



## Lameness and Its Dietary Management in animals

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### *Abstract*

Lameness is one of the most important and economically demanding diseases in livestock, manifested with change in locomotion and associated with not only a welfare problem, but also affect production and profit. Nutrition as one of the important predisposing factors causing lameness in animals. The review focus on incidence and dietary management of lameness in livestock. Excessive grain and/or concentrate feeding and high ratio of non-fiber carbohydrate to neutral detergent fiber affects the gastrointestinal functioning result in lameness. Besides, high dietary protein content, vitamin and mineral deficiencies/ imbalances and some anti-nutritional factors are other dietary causes leading to lameness in animals Feeding management is perhaps the single most effective means to reduce the occurrence of lameness in animals as a sustainable strategy.

**Keywords:** Diet, Lameness, Livestock, Nutrition

### **Introduction**

Most disease conditions in animals are affected by the diet offered to them. Diet plays a pivotal role in both the genesis and management of several common diseases/ conditions of livestock. For some conditions and diseases this may simply be related to adverse effects of inadequate nutrient intake associated with hyporexia or anorexia of illness. Moreover, changes in type and quality of feed may predispose animals to a range of problems. For many disease conditions, there are specific nutritional management interventions. Feeding of clinically diseased animals should be based on their nutritional requirements while giving due importance to their natural diet, feeding behavior and frequency of feeding. Affected animals often have decreased appetite and weight loss, hence palatability is one of the most important factors deciding the effectiveness of diet for which the quality of the feed ingredients need to be chosen accordingly. Highly digestible ingredients compensate for decreased activity of intestinal enzymes ensuring an optimal nutrient supply. Supplementation of all essential nutrients as protein, fats and carbohydrates (energy) and micro-nutrients (minerals and vitamins) helps in faster



recovery from illness in livestock. The diseased animals need to be encouraged to consume different good quality forages for ensuring proper gastro-intestinal health. Besides, provision of nutraceuticals helps to promote good health in livestock. Lameness is a common cause of welfare and economic concerns in animal agriculture. Lameness is described as a clinical symptom, which is recognizable by a change in locomotion caused by either a structural or functional disorder of locomotor system. More than 90 percent of diagnosed lesions affect the distal part of limb (Daros *et al.*, 2019); however, resulting lesions are not only a welfare problem, but also affect production and profit (Jewell *et al.*, 2019). Burger (2017) reported that 27 percent of costs of production diseases is due to lameness problems. Lame animals have lower dry matter intake (Havlicek, 2014), poor production performance (Novotna *et al.*, 2019), reduced fertility (Coetzee *et al.*, 2017) and have higher risk of culling (Barbosa *et al.*, 2020). There are many causes of lameness which are classified as degenerative, developmental, metabolic, infectious, inflammatory and traumatic. Developmental and metabolic causes of lameness are found to be more in young growing animals and degenerative causes in aged ones. Predisposing factors which also contribute significantly to lameness in livestock include management like hoof trimming, flooring, animal comfort, stall dimensions, environment and nutrition (Chesterton *et al.*, 1989). Nutritional factors moderate the incidence and severity of lameness by contributing to occurrence of laminitis. The causes of lameness vary widely and are significantly influenced by species, breed, age, sex and nutrition of animal. This article provides an overview of lameness in different livestock species and role of diet in management of lame animals.

### **Lameness in Small Ruminants**

The lameness has a huge impact worldwide on the economics of small ruminant production. Incidence of lameness in small ruminants is higher during wet months. Overgrown hooves and traumatic injuries are important predisposing factors (Henneman, 2013). Although there are many causes of lameness in small ruminants, the major conditions being: (1) interdigital dermatitis, caused by *Fusobacterium necrophorum* due to impaction of interdigital space with mud, grass or manure (2) foot rot, caused by *Dichelobacter nodosus* following an initial interdigital infection with *Fusobacterium necrophorum*, (3) contagious ovine digital dermatitis (CODD), (4) toe abscess due to impaction of gap (Shelly hoof) by dirt and debris resulting in pus formation, (5) foot abscess *i.e.* deep sepsis of pedal joint, (6) toe granulomas are a common result of over-trimming causing bleeding and very vascular outgrowths of granulation tissue which rarely heal untreated, but often become covered by loose horn.



