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Value Addition of Fodder and Crop Residues for Sustainable Livestock Production

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★ Key message

- Value addition of fodder resources improves the nutritional quality, palatability, shelf life, and utilization efficiency of livestock feed while reducing fodder wastage.
- Technologies such as TMR/feed blocks, silage, hay making, fodder pelletization, hydroponic fodder production, and urea enrichment of crop residues help ensure year-round availability of quality feed.
- These practices enhance animal health, productivity, feed efficiency, and reproductive performance while lowering dependence on expensive commercial feeds.

Abstract

Value addition of fodder resources offers a viable and sustainable solution for supplementing livestock feed. Techniques such as the preparation of complete feed blocks, fodder pelletization, conservation and urea enrichment of crop residues are widely adopted for the efficient utilization of available fodder resources through value addition. These technologies improve the nutritional quality, shelf life, palatability and economic value of fodder crops. As a result, they helps to increase livestock production efficiency while reducing feed costs and minimizing fodder wastage.

Key words: Fodder pellatization, Silage making, Total mixed ration, Urea enrichment, Value addition

Introduction

Livestock is an important source of income for landless and marginal farmers and plays a significant role in the National economy. Livestock had a contribution of 29.35% in total gross value added (GVA) of agriculture and allied sector and 4.35% in total GVA as per Economic Survey 2021-22 (Annon, 2022). Hence, sustainable livestock production is considered as one of the key components in supporting rural livelihoods and income generation.

However, the scarcity of quality fodder, high cost of commercial feeds and seasonal fluctuation in forage availability are the major barriers that limit profitable livestock production in India (Dhillon et.al., 2023). Therefore, a sustainable supply of adequate and nutritious feed and fodder is essential for the development of livestock sector. Crop residues and green fodders constitute the major feed resources available for livestock in India. However, the country presently facing a severe fodder crisis. Recent estimates indicate an 11.24% deficit in green fodder and a 23.4% shortage in dry fodder (Dhamodharan et.al., 2024). Feed represents the largest single expense input for livestock production. Livestock producers look for low-cost alternative feed resources, especially when conventional feeds are expensive.

In this context, value addition of fodder resources provides a viable and sustainable option for supplementing livestock feed. Value addition techniques improve the nutritional quality, shelf life, palatability, and economic value, there by helps to increase production efficiency of livestock while reducing feed costs and minimizing fodder wastage. Techniques such as preparation of complete feed blocks, fodder densification, silage making, hay preparation and urea enrichment of crop residues are widely adopted for effective utilization of available fodder resources. Thus, value addition of fodder plays a crucial role in ensuring sustainable livestock production, improving farmers income, and strengthening food and nutritional security.

Advantages of Value Addition

- Improves animal health and productivity - Value-added fodder retains essential nutrients such as vitamins, minerals, and moisture, which improves feed utilization, growth, production and reproductive performance. It also supports better immunity, digestion and reduces the occurrence of metabolic and nutritional disorders.
- Reduces feeding cost - Feeding a balanced and value-added fodder reduces dependence on costly commercial concentrate feeds, thereby lowering the overall cost of livestock production.
- Minimizes fodder wastage - Fresh green fodder is highly perishable. Value addition techniques such as silage making and hay preparation help prevent spoilage and improve efficient utilization of available fodder resources.
- Ensures year-round fodder availability – Value addition in the form of silage, hay or feed blocks provides a continuous supply of nutritious feed during droughts and fodder-scarcity periods.
- Enhances farmers income - Improved livestock productivity, reduced feed costs and better animal health collectively increase the profitability and income of farmers.

- Improves shelf life and storage – Value-added fodder can be stored for longer periods without significant nutrient loss, ensuring feed security and easier transportation.

Strategies for value addition of fodder resources

The following strategies can be followed for value addition of fodder resources

- Preparation of Complete feed (Total Mixed Rations)
- Conservation of fodder
- Physical processing of Fodder
- Hydroponic fodder production
- Urea enrichment of crop residues

I. Preparation of Complete feed (Total mixed ration (TMR)

Total Mixed Ration (TMR) is a balanced feeding system that consists of forages, grains, protein supplements, minerals, vitamins and feed additives blended uniformly into a single feed mixture formulated to meet the nutrient requirements of livestock. Traditionally, roughages (green/dry fodder) and concentrates are fed separately and due to differences in the nutrient density, the efficiency of nutrient utilization is also different. Feeding of concentrates and roughages together in a mixed form result in a steady supply of nutrients resulting in better efficiency of nutrient utilization and improved production and this forms the basis for the total mixed rations. In a TMR system, every mouthful consumed by the animal contains the correct proportion of nutrients required for a balanced ration. It also provides adequate sources of carbohydrates and nitrogen that differ in their rate and extent of rumen degradation, helping to optimize rumen fermentation and animal performance. Total mixed ration can be prepared in the form of complete feed block or in extruded form which facilitate easier handling, storage, and transportation.

