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Impact of Modern Technology on Feed and Fodder Processing: A Review

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Abstract

Thepresent review article provided text covers of various aspects of modern technology infeedandfodderprocessing,discussingtheglobalimportanceoftheindustry,purposesofprocessing,methods for altering feed characteristics, and specific modern technologies employed in the field. Itemphasizes the significance of feed processing in animal production, outlining its role in enhancing profitability, improving animal health, and addressing nutritional needs. Additionally, the text highlights the challenges faced by countries like India in meeting the demands of their livestock populations and the role of technology in overcoming these challenges. The document begins byintroducing the importance of animal feed in ensuring the growth and health of livestock, followedby an overview of India's role in global livestock production despite limited resources. It thendiscusses the current availability of feed resources in India and the existing deficits in key feedcategories. The text emphasizes the importance of modern technology in feed processing, noting itsrole in optimizing nutrient content, enhancing digestibility, and improving overall sustainability inlivestock production systems. Moreover,the document provides insights into specific modern technologies used in feed processing, such asgrinding, pelleting, roasting, extruding, cubing, flaking, micronization, and Urea Molasses Mineral Block (UMMB) treatment. Additionally, it outlines precautions and guidelines for the safe and effective utilization of these technologies in livestock feeding programs. overall, the document presents a comprehensive overview of modern technology in feed and fodder processing, addressing its significance, purposes, methods, and specific applications.

Key words : Feeds, Fodder processing, Modern technologies.

Animal feed is food given to domestic animals, especially livestock, in the course ofanimalhusbandry.Adequatenutritionduringinfancyandearlychildhoodisessentialtoensurethegrowth, health, and development of children to their full potential. There are two basic types:fodder and forage (Leroy *et al*.2022). In the realm of animal husbandry and agriculture, the questfor enhancing productivity, improving animal health, and ensuring sustainable practices has beenan ongoing endeavor (Tona, 2018). Central to these goals is the processing of feed and fodder,which forms the cornerstone of livestock nutrition and performance. Over the years, traditionalmethods of feed processing have given way to a wave of modern technologies, ushering in a neweraof innovation and efficiency (Bazerand Rollin, 2011).

India's remarkable contribution to global livestock production is underscored by the fact that it sustains 15% of the world's livestock population on a mere 2% of the world's geographical area, showcasing the country's significant role in the livestock sector despite limitedresources (Miassi, and Dossa, 2023). With only 5.23% of its cultivated area dedicated to fodder production, India faces unique challenges in meeting the nutritional needs of its vast livestock population. The current availability of feed resources in India highlights the disparities betweendemand and supply (Roy *et al*.,2019). Green fodder, crucial for the nutritional needs of livestock, is available at a

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quantity of 222 million metric tons (m.t.), while dry fodder amounts to 416 million m.t (Dhaliwal *et al*., 2023). The contribution of different sources to fodder availability is asfollows: crop residue accounts for 54%, cultivated fodder for 28%, and grasslands for 18%. Despite theseresources, India grapples with significant deficits in key feed categories. There is a net deficit of 36% in green fodder, 40% in dry crop residues, and a substantial 57% in concentrate feedingredients, highlighting the pressing need for interventions to bridge these gaps and ensure thenutritionalrequirementsof livestock aremet (Rao,and Birthal, 2008).

The advent of modern technology in feed and fodder processing has brought about transformative changes, offering unprecedented opportunities to optimize nutrient content, enhance digestibility, and streamline production processes (Balehegn *et al*. 2020). From precision feeding systems to advanced extrusion techniques, these technologies have not only elevated thequality of animal diets but have also revolutionized the way feed is formulated, processed, and delivered (Poel *et al*. 2020). Moreover, in the face of global challenges such as population growth, climate change, and resource scarcity, the adoption of modern feed processing technologies has become increasingly imperative. These technologies hold the promise of mitigating environmental impacts, reducing feed waste, and improving overall sustainability in livestock production systems (Fróna *et al*. 2020).

The significance of feed in animal production cannot be overstated, considering it represents the largest single cost factor, accounting for approximately 65% of total expenses (Alqaisi *et al*. 2017).