## Lameness in Large Ruminants

Lameness is currently one of the most critical problems in dairy farming affecting animal health and welfare (Langova *et al.*, 2020), with a reported annual incidence of 10-14 percent (Westwood and Lean, 2001). After mastitis and reproductive problems, lameness is regarded as the third most expensive disease to treat in dairy animals (Thompson *et al.*, 2019). At least 10 percent of cows in a herd are culled for reasons related to lameness. The prevalence of lameness in dairy herds is generally estimated at around 25-35 percent with considerable differences among the countries due to variation in their agricultural conditions (Holzhauer *et al.*, 2012); however, under Indian conditions, the prevalence of clinical lameness in lactating cows and buffaloes is about 9 and 2 percent, respectively and 40-50 percent cows have sub-clinical lesions (Randhawa, 2006). Cows in poor condition have a greater pre-disposition to lameness. Cows that are lame before breeding have a reduced ability to conceive and cystic ovaries are much more common in lame cows. Lame cows are less aggressive in their struggle for feed and are more likely to die early or be culled. Lameness in large ruminants can be caused by infectious or non-infectious agents. Non-infectious lesions are associated with loss of tissue integrity due to traumatic events, excessive wear, nutritional deficiencies or unduly hoof modification, which may provide the primary gateway for infection. Non-infectious lesions include laminitis (Pinedo *et al.*, 2017) which is associated with metabolic disease more often secondary to rumen acidosis (Alvergnas *et al.*, 2019) and is reported to be one of the most common causes of lameness in dairy cattle (Bergsten *et al.*, 2003). Other lesions of limb disease include white line disease, sole ulcers, heels erosion, hemorrhages, strains of tendons and joints, arthritis and others. One main cause of lameness in dairy cattle is pain in limbs, especially in foot, hind feet are found to be more affected than front feet (Blowey, 2005).

## Lameness in Equines

Incidence of lameness is always high in equines. In horses, lameness is common in fore limb than in hind limb (Bokko *et al.*, 2003). Common causes of lameness in horses are degenerative conditions like degenerative joint disease (DJD or osteoarthritis), developmental abnormalities like osteochondrosis (OCD), physitis (epiphysitis), metabolic diseases like laminitis, exertional rhabdomyolysis (tying up), mechanical conditions (overload), infectious causes like foot abscess, infected wound, cellulitis, joint infection, inflammatory and traumatic causes. Age and duration of service is not found to be significantly different between lame and non-lame population of horses. Laminitis is one of the most common conditions in horses, the condition being also known as founder, has a range of inciting causes, but all result in a common pathologic consequence and consistent clinical



signs. Although the exact mechanism for occurrence of laminitis in horses has not been definitely determined; however, a digestive and/or metabolic disturbance is postulated (Geor, 2009). Laminitis is caused by issues associated with dietary factors such as carbohydrate overload and overfeeding or pasture induced. Metabolic problems such as equine metabolic syndrome (obesity and insulin resistance), Cushing's syndrome (overproduction of corticosteroid hormones by adrenal gland), excessive use of corticosteroids to treat inflammation and hyper-insulinaemia are predisposing factors for laminitis development in equines. Traumatic laminitis is caused by trimming the hoof wall's bearing border to the level of the sole and housing the horses on hard footing for extended periods. Moreover, pregnancy-associated laminitis has been reported in mares (Johnson *et al.*, 2009).

### **Lameness in Swine**

The prevalence of lameness in swines is estimated between 8-17 percent (Kilbride *et al.*, 2009) and is considered as one of the main reasons for premature culling or euthanasia of breeding animals from the herd. In pigs, lameness is a multi-factorial condition that depends on managerial as well as genetic variables. Herd health, nutrition, trauma, flooring and group management, as well as limb conformation, all play a role in development to lameness. In piglets, rough and abrasive floors are found to be an important cause of lameness. Claw and foot lesions as cause of lameness are extremely common, with a prevalence varying from 88-100 percent (Pluym *et al.*, 2011). The high prevalence of claw lesions may be linked with intensive farming of pigs on concrete floors, with minimal or no bedding and the selection towards highly productive sows and fast growing pigs in today's swine industry. Lameness affects the viability, growth, reproduction and cause severe economic loss in pigs.

### **Lameness in Canine**

Lameness is very common in dogs due to their active nature. Musculoskeletal disorders are found to be more common cause than neurological disorder in dogs (Scott and Witte, 2011). Apart from fractures, the other important causes of lameness include hip dysplasia, hip dislocation, nerve paralysis, vitamin and mineral deficiencies etc. Age, sex and breed of animals also influence the type and cause of lameness. Skeletal disorders are found to be more in large breeds that occur during the period of rapid growth up to two years of age. Lameness in hind limb is commonly associated with stifle (cranial cruciate ligament disease) and hip (hip dysplasia). Conditions like hind quarter weakness are found to be more in males than in female animals and causes are degenerative myelopathy, injury to spinal cord, Cushing's disease, diabetes and arthritis. Hip dysplasia was found mostly in German Shepherds and Spitz due to its increased activity is found to be very prone to all conditions of lameness like nerve



injuries, dislocations and wounds. Shifting lameness has been reported in dogs diagnosed for Lyme disease (Wright, 2013).