Complete Feed Block

Complete feed blocks are a form of total mixed ration in which roughage and concentrate components are blended together to provide all the essential nutrients required by livestock. Locally available agricultural wastes, crop residues and agro-industrial by-products can also be incorporated into the preparation of these feed blocks, making them a cost-effective and sustainable feeding option. Crop residues such as paddy straw and groundnut haulms can be converted into feed blocks to improve their palatability and digestibility.

For example, nutrient enriched paddy straw blocks, serve as an excellent feed resource for livestock, particularly during periods of fodder scarcity. To prepare the blocks, the roughage source is dried, chaffed and mixed with ground feed ingredients such as groundnut oil cake,

bran, mineral mixture, and salt. Boiled refined wheat flour can be used as a binding agent. The mixture is compressed into blocks using a hydraulic press and then dried in the sun for about 3–4 days. The weight of each block is approximately one kg.

Extruded TMR

Extruded feeds are manufactured by forcing ground feed materials through a die under pressure and steam heat, resulting in a uniform shape and texture. The final product has the consistency of dry feed and is commonly produced using cold processing with a single-screw extruder in animal feed preparation. The extrusion process improves the digestibility of starch and enhances protein utilization. It also modifies the particle size, solubility and chemical structure of dietary fibre, thereby improving the overall nutritive value of the feed. Total mixed ration (TMR) can be converted into extruded feed suitable for different species of animals. Extruded feed is widely used to improve feed efficiency, animal productivity and reduce feed wastage. Various feed resources such as crop residues, tree leaves and agro-industrial by-products can also be processed into extruded feed, making it an economical and sustainable feeding option for livestock.

II. Conservation of fodder

In India, the availability of green fodder is highly seasonal and depends on agroclimatic conditions. Surplus green fodder is generally available from September to January, while an acute shortage occurs between March and June. Therefore, the excess fodder produced during the surplus season must be properly processed and stored for future use. Forage conservation in the form silage and hay making, is also an important value addition strategy that helps to ensure a continuous supply of quality feed during periods when green fodder is scarce.

Silage making

The surplus fodder can be preserved as silage for feeding livestock during periods of fodder scarcity. Silage is the preservation of green fodder in its original form through anaerobic fermentation. The container used for silage making is known as silo. Different types of silos are available, namely Tower silo, Pit silos, Trench type, Bunker type etc. Generally, crops with thick stems are conserved as silage. However, any crop having sufficient soluble carbohydrates and moisture to produce adequate quantities of lactic acid can be used for silage making. The most commonly used crops for silage preparation are Fodder maize, Fodder sorghum, Fodder bajra, Hybrid Napier grass etc. Among these, fodder maize and sorghum are considered as the best crop for silage making. The fodder harvested during grain filling stage with desired moisture content of 65-70% is best for ensiling process.

Crops should be harvested at the stage when they contain maximum nutrients. Cereal

fodders should be harvested at the milking stage while grass fodders should be harvested at the half bloom stage. After harvesting, the fodder should be chaffed before filling the silo, as chaffed forage can be compressed more effectively, ensuring better airtight packing of the silo. To obtain good quality silage in terms of lactic acid and acetic acid content as well as palatability some additives like molasses (2 %) and common salt (1%) can be added. These additives improve the quality of silage by increasing lactic acid and acetic acid production and also increases the palatability of silage. The filling of silo should be rapid and it should not take more than two days. During filling, the forage should be compressed properly so that neither there is any air pocket inside the silo. The silo must be sealed airtight to prevent the entry of atmospheric air. The top of the silo should be covered with dry fodder followed by plastic sheet and wet mud. After a period of 4-6 weeks the silage is ready for feeding livestock. Good quality silage is characterized by a greenish-yellow colour, a pleasant vinegar-like odour and a pH of 4.2 or less.

Hay making

Hay making is one of the traditional methods of forage conservation. Hay refers to cereals, grasses, or legumes that are harvested at the appropriate stage, dried and stored in such a way that there is minimum loss of nutrients. The principle involved in hay making is to reduce the moisture content of the herbage to 15% or less so that it can be safely stored in bulk without undergoing fermentation or becoming mouldy.

