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Rice Straw for Ruminants: From Field Residue to Functional Roughage

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Abstract

Rice straw is one of the most abundant crop residues in rice-growing regions and is widely used as roughage for cattle, buffaloes, sheep, and goats, especially during fodder scarcity. However, untreated rice straw is a low-quality feed because it contains low crude protein, high fiber, lignin, silica, and poor mineral balance. These factors reduce rumen microbial attachment, voluntary intake, digestibility, and animal performance. Its feeding value can be improved through simple and practical methods such as chopping, urea or urea–molasses treatment, protein–energy–mineral supplementation, proper storage, and balanced ration formulation. Emerging approaches such as fungal treatment, enzyme application, and breeding of more digestible rice straw varieties are promising but require wider field validation. Therefore, rice straw should not be viewed either as waste or as a complete feed. It should be used as a basal roughage that requires scientific processing and supplementation.

Keywords: Rice straw, ruminants, urea treatment, crop residue, fodder scarcity, roughage, cattle, buffalo

1. Introduction

Every rice harvest leaves behind a second harvest: rice straw. For many farmers, it is a disposal problem; for ruminants, it can become a useful roughage resource. The difference lies in management. When burned, rice straw contributes to air pollution, nutrient loss, and health hazards. When collected, processed, treated, stored, and supplemented properly, it can help reduce fodder scarcity and feeding cost in cattle, buffalo, sheep, and goat production systems.

Rice straw is particularly important in Asia, where rice-based farming systems generate enormous quantities of residue. Annual rice straw production has been estimated at approximately 100–140 million tonnes in Southeast Asia, 330–470 million tonnes in Asia, and 370–520 million tonnes globally (Hung et al., 2020). Despite this availability, loose rice straw is bulky, scattered after combine harvesting, difficult to collect manually, and costly to transport. These limitations often encourage open-field burning. Efficient collection, baling, densification, and storage are therefore essential before rice straw can become a reliable fodder resource (Balingbing et al., 2020). Conceptual pathway showing how rice straw can be shifted from open-field burning to ruminant feeding through collection, baling, chopping, treatment, supplementation, and improved rumen utilization shown in Fig. 1.

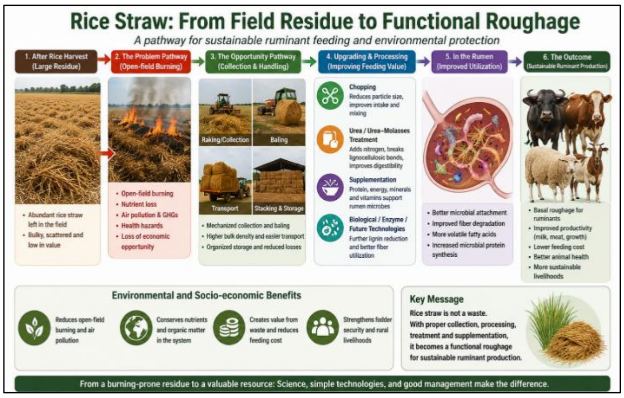

Figure 1. Rice straw: from field residue to functional roughage.
Source: Conceptualized from Hung et al. (2020), Balingbing et al. (2020), Aquino et al. (2020), Sarnklong et al. (2010), Kamal et al. (2025), and Yamsa-Ad et al. (2025).

2. Why rice straw matters in ruminant feeding

Ruminants can convert fibrous plant residues into milk, meat, manure, and draft power through rumen microbial fermentation. This makes rice straw valuable during dry seasons or fodder-scarce periods when green fodder and pasture availability decline. In tropical smallholder systems, rice straw is important not because it is nutritionally superior, but because it is available, cheap, storable, and familiar to farmers (Sarnklong et al., 2010). However, rice straw cannot sustain high production when fed alone. Its usefulness depends on processing, treatment, supplementation, and ration balancing. Therefore, it should be considered a basal roughage rather than a complete ration.

3. Why untreated rice straw is nutritionally weak

Rice straw contains potentially fermentable carbohydrates, but much of this fraction is trapped within a rigid lignified and silicified cell-wall matrix. Its direct feeding value is limited by low crude protein, high fiber, lignin, silica, low readily fermentable energy, and poor mineral balance. Sarnklong et al. (2010) identified lignification, silicification, slow ruminal carbohydrate degradation, and low nitrogen content as major constraints to rice straw utilization. Aquino et al. (2020) also described rice straw as low in energy and protein, with utilization further restricted by poor digestibility, high silica, oxalates, variable nutritive value, and storage-related contamination risks.

In practical terms, untreated rice straw may fill the rumen before meeting nutrient requirements. Slow degradation and passage reduce voluntary intake and limit production.