### **Dietary Management of Lameness**

Among the major predisposing factors for laminitis principally contributing to lameness in livestock is the nutrition. Animals that have suffered from hoof disorders in the past are more likely to develop other diseases, especially white line disease, digital dermatitis, sole ulcers and hemorrhages, which are all related to feeding (Alvergnas *et al.*, 2019). Laminitis is closely associated with digestive disturbance, with production of excessive organic acids in gastro-intestinal tract. Rapid urbanization has limited the availability of cultivable land, which in turn leads to reduction in production and availability of fiber resources for animal feeding resulting in increased dependence on concentrate feed resources. Feeding of high grain/concentrate diet to the animals in order to fasten growth or optimize milk production predispose animals to laminitis contribute to incidence of lameness. Occurrence of laminitis also reflects improper ration formulation or feeding management. The major nutritional factors contributing to lameness in livestock include:

- High carbohydrate diet
- Low dietary fiber
- High dietary protein
- Vitamin disorders
- Mineral deficiencies
- Dietary anti-nutritional factors

The nutritional management to maintain an ideal GIT functioning is perhaps the single most effective means to help improve and maintain musculo- skeleton and hoof health for reducing the occurrence of lameness in animals. These include:

1. Ensure optimum fiber in diet and at least 15 percent of fiber particles should exceed 1.5 inches in length. Forage neutral detergent fiber (NDF) should exceed 19-21 percent depending on forage digestibility and inclusion level of non- forage fiber. Magrin *et al.* (2020) reported reduced risk of hoof infectious diseases in beef cattle that were fed a diet containing increased NDF.
2. Avoid excessive grain/ concentrate (containing >28% starch) feeding and enhance use of slowly fermentable polysaccharides. Add buffers such as Sodium bicarbonate (100-150 gm per day) to lactation diets. Use total mixed ration. Feed forages before grain or concentrates if total mixed ration is not used.



3. Prevent sudden changes in diet, which cause shift in composition of GIT microbiota. The microbiota is not quick enough to adapt to rapid dietary changes which can lead to GIT function disorders.
4. Only a small dose or none of concentrates should be offered to animals during the dry period. The dose should be increased just before and after parturition. Excessive concentrate feeding during the dry period causes hyperinsulinemia and hyperglycemia in early phase of lactation, which are classic symptoms of insulin resistance.
5. Follow transition ration. Use minimum of two rations (close-up dry cow and fresh cow rations) for rumen adaptation during transition period. Do not change the energy level between transition rations to more than 10 percent.
6. Feeding animals as per their body requirements to maintain a lean body condition over the animal's lifetime to prevent obesity as weight management strategy. Obesity is known to increase stress on joint structures and articular cartilages. Reduction by 11-18 percent of initial body weight has been reported to significantly decrease hind limb lameness in animals (Perea, 2012).
7. Feeding of diets that delivers a high levels of long chain polyunsaturated fatty acids specifically eicosapentaenoic acid (EPA) and docosaheptaenoic acid (DHA) and a low omega-6 to omega-3 fatty acid ratio (<5:1) may help to modulate the inflammatory response related to lameness in animals.
8. Inclusion of glucosamine and chondroitin sulphate in commercial pet foods serves as precursors for glycosaminoglycans and other components of articular cartilages. Besides, these additives suppress proteolytic enzymes and inflammatory cytokines related to lameness for clinically benefiting the animals.
9. The use of supplemental antioxidants at boosted levels is advocated to help manage the excessive production of free radicals associated with clinical lameness as therapeutic strategy.
10. Supplementation of minerals and vitamins to overcome the dietary deficiencies is associated with reduction in incidence of lameness in animals. Animals are estimated to require several minerals especially calcium, phosphorus, zinc, copper, manganese, selenium, iodine or sulphur amino acids in their diet which play a considerable role in specific biochemical pathways that are associated with keratin synthesis determining the structural strength of hooves/claws and rigidity of skeleton. Vitamins A, C, D and E play a notable role in reducing the incidence of lameness by regulating calcium metabolism and affecting keratinisation.



11. Probiotics as cultures of *Saccharomyces cerevisiae* can be added to the ration of animals to improve fermentation and promote beneficial changes in digestive processes. Yeast cultures stimulate the growth of beneficial microbiota in gut, which use lactic acid minimizing the risk of acidosis and thus predisposition to laminitis and subsequent lameness.

## Conclusion

Nutrition is one of the most important predisposing factors for lameness in animals, which is currently a critical problem in livestock farming affecting animal health, production economics and welfare. It is a crucial preventive factor, as it acts as a first line of defence in maintaining the limb health including hoof integrity. Nutritional deficiencies lead to weak skeleton susceptible to bone disorders, formation of fragile horn which is prone to cracks and infections. Non-infectious diseases causing lameness include, in particular laminitis. In case of limb diseases, prevention is necessary, which is economically much less expensive than treatment of painful lesions. The importance of limb health is expected to increase with increasing intensification of livestock farming. Limb health management requires a team approach involving the farmer, veterinarian and nutritionist.

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