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Feeds and Feeding During Natural Calamities: A Review Article

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ABSTRACT

Natural calamities such as droughts, floods, cyclones, earthquakes, and tsunamis pose a serious threat to livestock production systems, particularly in developing countries like India. These disasters lead to acute shortages of feed, fodder, and drinking water, thereby compromising livestock survival, productivity, and farmers' livelihoods. Feed security during disasters is as critical as food security for humans, as the survival of livestock ensures post-disaster recovery and income generation. This review compiles and critically discusses various feeding strategies and nutritional interventions aimed at sustaining livestock during and after natural calamities. Emphasis is placed on restricted feeding, efficient water management, utilization of conserved and non-conventional feed resources, densification technologies, hydroponic fodder production, and strategic supplementation through urea–molasses multi-nutrient blocks. Adoption of these approaches can significantly reduce livestock mortality and morbidity and facilitate faster recovery through compensatory feeding once normal conditions are restored.

Keywords: Natural disasters, feed scarcity, livestock nutrition, drought feeding, unconventional feeds, disaster management

1. INTRODUCTION

India is among the top ten most disaster-prone countries in the world and is frequently affected by a wide range of natural calamities such as droughts, floods, cyclones, earthquakes, famines and tsunamis (Bhagwat, 2008). In recent decades, the frequency and intensity of these disasters have increased considerably, largely due to climate change, global warming, erratic rainfall patterns and extreme weather events. In addition to natural disasters, man-made or induced calamities such as industrial accidents, transport mishaps, environmental pollution and destruction of natural habitats further aggravate the vulnerability of livestock production systems. Although man-made disasters may not always cause direct animal mortality, they often disrupt feed supply chains, grazing resources and water availability, thereby indirectly affecting animal health and productivity.

Livestock plays a crucial role in the Indian agricultural economy by providing milk, meat, draught power, manure and income security to millions of small and marginal farmers. During natural calamities, livestock losses can be enormous and have long-term socio-economic consequences. In rural areas, animals often serve as movable assets and act as insurance against crop failure. Therefore, feed security during disasters is as important as food security for humans, as the survival of livestock ensures livelihood security and facilitates faster recovery of farming families after the calamity (Bakshi et al., 2018).

Developing countries like India already face a chronic shortage of feed and fodder resources, and this deficit is further aggravated during natural disasters due to destruction of standing crops, crop residues, grazing lands and fodder storage facilities. Hydro-meteorological disasters severely disrupt transportation networks, making it difficult to move feed and fodder from surplus to deficit areas. Moreover, the bulky nature of conventional feeds such as straw, hay and green fodder increase transportation costs and limits their availability in emergency situations. As a result, livestock are often exposed to prolonged periods of undernutrition and water scarcity.

During natural calamities, the primary objective of feeding management is to ensure the survival of animals rather than the maintenance of high productivity. Restricted feeding strategies aimed at maintaining animals above a critical body weight become essential under such circumstances. Preferential feeding of productive and vulnerable stock such as pregnant, lactating and breeding animals is often recommended to safeguard future herd productivity (Thole et al., 1993). Ruminants are particularly vulnerable during disasters, as they largely depend on crop residues, common property grazing lands and pastures, which are severely affected during droughts and floods. Acute shortage of feeds and fodder continues to be one of the major constraints to livestock productivity in India, especially during periods of natural calamities (Bhagwat, 2008).

In this context, the development and adoption of appropriate feeding strategies during natural disasters are essential components of livestock disaster management. Scientifically planned nutritional interventions can reduce animal mortality, minimize production losses and enhance resilience of livestock systems. The present review focuses on various feeding strategies and technologies that can be effectively used to manage feed scarcity during natural calamities and support recovery of livestock production systems in the post-disaster period.

2. Principles of Feeding Strategies During Natural Calamities

The formulation of feeding strategies during natural calamities should be based on well-defined nutritional and physiological principles, with the primary objective of ensuring animal survival under conditions of severe feed and water scarcity. The first priority during any disaster situation is to prevent starvation and excessive body weight loss, while the second priority is to sustain the productivity of the surviving animals. Under emergency conditions, feeding for maintenance rather than production becomes the guiding principle of livestock nutrition.