Table 1. Major constraints of untreated rice straw as ruminant feed

Constraint	Nutritional meaning	Practical effect	Key source
Low crude protein	Inadequate nitrogen for rumen microbes	Poor fiber digestion and low productivity	Sarnklong et al. (2010); Aquino et al. (2020)
High lignin	Protects cellulose and hemicellulose	Slow rumen degradation	Sarnklong et al. (2010)
High silica	Limits palatability and microbial access	Lower intake and digestibility	Sarnklong et al. (2010); Aquino et al. (2020)
High NDF and ADF	High structural fiber load	Rumen fill before nutrient needs are met	Sarnklong et al. (2010)
Low P and trace minerals	Poor mineral balance	Supplementation required	Aquino et al. (2020)

Bulky loose form	Difficult handling and transport	Burning becomes easier than collection	Balingbing et al. (2020)

Table source: Compiled from Sarnklong et al. (2010), Aquino et al. (2020), and Balingbing et al. (2020).

4. Rice straw is not a complete ration

Rice straw can provide rumen fill and some fermentable fiber, but it does not supply enough protein, energy, phosphorus, sulfur, trace minerals, and vitamins for growth, lactation, reproduction, or recovery from poor body condition. It is more suitable for maintenance animals, dry cows, and emergency feeding during fodder scarcity. In lactating animals, growing calves, pregnant animals, and high-producing buffaloes, it should be only one component of a balanced ration. Aquino et al. (2020) reported that rice straw may constitute about 50% of the ration for dry cows with proper supplementation, but for cows with calves it should not exceed about 25% of the total ration. For lactating cows, rice straw alone is inadequate and must be supplemented with concentrates or dried legumes.

5. Improving rice straw feeding value

Chopping

Chopping is the simplest farmer-ready step. It reduces wastage, improves mixing, and allows better incorporation with green fodder, concentrate, molasses, mineral mixture, or treated straw. However, straw should not be ground too finely because ruminants need physically effective fiber for chewing, saliva production, and rumen health. Excessive particle-size reduction may increase passage rate, reduce rumination, and compromise effective fiber digestion (Aquino et al., 2020; Kamal et al., 2025).

Urea treatment

Urea treatment is a practical technology for upgrading rice straw. During airtight storage, urea dissolves in water and releases ammonia, which increases nitrogen content and helps disrupt lignocellulosic bonding, improving microbial access to fiber. Sarnklong et al. (2010) reported that urea is safer than anhydrous ammonia, cheaper than sodium hydroxide or ammonia, easy to handle, and suitable for smallholder use. Urea treatment improved in vitro dry matter degradability of low-quality rice straw from about 45% to 55–62%. Kamal et al. (2025) reported that urea–molasses-treated rice straw increased crude protein from 4.7% to 7.9% and dry matter digestibility from 47% to 55%.

Safety note: Urea-treated straw should be prepared with correct moisture, airtight storage, and adequate treatment time. Urea should never be sprinkled directly on straw and fed immediately. Moldy, rotten, or strongly irritating straw should be discarded.

Lime and urea–lime treatment

Lime treatment may improve degradability and supply calcium. However, it needs careful preparation because reduced acceptability and mold growth have been reported. Sarnklong et al. (2010) noted that lime treatment can increase degradability but may reduce dry matter intake due to lower acceptability; mold growth was also observed in calcium hydroxide-treated straw. A combined urea–lime approach may be more useful because it can improve degradability while supplying nitrogen and calcium (Sarnklong et al., 2010; Aquino et al., 2020).

Supplementation

Supplementation is essential because rice straw is deficient in nitrogen, minerals, and readily fermentable energy. Green fodder, legume fodder, concentrate mixture, oilseed cakes, molasses, mineral mixture, common salt, and urea–molasses mineral blocks can support rumen microbes, fiber digestion, intake, and animal response. Sarnklong et al. (2010) emphasized that protein, energy, and mineral supplementation improves rumen function and rice straw utilization. Aquino et al. (2020) also highlighted the need to balance phosphorus and trace minerals in rice straw-based rations.

6. Biological, enzyme, and future technologies

Biological treatment uses fungi, bacteria, or enzymes to partially open the fibrous structure before rumen fermentation. White-rot fungi are especially relevant because of their lignin-degrading capacity, while cellulase and xylanase may support fiber breakdown. However, these methods are not yet universally farmer-ready. Sarnklong et al. (2010) concluded that ligninolytic fungi and enzymes are promising, but available data remain limited. Aquino et al. (2020) noted challenges such as fungal strain selection, incubation period, possible toxin production, and the need to preserve cellulose and hemicellulose while degrading lignin. Kamal et al. (2025) further reported that biological treatment may improve intake, digestibility, and productivity, but lack of expertise and possible dry matter loss can restrict adoption.

