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A Review Study on Legs Lameness and Weaknesses Assessment Methods in Commercial Broiler Farming in Pakistan

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ABSTRACT

First, a brief history of chickens was discussed, followed by an investigation of the term "leg weakness" and what it implies in the broiler industry. Leg weakness is a broad phrase that refers to infective and non-infectious characteristics found in contemporary, fast-growing broilers. Commercially raised modern broilers are prone to foot issues such as lameness, footpad dermatitis, and hock burn. Lameness is a broad word that refers to a variety of injuries in commercial poultry caused by infectious and non-infectious sources. In the poultry business (Broiler, Breeders and Layers), lameness is a major issue. In 2010, the expense of lameness was estimated to be between $80 million and $120 million in the United States. However, it has been established in the literature that lameness is closely linked to weight, growth rate, and activity. In 80 years, the time it takes for a chick to attain a live weight of 1500 g was decreased from 120 days to 30 days. Broiler chicks have had serious difficulties as a result of their rapid growth. Animals with serious issues, for example, have poorer feed efficiency and growth. The value of these animals' carcasses has likewise been reduced. In addition to the welfare issues that have arisen as a result of leg difficulties, the producers have also suffered financial losses. As a result, the initial goal of this study is to evaluate broiler leg deficiencies and offer readers with a brief explanation of the elements that influence this condition. The second goal of this research is to examine commercial poultry lameness and lameness evaluation techniques. Furthermore, the benefits and drawbacks of various approaches are explored. Brief findings and a reference list may be found at the end of this review.

Introduction

The poultry business has expanded dramatically over the last fifty years, with more than 35 billion broiler birds produced each year [1]. Due to the economic benefits of increasing body weight, the need for enhanced growth rate and output has resulted in differential growth of body components, such as rapid muscular growth [2]. This expansion, however, is not accompanied by skeletal development. Lame broilers have trouble walking and, as a result, they can't go to the feeder or drinker when they are hungry or thirsty [2]. Their quality of life is being harmed by their laziness. The presence of lameness in birds is significantly linked to their weight and fast development [3]. Furthermore, the broilers may experience discomfort as a result of mobility issues. It can reduce

bird's activity and cause a variety of issues, such as hock burns and chest dirtiness [4]. Broiler chicks are protected against frailty by a rapid development rate coupled by appropriate feeding, good management, ideal lighting and temperature, and a disease-free environment [5]. Leg diseases are caused by the lack of any of these components in combination with inherent weight-bearing features [3]. Infectious, developmental, metabolic, and degenerative diseases can all cause leg weakness. Leg ailment is associated with a higher rate of morbidity than mortality [3]. The handicapped bird, on the other hand, suffers from discomfort, is unable to obtain food and water, and eventually dies from inanition [6]. As a result, the initial goal of this study is to evaluate broiler leg deficiencies and offer readers with a brief explanation of the elements that influence this condition [7]. Nutritional deficiencies, mechanically produced injuries, toxins, genetic abnormalities, infections infectious illnesses, sex, weight and development rate, age, feed conversion efficiency, handling, and mobility are all variables that contribute to leg weakness [8]. The second goal of this research is to examine broiler lameness and lameness evaluation techniques.

Leg Problems

Broiler nutritional and physical density rose as a result of the food modifications. Higher nutrient intakes, as well as a combination of these two variables, have resulted in a significant increase in broiler growth rates [9]. To use this genetic potential for growth, the time until the chick reaches a live weight of 1500 g was lowered from 16 weeks to 4 weeks. Good highly concentrated feed in pellet form and intensive lighting cycles are necessary [10]. A high body weight has also been chosen for the creation of more breast muscles, in addition to a selection for quick growth to rap to accomplish. This causes the chicks' conformation to alter, which can lead to bone deformities [11]. In addition to the welfare issues caused by leg difficulties, the producer will suffer a financial loss. Animals with serious issues have a poorer feed efficiency and develop at a slower rate. These animals' carcass quality will deteriorate as well [12].

Occurrence

The majority of broiler lameness is caused by skeletal anomalies, although this is difficult to explain. Increases in the mortality rate, "the cull," the percentage of rejected chicks, and "downgrades from trimming" [13] may result from the costs and losses incurred as a result of bone abnormalities. Broiler losses due to skeletal anomalies are considerable (Garner et al., 2002). At some stables, up to 90% of the birds in slaughter age show some degree of lameness [14], and roughly 30% of the birds are just too badly handicapped [15].

Behavioral Changes

A roaster's day is spent for the most part. The hens appear to sleep around a quarter of the time and do nothing more than half of the time. A healthy chicken spends 76% of its time laying down. This proportion rises with age, and it appears to be substantially greater with a higher level of lameness (up to 86%).