Preferential feeding of productive and vulnerable stock such as pregnant, lactating and breeding animals is strongly recommended during natural calamities, as these categories of animals contribute directly to future herd productivity and livelihood security (Thole et al., 1993). Non-productive, aged or weak animals may be subjected to more stringent feed restriction or early

disposal to reduce pressure on limited feed resources. Such strategic allocation of feed helps in optimizing the use of scarce resources and minimizing overall livestock losses.

Body weight loss is a critical indicator of survival during prolonged periods of undernutrition. It has been reported that cattle are unlikely to survive if body weight loss exceeds 20% of their critical body weight, whereas sheep and camels can tolerate losses of up to 30% due to their greater adaptive capacity (Young and Scrimshaw, 1971). Animals with adequate body fat reserves at the onset of a disaster are more resilient, as fat serves as the primary source of energy during periods of negative energy balance. Mortality during droughts and other prolonged calamities is often associated with the complete exhaustion of body fat reserves.

Restricted feeding is an important adaptive strategy during feed scarcity. During periods of restricted nutrient intake, animals undergo metabolic adjustments to reduce energy expenditure and enhance survival. Basal metabolic rate is reduced primarily due to a decrease in the size and metabolic activity of visceral organs such as the liver and gastrointestinal tract (Ortigues and Durand, 1995). Additionally, there is a shift in nutrient utilization patterns, wherein adipose tissue releases increased amounts of free fatty acids and the liver produces ketone bodies, which are utilized by muscles and other extra-hepatic tissues as alternative energy sources (Bossart et al., 1985). These physiological adaptations enable animals to survive longer under conditions of limited feed availability.

Another important principle of feeding during natural calamities is the efficient utilization of low-quality roughages. Since high-quality concentrates and green fodders are often unavailable during disasters, animals are largely dependent on crop residues and dry roughages. Strategic supplementation with small quantities of nitrogen, energy and minerals can significantly improve the digestibility and intake of such feeds by enhancing rumen microbial activity. Therefore, balanced supplementation rather than ad libitum feeding should be emphasized during emergency situations.

Overall, feeding strategies during natural calamities should aim at minimizing body weight loss, maintaining animals above critical survival thresholds, and preserving the productive potential of the herd. Scientifically planned nutritional interventions based on these principles play a vital role in reducing livestock mortality and ensuring faster recovery once normal feeding conditions are restored.

3. Water Management During Natural Calamities

Adequate availability of drinking water is a critical component of livestock survival during natural calamities, particularly during droughts and prolonged heat stress conditions. Water plays an essential role in regulating body temperature, maintaining cellular homeostasis, facilitating digestion and absorption of nutrients, and enabling metabolic waste removal. During disasters, scarcity of drinking water often poses a greater threat to livestock survival than feed shortage, as animals can withstand feed deprivation for longer periods compared to water deprivation.

Water requirements of livestock vary depending on environmental temperature, physiological status, level of production and dry matter intake. Lactating animals and growing stock have significantly higher water requirements compared to non-productive animals. Lactating cows typically require about 2.5–4.5 litres of water per kilogram of dry matter intake under normal conditions (Patil, 2006).

During periods of heat stress and drought, water requirements may increase further due to elevated evaporative losses and reduced feed intake.

Under conditions of water scarcity, strategic water management practices become essential to ensure survival of livestock. One such practice is the reduction in watering frequency. In large ruminants, watering once every two to three days has been found to be a feasible strategy during drought situations (Leng, 1986). Reduced watering frequency lowers overall water and feed intake, which may help animals adapt to limited resource availability. In some cases, this practice has also been associated with improved feed digestibility and feed conversion efficiency due to slower rate of passage of digesta through the gastrointestinal tract.