A newer approach is to breed or select rice varieties with more digestible straw. Yamsa-Ad et al. (2025) studied brittle rice straw lines using in vitro rumen gas production. Brittle rice straw had higher crude protein and hemicellulose, lower cellulose, higher gas production, and higher in vitro dry matter digestibility than wild-type rice straw. The best line improved IVDMD from 46.5% to 55.1%. However, this was an in vitro study, so animal feeding trials are needed before field recommendation. Untreated rice straw is restricted by lignin, silica, low nitrogen, and poor mineral balance, whereas chopping, urea treatment, supplementation, and biological approaches improve microbial access, fiber degradation, volatile fatty acid production, and microbial protein synthesis.

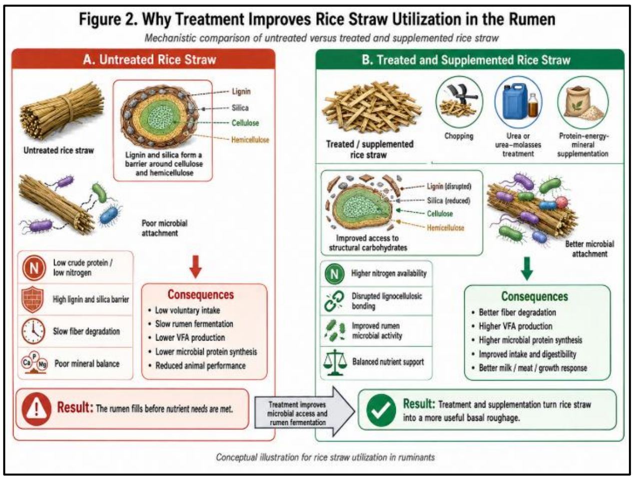

Figure 2. Why treatment improves rice straw utilization in the rumen. Source: Conceptualized from Sarnklong et al. (2010), Aquino et al. (2020), Kamal et al. (2025), and Yamsa-Ad et al. (2025).

Table 2. Practical and emerging methods to improve rice straw feeding value

Method	**Main action**	**Practical benefit**	**Limitation/ caution**
Chopping	Reduces particle size and wastage	Better mixing and intake	Avoid excessive grinding
Urea treatment	Adds nitrogen and releases ammonia	Improves CP and digestibility	Needs airtight storage and safe preparation
Urea–molasses treatment	Adds nitrogen and fermentable energy	Improves palatability and digestibility	Incorrect use may risk urea toxicity
Lime treatment	Alkali effect and	May improve fiber	Palatability and mold risk

	calcium supply	degradability	
Supplementation	Supplies protein, energy, and minerals	Supports rumen microbes and productivity	Requires ration balancing
Biological treatment	Partial lignin degradation	Potential digestibility improvement	Cost, strain, toxin, and incubation issues
Brittle rice straw breeding	Genetic improvement of straw structure	Better in vitro fermentability	Animal trials still needed

Table source: Compiled from Sarnklong et al. (2010), Aquino et al. (2020), Kamal et al. (2025), and Yamsa-Ad et al. (2025).

7. Practical field guide

For field-level feeding, rice straw should be used with simple precautions. These practices reduce wastage, improve safety, and prevent the common mistake of feeding rice straw as the only feed for productive animals.

Table 3. Practical "Do and Avoid" guide for rice straw feeding

Do	**Avoid**
Chop straw before feeding	Feeding long, unprocessed straw with high wastage
Treat straw with urea only after proper training	Feeding freshly urea-sprinkled straw immediately
Supplement protein, energy, minerals, and salt	Feeding straw alone to lactating or growing animals
Store straw dry and protected from rain	Feeding moldy or spoiled straw
Use more straw in maintenance animals	Using high straw levels in high-producing animals
Combine straw with green fodder or concentrate	Assuming straw can fully replace good-quality fodder
Promote baling and storage	Burning straw after harvest

Table source: Practical synthesis based on Sarnklong et al. (2010), Aquino et al. (2020), Balingbing et al. (2020), and Kamal et al. (2025).

8. Conclusion

Rice straw is neither useless waste nor a complete feed. Untreated rice straw is low in protein, poorly digestible, high in lignin and silica, and unable to support high production when fed alone. However, when chopped, treated, supplemented, and stored properly, it becomes a useful basal roughage for ruminants. Wider adoption of rice straw feeding depends on efficient collection, safe storage, proper treatment, and balanced ration formulation. Future technologies such as biological treatment, enzyme application, and brittle rice straw breeding may further improve its value, but farmer-ready solutions must remain simple, safe, economical, and repeatable. With scientific management, rice straw can shift from a burning-prone residue to a functional roughage resource in sustainable ruminant production.

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