Defects and their Types

Broiler lameness is caused by a variety of factors, including abnormalities and illness. Heavy, disease-free birds wander about her as though she's in pain and want to stay. This might imply that the discomfort is caused by body weight and strain on the bones and tissues [16].

Abnormalities of the Bones

Nutritional deficiencies, mechanically produced injuries, toxins, and genetic flaws are all possible causes of bone abnormalities [17]. All of these features are more important in fast-growing chicken breeds. They require it for their quick expansion. Because their bones are not fully formed, they are more prone to damage as they consume more and more specialized nutrients. As a result, bone anomalies are prevalent in commercial broiler production.

Valgus-Varus

A "knock-kneed" look is caused by valgus deviation. When the tars metatarsus is lined up with the tibiotarsus, the tars metatarsus deviates laterally. It's the most frequent type of long bone deformity, and it's also the most dangerous [18]. This aberration gives the impression of being 'bowlegged.' The tars metatarsus differs in that it now wonders whether she will be positioned on a line with the tibiotarsus. This aberration is less frequent, but it can cause serious walking problems [19].

Dyschondroplasia of the Tibia (Td)

TD appears to be a dissociation of growth plate chondrocyte proliferation and leg extension during endochondral calcification [20].

Rickets

This is most likely the most well-known bone disease in poultry. When bone mineralization is decreased, this occurs. A lack of calcium and phosphorus, or an imbalance between the two, is the most prevalent cause [21]. 'Rickets' can affect both rapid and slow-growing chicks, although they are exacerbated by the increased requirement for nutrition during growth.

Necrosis of the Femoral Head

The reasons of this condition are unknown, but it has the potential to impact the entire house. The incapacity of the broilers to stand up is the most obvious sign [22]. It is the end of the femur when an autopsy is performed on the birds. Although broilers can respond to vitamin D3 in drinking water, this approach does not always effective [23].

Chondrodystrophie

Shorter bones with various anomalies can occur in poultry lacking in water-soluble vitamins. If the deficit is severe enough, the supporting gastronomies tendon might slide cartilage [24].

Dermatitis due to Contact

Feet burns, also known as contact dermatitis, have been more common in broilers during the last few decades. Contact dermatitis is thought to be induced by the ammonium chemical's action on the urea in the litter. There is also evidence that the occurrence and severity of contact dermatitis are related to the litter and air quality, and hence to welfare factors other than pain [25]. Because of the amount of time spent sitting and the poor quality of the litter, contact dermatitis is evident. The amount of time the chicks spend sitting and reclining rises with age, from 75% in the first week to 90% at five weeks [26]. Footpad dermatitis is a form of contact dermatitis that causes sores on the soles of chickens' feet. Swelling and necrotizing tissue can develop or be seen in more severe instances [27]. This might pose a food safety issue since these lesions could be utilized as a bacterial entry point. As a result, the carcass quality suffers [28].

Viruses and Infectious Diseases

Pathogens

Reovirus, Mycoplasma sinoviae, Staphylococcus aureus, and Retroviruses are the most common infections that cause lameness.

Reovirus

Avian reoviruses, which cause viral arthritis and tenosynovitis (tendon sheath inflammation), are common in the broiler business. The virus is thought to propagate by 'avian egg transmission,' especially because the infection was discovered in seemingly normal commercial chicken embryos. Mild to moderate lameness characterizes the clinical picture, with enlarged "hocks" and a significant increase in fluid in the "hock" joints [29].

Mycoplasma Synovial

Mycoplasma Synoviae causes respiratory infections in hens and turkeys, as well as airsacculitis and synovitis. M. synoviae's effects were originally discovered in the 1950s, and the organism is still known. The pathogenicity of distinct strains of M. synoviae is a distinguishing feature of the organism. The disorders of the respiratory tract and/or synovitis appear to be unaffected by any of these [30].

Retroviruses

The avian leucosis viruses are among the most significant retroviruses. They are further split into subcategories. One of the most economically important diseases in broilers is avian leucosis virus subgroup J (ALV-J). The nodes are made up of myelocytes with eosinophilic cytoplasmic granules. Other forms of lesions, such as lengthy sarcomas with aberrant feathers and myelocyte infiltration in the bones and periosteum of the sternum and ribs, may develop [31].

Staphylococcus Aureus

In the commercial Poultry, Staphylococcus aureus is a major source of disease. S. aureus infection can result in septicemia (the prevention of harmful bacteria and their toxins in the blood), bone and joint infections, abscesses, and dermatitis, among other clinical manifestations [32]. Such diseases affect animal welfare and result in financial losses at the slaughterhouse owing to downtime, lower production, and corpse contamination [33].