However, prolonged or severe water deprivation can have serious physiological consequences. Dehydration leads to reduced blood volume, impaired thermoregulation and decreased nutrient transport. It is often accompanied by increased protein catabolism, electrolyte imbalance and accumulation of nitrogenous wastes in the body. In extreme cases, prolonged dehydration may result in renal dysfunction and eventual failure, leading to increased mortality. Therefore, while controlled watering strategies may be adopted during moderate water scarcity, complete deprivation of drinking water should be strictly avoided.

In disaster situations such as floods and cyclones, availability of water may not be a limiting factor, but water quality often becomes a major concern. Floodwaters can contaminate drinking water sources with pathogens, chemicals and organic debris, increasing the risk of water-borne diseases. Provision of clean and safe drinking water through protected sources, temporary storage tanks or treated water is essential to prevent disease outbreaks and ensure animal health.

Overall, efficient water management, along with appropriate feeding strategies, plays a crucial role in minimizing livestock losses during natural calamities. Ensuring minimum water availability and maintaining water quality are indispensable components of disaster preparedness and livestock resilience.

4. Strategies to Improve Feed Utilization and Availability During Natural Calamities

During natural calamities, the availability of feed resources is severely constrained due to destruction of crops, grazing lands and fodder reserves, as well as disruption of supply chains. Under such circumstances, efficient utilization of available feed resources becomes as important as increasing feed availability. Adoption of appropriate feed processing, conservation and management strategies can significantly reduce feed wastage and enhance the nutritive value of low-quality feeds, thereby improving livestock survival.

4.1 Reduction of Feed Wastage Through Processing

Reduction of feed wastage is one of the simplest and most effective strategies during periods of feed scarcity. Processing of crop residues and roughages, particularly chaffing or chopping, helps in improving intake and reducing selective feeding by animals. When straw is offered unchaffed, a significant proportion is wasted due to trampling and refusal. It has been reported that about 15–20% of straw is refused when fed in unchaffed form, whereas chaffing considerably reduces wastage

and improves overall utilization (Shukla et al., 1988). Chaffing also facilitates uniform mixing of supplements such as concentrates, molasses or urea, ensuring balanced nutrient intake.

4.2 Restricted Feeding as a Survival Strategy

Restricted feeding is a commonly adopted practice during natural calamities when feed availability is insufficient to meet normal requirements. This strategy involves deliberate reduction in feed allowance to maintain animals above critical survival thresholds. Restricted feeding leads to metabolic adaptations that reduce energy expenditure and enhance feed efficiency. Basal metabolic rate decreases primarily due to reduced mass and metabolic activity of visceral organs (Ortigues and Durand, 1995). Such physiological adjustments enable animals to survive longer under conditions of limited nutrient supply.

From a practical standpoint, restricted feeding should be applied judiciously, with priority given to breeding, pregnant and lactating animals. Supplementation with small quantities of energy- and protein-rich feeds can help minimize excessive body weight loss and maintain essential physiological functions.

4.3 Use of Conserved Fodders

Conserved fodders such as hay, silage and dried roughages play a vital role in bridging the gap between feed demand and supply during droughts, floods and other disasters. These fodders can be transported from surplus to deficit regions and stored for emergency use. Properly conserved fodders retain much of their nutritive value and can serve as the main roughage source during calamities. Establishment of fodder banks and strategic reserves at regional and district levels can greatly enhance preparedness for future disasters.

Overall, improving feed utilization through processing, restricted feeding and efficient use of conserved fodders is essential for minimizing livestock losses during natural calamities. These strategies, when combined with appropriate supplementation, contribute significantly to sustaining animal health and productivity under adverse conditions.

5. Alternative and Innovative Feeding Options During Natural Calamities

Natural calamities often create situations where conventional feed and fodder resources are either unavailable or insufficient to meet the nutritional requirements of livestock. Under such conditions, alternative and innovative feeding options play a crucial role in sustaining animal health and survival. These approaches focus on maximizing the use of locally available resources, reducing dependence on conventional fodders, and improving the efficiency of nutrient delivery during emergency situations.