Advancements in feed processing technology offer a promising avenue to mitigate these costs through various means, including enhancing feed quality and nutritional value, reducing production expenses, and maximizing the utilization of locally available feeding redients (Becker, 2008). Feed processing encompasses altering the physical, and sometimes chemical, characteristics of feed commodities to optimize their utilization by animals and improve the mixing and stability of the diet (Kiarie and Mills, 2019). This process is particularly crucial for the major components of any diet, namely rough age and grain, which are the feeds most commonly subjected to processing (Kiarieand Mills, 2019). Grain processing for feeding ruminants has been extensively studied and reviewed. Ruminants, withth eirunique digestive systems, require specialized processing methods to optimize nutrient utilization and digestion efficiency (McGrath *et al*. 2018). By breaking down the physical structure of grains, processing methods such asgrinding, rolling, and cracking increase their accessibility to rumen microbes, thereby improvingdigestibilityand nutrient absorption (Safaei and Yang, 2017).

Additionally, advancements in grain processing technologies have facilitated the development of novel approaches to enhance feed efficiency and animal performance. These mayinclude techniques such as steam flaking, micritization, and extrusion, which not only improve nutrient availability but also offer benefits in terms of palatability and digestibility (Li, Niu, 2023). Furthermore, the utilization of local feed ingredients through effective processing methods holdsgreat potential for reducing feed costs and enhancing sustainability in animal production systems. By processing alternative feed sources such as by-products, crop residues, and locally availablegrains, producers can mitigate reliance on expensive imported feeds and promote economic viability within the local agricultural economy (Rahmawati *et al*. 2020).

What is meant by feed and fodder : Fodder refers particularly to foods or forages given to the animals (including plants cut and carried to them), rather than that which they forage for themselves. It includes hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes (Mutwedu *et al*. 2020).

Forage is a plant material (mainly plant leaves and stems) eaten by grazing livestock. Historically, the term forage has meant only plants eaten by the animals directly as pasture, crop residue, or immature cereal crops, but it is also used more loosely to include similar plants cut for fodder and carried to the animals, especially as hay or silage (Mutwedu *et al*. 2020).

The global feed and fodder industry : Feed and Fodder play an important role in the food industry globally in terms of economic. Feed is the largest and crucial element to ensure safe, abundant and affordable animal proteins throughout the world (Varijakshapanicker *et al*. 2019).

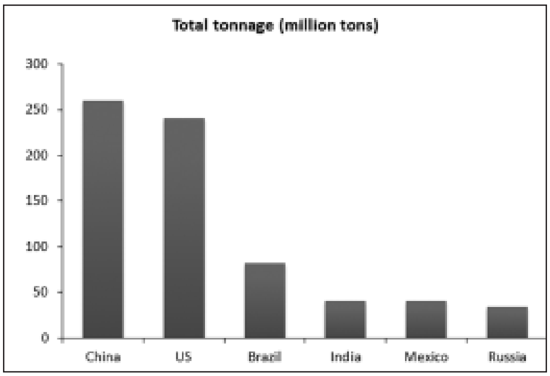

Fig. 1. Global feed tonnage (Source: Alltech 2023 Global Feed Survey)

Table 1. Feed requirement in India (Source: CLFMA2022; AHI Analysis)

Type	Requirement
Compoundfeedrequirement	80 mt (t)/year
Requirementfordairyanimals	30 mt (t)
Present market for compound dairy feed	5.5 mt (t)/year
Privatefeedsector	1.2 mt (t)
Dairycooperatives	2.5 mt (t)
Unorganizedsector	1.8 mt (t)

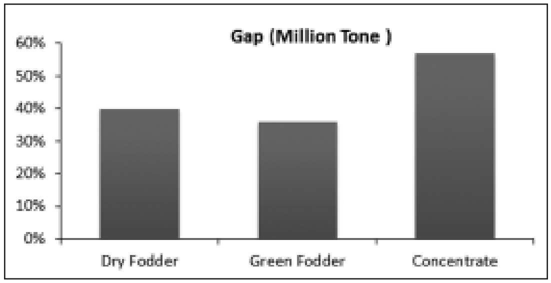

Fig. 2. Feed and Fodder Demand, Availability and Gap in India (Source: Annual Report Department of Animal Husbandry, Dairying & Fisheries14-15)

