1. Fodder quality and mineral composition of paddy straw

Parameter	Concentration (%)	Nutrient	Concentration (%)
Dry matter	88–96.87	Nitrogen	0.65
Organic matter	83–90	Phosphorous	0.10
Crude protein	2–6.5	Potassium	1.40
Crude fibre	30–40	Zinc	0.02
Acid detergent fibre	49–73.01	Sulphur	0.075
Neutral detergent fibre	39.83–85	Silicon	4.25–13
Nitrogen free extracts	40–46	Magnesium	0.91–2.21
Cellulose	31.96–60	Calcium	0.52–2.24
Hemicellulose	13–32.24	Iron	0.04–0.45
Ash	11–16	Manganese	0.07
Acid insoluble ash	3–5	Copper	0.005
Acid detergent lignin	4.63–13.2	Boron	0.0010



Paddy straw chopping (Source: Feedipedia)



Demonstration of straw treatment to improve quality and taste
(Source: ICRISAT)



Treatment of paddy straw (Source: FAO photo library)

higher intake by the animal as well as nutrient digestibility and increase the passage rate of the feed.

Chemical treatment

Certain chemicals like urea, lime, sodium hydroxide and ammonia are commonly used in treating rice straw to improve its palatability, intake and digestibility. These chemicals break the links between the lignin-cellulose structures of the straw, which are sensitive under alkaline or acidic conditions. Among the chemicals used, alkali agents are extensively explored and practically accepted under farm conditions.

Urea treatment: Urea treatment is the most practical and widely used chemical method in treating rice straw. It is adaptable to both small-scale and commercial livestock farms. The main function of urea is to increase the protein content of the treated straw during the fermentation process. A solution (5%) of 5 kg urea dissolved in 100 litres of water is sprayed at the rate of 100 litre/100 kg chopped paddy straw, once a layer of 100 kg has been treated, an additional layer of 100 kg is placed on top and sprayed with urea. This process is repeated to make a stack and is left for 9

days. Urea treatment increases the crude protein (CP) content of rice straw from 3.5–8.0% and improves the digestibility of dry matter from 40–50% and has a soft texture with 3.0–4.0% digestible crude protein (DCP) and 55–60% total digestible nutrients (TDN). This involves a combination of physical, chemical and biological treatments. The paddy straw is chaffed and moistened (physical) with urea solution (chemical), the breakdown of urea release ammonia gas, a part of which is utilized by microbes (biological) for their proliferation (enriching the straw with microbial protein), resulting in a rise of stack temperature, which facilitates the penetration of ammonia in the cell wall, resulting in breakage of ligno-cellulosic bonds making cellulose and hemicellulose assessable for utilization by microbes in the rumen.

Lime Treatment: Lime is also a source of calcium for ruminants in low-calcium rations but it has longer solubility in water compared to NaOH or urea. Treatment of straw with lime can be done in two ways, soaking and ensiling. The lime treatment provides complementary effects in combination with urea. The combination of lime and urea

treatment has been an advantage in increasing degradability and incrementing both the calcium and nitrogen contents of the treated straw.

SUMMARY

The feed resource availability in the country for livestock is not adequate and the gap between the requirement and availability is widening. There are many opportunities such as, physical methods (chopping, pelleting, grinding and soaking etc.) and chemical methods (urea treatment, ammonia treatment, alkaline and lime treatment) which can improve the digestibility and intake of straw. These methods help in combat with fodder crisis and also reduce the environment footprint. Punjab government proposes use of paddy straw as cattle feed in *gaushalas* after proper treatment with urea to reduce the burning. The entire cost for the process, including spray pumps and other logistics, has to be borne by district administration from their own funds.

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Know Krishi Unnati Yojana

The *Krishi Unnati Yojana*, a central sector scheme, is envisaged as umbrella programme for focusing on food security, by merging schemes on Soil-health Card, Integrated Scheme on Agricultural Co-operation and Agricultural Marketing, National Mission on Agriculture Extension, Horticulture Development, Price Stabilization Fund, National Mission on Sustainable Agriculture and other programmes.