5.1 Hydroponic Fodder Production

Hydroponic fodder production has emerged as a promising alternative for addressing acute shortages of green fodder during natural calamities. Hydroponic fodder is produced by germinating cereal or legume seeds using water without soil, under controlled environmental conditions. This system requires minimal land and water and allows rapid production of nutritious green fodder within a short period of 7–10 days. Low-cost hydroponic units, consisting of simple greenhouse structures made

of polyethylene sheets fixed on wooden or metal frames, can be easily established even in disaster-affected areas (Bakshi et al., 2017).

Hydroponic fodder is highly palatable and digestible and provides essential vitamins, enzymes and antioxidants. Although it may not completely replace conventional green fodder, it serves as an effective supplementary feed during emergencies, particularly for lactating and young animals.

5.2 Feeding of Non-Conventional Feed Resources

Non-conventional feed resources assume great importance during natural calamities when conventional feeds are scarce or expensive. These feed resources include a wide range of agro-industrial by-products, tree-based feeds and locally available materials that are otherwise underutilized. Incorporation of such feeds helps reduce the feed deficit and lowers the cost of feeding during emergency situations.

Several non-conventional feed resources have been identified for use in livestock rations, including mahua (*Madhuca indica*) seed cake and flowers, salvadora deoiled cake, subabul (*Leucaena leucocephala*) seeds, seaweeds (*Sargassum* spp.), rain tree pods (*Pithecolobium saman*), tomato processing waste, isabgul by-products, neem cake, kusum cake, palm male flowers, jowar gluten and cake, and banana root bulbs (Patil, 2006). Proper processing, detoxification and balanced supplementation are essential to ensure safe and effective utilization of these resources.

5.3 Urea–Molasses Multi-Nutrient Blocks (UMMBs)

Urea–molasses multi-nutrient blocks are widely recognized as an effective and economical method of strategic supplementation during natural calamities. UMMBs provide a balanced source of fermentable energy, nitrogen and essential minerals, which are often deficient in low-quality roughages commonly fed during disasters. Supplementation with UMMBs enhances rumen microbial activity, improves digestion of fibrous feeds and increases the availability of microbial protein and volatile fatty acids to the host animal (Bakshi et al., 2018).

UMMBs are easy to transport, store and distribute, making them particularly suitable for emergency feeding programmes. Their controlled intake through licking ensures safety and sustained nutrient supply, enabling animals to survive until pasture and feed conditions improve.

6. Feed Processing and Densification Technologies for Disaster Management

During natural calamities, one of the major challenges in livestock feeding is the transportation and storage of bulky feed resources. Feed processing and densification technologies play a crucial role in overcoming these constraints by reducing volume, improving handling efficiency and ensuring uniform nutrient supply. These technologies enable effective utilization of crop residues and agro-industrial by-products, thereby minimizing feed shortages during emergency situations.

6.1 Baling and Densification of Crop Residues

Crop residues such as rice straw, wheat straw and maize stover constitute a major proportion of livestock feed resources in India. However, their low bulk density makes transportation to disaster-affected areas costly and inefficient. Baling of crop residues using manual or automatic balers converts loose straw into compact bales, significantly reducing transportation and storage costs.

Automatic balers are capable of producing uniform, high-density bales that are easy to stack, handle and transport over long distances.

The use of baled straw has proven effective in providing emergency fodder during floods and droughts. Timely collection and baling of crop residues from surplus regions can ensure rapid supply of fodder to deficit areas, thereby preventing large-scale livestock mortality (FAO, 2012).

6.2 Densified Complete Feed Blocks (DCFBs)

Densified complete feed blocks are nutritionally balanced rations designed to meet the daily nutrient requirements of ruminants in a compact form. These blocks are prepared by compressing a mixture of roughages, concentrates, minerals and additives into solid blocks that can sustain animals for a 24-hour feeding period. The compact nature of DCFBs makes them particularly suitable for disaster relief operations, as they are easy to transport, store and distribute.