Purpose of processing

Tomakea profit : Processing methods like grinding, pelleting, orextrusion break down feed ingredients into more digestible forms. This enhances nutrientabsorption by animals, leading to improved feed efficiency and reduced wastage, ultimately lowering production costs (Behnke, K. C. 1996). Enhanced digestibility and nutrient availability through processing lead to better utilization of feed by animals. This results in improved growth rates, reproductive performance, and overall productivity, which directly contribute to increased profitability (Behnke, K. C. 1996). Certain processing techniques can enhance the palatability and texture offeed, stimulating animals to consume more. Higher feed intake translates to better nutrient intake,improvedgrowth, and ultimately higherprofitability forproducers (Lancheros *et al*, 2020).

To change moisture content : Indeed, altering moisture content in feed and fodder is a crucial aspect of processing, serving various purposes and ensuring safe storage and utilization. Here's how changing moisture content contributes to different objectives and the methods involved, along with specific moisture content guidelines for different types offeed(Uyeh, 2021). Proper moisture content prevents spoilage, mold growth, and the proliferation of harmful microorganisms during storage. Controlling moisture levels isessentialfor preserving feed quality and safety overtime (Amit *et al*. 2017).

Method store move moisture

a) Aeration with heat : This method involves using airflow and heat to evaporate excess moisture from feed. It is commonly used fordrying grains, hay, or other forage material stored ucemoisture content and prevent spoilage (FAO, 2011).

b) Aeration without heat : In this method, airflow is used to facilitate moisture evaporationwithout the addition of heat. It is often employed for drying feed materials at ambient temperatures or for reducing moisture content in enclosed storage facilities (FAO, 2011).

Moisture content guidelines for safe storage : Optimal moisture content for loose hay storage is around 25% to prevent mould growth and heating. Baledhay should ideally have amoisture content of 20-22% to minimize the risk of mould formation and maintain quality during storage. Chopped: For chopped feed, such as silage orhaylage, moisture content should range from 18-20% to ensure proper fermentation and preservation. Cubed feed should have a lower moisture content of 16-17% to prevent spoil ageand maintain integrity during storageand handling (FAO, 2011).

Them odern technologies use for feed processing given as under

Grinding : A hammer mill is usually used for grinding. There are many grinding chamber designs, including a half circle, a full circle, a teardrop and a split screen. Hammers, either fixed or free swinging, are attached to the rotor assembly. As the assembly rotates, the hammers impact and shatter the grain when they reach a critical 'tipspeed' (Lynch and Rowland, 2005). Finalparticle sizeis determined by the hole size in the screen. The grinding method is also commonly utilized by the feed industry to produce concentrate feeds and TMR while preventing feed materials separation Grinding mayincreasethe nutritional value offeeds by reducingthe particle size (Acosta *et al*. 2020). Increasing the surface are a of the in gested feed and facilitating digestion. This method is widely used in the pig and poultry industries. Grinding of corn increases the feed surface area and increases the digestibility of grain,resulting in improved grain utilization and productionin monogastric animals (Kiarie and Mills, 2019).

Pelleting : Coarsely grinded concent rate feed is mixed with binder substances like sodium bentonite and made into small cylindrical cubes called as pellets (Kaliyan, N. 2008). Compacts the mixed feed ingredients and increases nutrient density and bulk density. Improves palatability or acceptability anddige stibility offeeds. Improves the use of low density, bulky, unpalatable feeds that might not otherwise be practical to use. Heat applied during compaction of the pellet may also improvedige stibility and destroy thermo labiletoxic factors (Amoozmehr *et al*, 2023).