Leguminous fodder crops should be harvested at the flower initiation stage or when crown buds start to develop, while grasses should be harvested at the pre-flowering stage. In the case of grain crops, cutting is done when the grains are in the milk stage. Fodder crops having soft and pliable stems are more suitable for hay making compared to hard-stemmed crops. In Indian conditions, most of the hay is prepared from crops such as sorghum, maize, and millets, usually harvested after grain removal. Harvesting should preferably be done when atmospheric humidity is low to facilitate proper curing. The harvested forage should be spread in the field and turned or raked a few times for quick and uniform drying. The dried forage is then collected and baled when the moisture content falls below 15%.

III. Physical processing of fodder

Green fodder is abundantly available during the monsoon season but becomes scarce during summer and periods of monsoon failure. To overcome fodder shortages, surplus fodder produced during the monsoon can be processed and value-added into fodder pellets with improved nutritive value and enhanced palatability. Several fodder crops are suitable for pellet production, including hybrid napier grass, guinea grass, fodder maize, lucerne, fodder cowpea,

hedge lucerne, subabul, agathi, moringa, and glyricidia.

Freshly harvested green fodders such as grasses, cereal fodders, legume fodders, and tree fodders should be dried to an optimum moisture content of 12–14%. Similarly, crop residues and other by-products must also be assessed and maintained at the same moisture level for effective pelleting. The dried feed materials are cut into smaller pieces using shredders and then powdered for pellet preparation. The powdered feedstocks are mixed thoroughly in a feed mixer machine and subsequently extruded into pellets. To improve the nutritive value and palatability, additives such as molasses, jaggery, salt, urea, and mineral mixtures may be incorporated into the powdered feed before pelleting.

IV. Hydroponic fodder production

Hydroponics is a method of growing plants without soil. Hydroponic fodder consists of palatable, germinated grains in which the root system and shoots are consumed together, resulting in minimal nutrient wastage. This technology is especially important in regions with limited forage production (Fazaeli *et al.,* 2012). Hydroponic fodder can be produced within about 8 days from seed to harvest and its nutritive value is improved, particularly the crude protein content, which ranges from 10–14%. The forage crops suited for hydroponic fodder production are maize, ragi, bajra, oats, barley, wheat, horse gram and cowpea with maize being the most commonly used seed. The system enables a continuous year-round supply of fodder regardless of monsoon failure, land scarcity, natural calamities or labour shortages. Therefore, hydroponic fodder production plays an important role in promoting sustainable livestock production during periods of fodder scarcity.

V. Urea enrichment of crop residues

Paddy straw is a major feed resource available for ruminants in India, however, it has poor nutritive value because of its high lignin content. Therefore, enrichment of paddy straw have been suggested to improve its feeding quality by increasing digestibility and enhancing palatability. This process helps in weakening and breaking down ligno-cellulosic bonds in crop residues, thereby increasing daily feed intake, improving the rate of digestion and enhancing the availability of nutrients. Among various chemical treatment methods, urea treatment is considered the simplest and most practical option. Urea is cheaper, easily available and safer compared to anhydrous or aqueous ammonia. In addition, it acts as a source of nitrogen (crude protein), which is otherwise deficient in straw, thereby improving its overall feeding value.

Urea enrichment of paddy straw

For the enrichment of 100 kg of paddy straw, 4 kg of urea is dissolved in 65 litres of water. This urea solution is then evenly sprinkled over the paddy straw, ensuring that all the straw is thoroughly wetted. After application, the straw is covered with a polythene sheet to

create airtight conditions. After about 21 days, the urea-treated paddy straw becomes ready for feeding. Urea treatment helps in breaking lignocellulosic bonds through the action of ammonia, thereby releasing cellulose from lignin. This improves the digestibility of the straw and enhances its utilization by livestock.

Conclusion

Value addition of fodder resources is essential for efficient livestock production and sustainable agriculture. Through practices such as total mixed ration preparation, fodder conservation, urea enrichment and pellatization, surplus biomass can be effectively preserved and converted into nutritious feed. These technologies not only help to bridge the gap between feed demand and supply but also improve the quality, palatability and digestibility of fodder resources thereby contribute to better animal health, increased productivity and reduced dependence on costly commercial feeds. Moreover, these practices support environmental sustainability by minimizing waste and promoting the recycling of agricultural residues. Therefore, value addition of fodder and crop residues is a key strategy for enhancing livestock productivity, improving farm profitability and achieving long-term sustainability in the livestock sector.

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