Feeding trials have demonstrated that DCFBs can maintain body weight and production performance in ruminants even when conventional feeding systems are disrupted. Their use during natural calamities helps prevent starvation, reduces feed wastage and ensures uniform intake of nutrients by animals (Thole et al., 1993).

6.3 Densified Complete Feed Pellets (DCFPs)

Densified complete feed pellets represent another effective feed processing technology for emergency feeding. These pellets are typically produced by grinding and mixing roughages such as crop residues with energy and protein supplements, followed by pelleting. Straw-based pellets generally contain crushed straw, molasses, de-oiled rice bran, oilseed cakes, urea, minerals and common salt, providing a balanced and easily digestible ration.

Pelleted feeds offer several advantages, including reduced bulk, improved palatability and enhanced nutrient utilization. Their uniform composition prevents selective feeding and ensures consistent nutrient intake. Due to their ease of handling and long shelf life, densified feed pellets are highly suitable for feeding livestock during prolonged disaster situations.

7. Role of Tree Fodders and Silvipastoral Systems in Mitigating Feed Scarcity

Tree fodders and silvipastoral systems play a vital role in sustaining livestock during natural calamities, particularly in arid, semi-arid and drought-prone regions. Trees and shrubs are generally more resilient to climatic extremes than annual fodder crops due to their deep root systems, which allow them to access moisture from deeper soil layers. As a result, they continue to provide green biomass even under adverse environmental conditions.

Tree leaves, pods and twigs serve as valuable sources of protein, minerals and vitamins during periods of fodder scarcity. Species such as *Leucaena leucocephala*, *Prosopis cineraria*, *Acacia* spp., *Albizia lebbeck*, *Bauhinia* spp. and *Sesbania* spp. are widely recognized for their fodder potential. Large-scale afforestation and social forestry programmes in India have highlighted the importance of tree fodders as emergency feed resources during droughts and floods (Patidar, 2006).

Silvipastoral systems, which integrate trees, forage crops and livestock on the same land unit, offer a sustainable approach to reducing feed shortages and improving ecosystem resilience. These

systems enhance fodder availability, improve soil fertility through nutrient recycling, reduce soil erosion and provide additional income through timber, fuelwood and non-timber forest products. The selection of appropriate tree, grass and legume species in silvipastoral systems depends on regional agroclimatic conditions such as rainfall pattern, soil type and temperature.

In the context of disaster management, silvipastoral systems act as a buffer by ensuring a continuous supply of fodder even when annual crops fail. Promoting the establishment of region-specific silvipastoral models can significantly strengthen the resilience of livestock production systems and reduce vulnerability to future natural calamities.

8. CONCLUSION

Natural calamities pose serious challenges to livestock production systems by disrupting the availability of feed and water and adversely affecting animal health, productivity and survival. In disaster situations, ensuring feed security for livestock is as important as food security for humans, as livestock play a critical role in sustaining rural livelihoods and supporting post-disaster recovery. The primary objective of feeding during calamities should be the survival of animals, with emphasis on protecting breeding and productive stock.

Adoption of appropriate feeding strategies such as restricted feeding, efficient water management and reduction of feed wastage can significantly enhance livestock resilience during periods of acute scarcity. The use of conserved fodders, non-conventional feed resources, urea–molasses multi-nutrient blocks and hydroponic fodder provide practical and cost-effective solutions for meeting nutritional requirements under emergency conditions. In addition, feed processing and densification technologies, including baling of crop residues and production of densified complete feed blocks and pellets, facilitate easy transportation, storage and uniform nutrient supply during disasters.

Tree fodders and silvipastoral systems offer sustainable long-term solutions by ensuring fodder availability under harsh climatic conditions and improving ecosystem stability. Once normal conditions are restored, compensatory feeding is essential to enable affected animals to regain lost body weight and productivity. Overall, systematic planning, preparedness and adoption of scientifically validated feeding strategies can substantially reduce livestock mortality and morbidity during natural calamities and contribute to strengthening the resilience of livestock production systems in disaster-prone regions.

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