Heat treatment : Heat treatment is a common method used in feed processing to enhance the nutritional value, safety, and digestibility of animal feeds. The effects of heat treatment on feed can vary depending on the type of feed, the specific heat treatment applied, and the nutritional goals. Heat treatment can break down complex carbohydrates, proteins, and other nutrients, making them more digestible for animals. For example, starch gelatinization during heat treatment improves energy availability in grains (Anderson, R. A. 1984). Many feeds contain anti-nutritional factors (e.g., trypsin inhibitors in soybeans) that can hinder nutrient absorption. Heat treatment can denature these compounds, enhancing the nutritional value of the feed (Leszczynski and Liptay, 1995). Heat treatment is effective in reducing or eliminating pathogens like *Salmonella*, *E. coli*, and mold spores in feed. This is crucial for preventing the spread of disease among livestock (Hocking and Pitt, 1979).

Proper heat treatment can improve the flavor and aroma of feed, making it more palatable and increasing feed intake by animals (McNeill & Stanley, 1975).

Roasting : Roasting is accomplished by passing the grains/proteinous feeds through flame byheating them to more than 100°C at various exposure times The moisture content of the productisalso reduced.Corn and Soybeans- Increase availability of starches and proteins (Sanjay *et al*., 2015). Soybeans - Improves feed efficiency and gains by 10% over ground corn. Fats - higher content in rawbeans. Greatly increases availability and value of protein for monogastrics (Nahashon *et al*, 2011).

Extruding : Extrusion is a modern feed processing method widely used in the production of animal feed, especially for pets, aquaculture, and livestock. This technique involves forcing feed ingredients through a die under high pressure and temperature, resulting in a final product with improved digestibility, nutritional value, and shelf life (Sule *et al*., 2024) (Rokey *et al*., 2010).

Cubing : Cubing is a modern feed processing method that involves compressing feed ingredients into dense, uniform cubes. This method is particularly useful for processing forages like alfalfa, hay, and other fibrous materials, making them easier to handle, store, and transport while also potentially improving feed efficiency and intake (Sokhansanj and Turhollow, 2004) (Göhl, B. O. 1982).

Flaking : Flaking in modern feed processing is a critical technique used to enhance the nutritional value, digestibility, and palatability of feed ingredients for livestock. This process involves the application of heat, moisture, and mechanical pressure to feed grains, leading to the gelatinization of starches and the improvement of nutrient availability (Zinn *et al*, 2002) (Rasmussen and Smith, 2004).

Micronisation : Micronisation is a process which cooks the starch in the grains thus making it moredigestible for the animal. This process is called gelatinization. The micronisation process includesfirstly soaking (steaming) the grain and then passing it through high temperature. Infrared burnersand then finally rolling the grain. Microwaves emitted from infra-red burner @ 300°F by gas fired infra-red generators (Kipriyanov *et al*. 2023) (Parsons *et al*., 1997).

Urea Molasses Mineral Block (UMMB): Urea molasses mineral block is prepared by mixing urea, molasses, mineral mixtureand other ingredients in a suitable proportion. It is a readily available source of energy, proteinand minerals for the dairy animal. Supplementing an animal with UMMB would provideadequate quantity of these nutrients and slow ingestion of urea leads to efficient microbial protein production and improved digestibility.

NDDB has developed ‘coldprocess’ of manufacturing UMMB licks (three kg blocks) and the technology is being provided to dairy cooperatives, private or ganizations and other agencies. UMMB is very useful for milk producers in green fodder (Kerketta *et al*. 2017)

Conclusions

In conclusion, the review article underscores the critical role of modern technology in feed and fodder processing within the global context, particularly highlighting its significance for countries like India facing challenges in meeting the nutritional needs of their growing livestock populations. By enhancing the nutrient content, digestibility, and overall quality of animal feed, these technologies not only improve animal health and productivity but also contribute to the sustainability of livestock production systems. The article emphasizes the diverse array of processing methods available, such as grinding, pelleting, roasting, and extruding, each tailored to optimize feed characteristics based on specific nutritional requirements and production goals. Furthermore, it provides essential guidelines for the safe and effective implementation of these technologies, ensuring their beneficial impact on livestock performance and profitability. Overall, the comprehensive insights offered serve to underscore the transformative potential of modern feed processing technologies in addressing the evolving challenges and opportunities within the global livestock industry.

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