Mycotoxins

Mycotoxins are one of the dietary variables that induce skeletal illnesses including Rickets, Articular Gout, and Tibia Dyschonroplasia, as well as a number of other bone diseases in broilers [34]. Because mycotoxins such as aflatoxin, ochratoxin, and fusarium toxin are poisonous to the liver and kidney, they cause rickets by preventing vitamin D3 conversion and absorption [35].

Lameness

Lameness is the leading cause of poor wellbeing in broiler hens, according to European Commission research [36]. Lameness is a broad term for a variety of broiler chicken injuries caused by infectious and non-infectious sources [37]. In the broiler business, lameness is also a major issue. The financial losses caused by lameness in commercially raised broilers are significant [38]. The cost of lameness in the United States was estimated to be between $80 million and $120 million in 2010 [39].

Causes Lameness

Infectious diseases, heredity, sex, weight and growth rate, age, feed conversion efficiency, nutrition, handling, and movement are all variables that contribute to lameness. These aspects will be explored in greater detail further down [40]. The genetic selection and management of non-infectious and non-nutritional bone abnormalities are the most important variables here [40].

Weight and Growth Rate

The quickly rising weight will place additional demands on the juvenile skeleton, and the resulting form change may affect the forces generated throughout the run. The high 'Gait Score' in broilers might be due to discomfort, biomechanical issues, or a combination of the two [41]. Observed at the connection between lameness, weight, growth rate, and age. Weight and growth rate were found to be significant variables in the development of lameness [42].

Gender

Lameness affects both males and females. Male chicks, on the other hand, have greater difficulties than female chicks, even when body weight is taken into account. The male had a 'gait score' that was nearly half a unit higher [43].

Genetics

There is evidence that the prevalence of 'leg weakness' differs between different commercial breeds that perform similarly in other areas [44]. Various genetic studies have revealed that the aetiology of lameness is bone anomalies with a degree of heredity [45]. Lameness appears to be more frequent in some breeds than in others. As a result, positive selection against these traits is feasible [46].

Age

It was discovered that with age, one's ability to walk correctly diminished [47]. The hens could still run well at four weeks of age. Less than 1% of these birds got a gait score of 4 or 5. At 6 weeks of age, broilers walked substantially poorly and could run significantly worse. The pace at which the chicks deteriorated was faster between 4 and 6 weeks than between 6 and 7 weeks [47].

Feed (Nutrients)

Nutrients have been demonstrated to be crucial for proper skeletal development. To avoid leg problems in broilers, they need a well-balanced feed. A lack of water-soluble vitamins, manganese, or zinc, for example, might result in shorter bones with valgus anomalies. In addition, a shortage of nutrition in fast-growing hens might aggravate 'rickets' [48]. Biotin deficiencies in feeding regimens resulted with an increase in footpad dermatitis [49].

Feeding Schedule and Composition

The development of bone abnormalities that are not induced by infection can be reduced by reducing the growth rate by dietary restriction. It's possible that calorie restriction works by decreasing muscle tissue growth, allowing bone tissue to grow at a faster pace. A study was conducted to see if changing the feed pattern or the early feeding pattern would have an effect [50]. A reduced incidence of TD, less "hock burn, a better stride, lower body weight, and improved feed conversion were all linked to fewer meals per day. It was hypothesized that this was due to a well-organized eating schedule, which resulted in increased activity [49].

Management

Bedding, ventilation, heating, lighting schemes, feeding, occupation, and cage enrichment are only a few examples of management. Consultants, according to management, are deficient in these factors, which is the primary reason of the high prevalence of foot pad dermatitis. Producers are urged to enhance ventilation and begin reasonably early. It's also a good idea to use thin layers of litter and switch from straw to wood shavings every now and again. Scraping the hens would be easier, and it would be easier to keep it dry and ventilated [51].

Litter

Litter on the ground is crucial for keeping chickens. An excellent litter material is one that can absorb and release a significant amount of moisture. Wine wood shavings and straw are the most often utilized materials in practice [52]. It was also shown that chicks that sat on wood shavings were more active than those which were on straw. This might also be an opportunity to be less lame [53].

Heating and Ventilation

Leg problems are more common when the weather is either hot or too cold. When there is a low occupancy, it is clear that the air has minimal impact on the quality of the chicks. The environment has an effect at a greater occupancy. The proportion of chicks with sick feet is smaller, and they are less dirty [54].

Lighting

To enhance food intake and development rate, the broiler industry uses a continuous lighting or almost continuous illumination (23 h light: 1 h dark) standard [47]. Light may have a variety of effects on behavior, physiology, and well-being. Different light times have been observed to impact the lameness and development of chicks in research [5].

Density (Placement)

High occupancy may be used in a variety of ways to gain the most economic benefit. However, the capacity of the surface is restricted due to the negative impacts on development and quality. The chicks' exterior quality is clearly influenced by their employment. The quantity of chicks with red heels is substantially smaller and the redness of the soles is notably less at the lower occupancy of 16 chicks per m2. Furthermore, with low stocking densities, there are fewer variations for less dirty chicks [5].

Enrichment

From 33 days, it was proven that birds that were taught had less bone defects [3]. The sober environment may aid in the movement of the young ladies. Various initiatives to improve the surrounding environment have been attempted. Enriching the broiler house can increase activity and enhance the health of hens' bones, as well as their wellbeing [55].

Assessment of Lameness

Manual grading of bird movement and other farm activities are among the traditional ways for determining the gait score as a lameness indicator. Nonetheless, scoring the actions of broiler

chicks is challenging. Fully automated image analysis approaches have numerous potentials for lameness assessment as compared to older methods. Because it is becoming cheaper, an automatic video image approach to assess activity as an indication of lameness in broilers is becoming more common [51]. It is also a noncontact technique, allowing for more frequent data collection during the lives of broiler chicks. When data is automatically analyzed in real-time, there is no need for large data storage [20]. Non-invasive and non-intrusive measures can also be taken constantly and automatically throughout the life cycle of birds. It also avoids the biosecurity risk of having individuals visit various commercial farms to conduct visual gait grading for boiler chicks [16].

Manual Assessment (Gait Scoring System)

The first manual evaluation approach for evaluating the gait issue in birds by visually examining and assigning gait scores to each broiler chicken [56]. This technique assigns a score ranging from zero (no leg issues) to five (totally paralyzed) based on the following factors. 0 (healthy broiler); 1 (broiler moves quickly but has a slight walking deficiency); 2 (broiler moves quickly but has a significant walking deficiency); 3 (broiler moves quickly but has a significant deficiency); 4 (broiler cannot move quickly and has a serious difficulty); and 5 (broiler cannot move quickly and has a serious difficulty) (the broiler cannot move anymore).

Bristol's System of Scoring

The Gait Scoring Guide from the University of Bristol is frequently used to measure walking ability. The idea behind this rating system is the same as the Gait Scoring System. Each broiler is given a score from 0 to 5 based on a set of criteria. Experts determine the score [57]. Although this approach is popular due to its simplicity, it is still very subjective. It is dependent on the observer's knowledge and experience. Other research has found that the visual gait score's repeatability isn't fully dependable. According to other research, just the movement, not the pressure produced by the chick, is measured with this approach. As a result, it will not provide objective information on whether or not the animal is in pain [58].

Automated Assessment Systems

System of Pedobarographs

The intensity of the light will be proportional to the amount of pressure exerted [4]. A custom-built pedobarograph was used to do the gait analysis. The emulsion side of the photographic paper pressed closer against the glass when pressure was applied to the surface, distributing the light. On the bottom of the glass, you can see this. In order to protect the birds, the glass plate and the career were both covered with polythene-backed protective sheeting" (Benckhote, Whatman International Ltd). A 45-degree angle mirror is used under the glass to provide a uniform surface. The mirror reflects the split light, which is recorded using a closed circuit camera (Panasonic WV-BP3101B0). Images were uploaded to a Powermac 8100/110 computer with a Scion LG-3 frame grabber card and processed using Scion Image (version 1.57) software after the video was captured on an S-VHS recorder (Panasonic AG-7355) (Scion Corporation, Maryland, USA). There were 12 frames per second in this experiment. Depending on the brightness of the point, each pixel is assigned a value between 1 and 254. After that, the system may be calibrated to correspond to applied pressure [59]. The following gait characteristics were assessed and compared between the groups:

1. Acceleration (m/sec)
2. Step rate (steps per minute)
3. Depth of the step
4. The length of each step
5. The angle of the step

Video Recordings

The behavior of broiler chickens examined in relation to lameness in another research [26]. Between the ages of 39 and 49 days, comparisons were made between healthy broilers and lame birds. Healthy birds slept 76% of the time and stood and/or moved 24% of the time. Broilers with a gait score of 3 spend 86% of their time laying down. Broiler age was similarly linked to an increase in lying occurrences [39].

Latency to a Lie Detector Test

Another approach for determining lameness in broilers was reported by [4]. The length of time that birds stood in water was assessed, and the results were compared to previous findings. There was a significant ($P<0.001$) connection between bird gait ratings and LTL. In a broiler house, over 750 chickens between the ages of 32 and 45 days were examined. Almost all of the healthy broilers could stand for at least 15 minutes, whereas the majority of the lame broilers were able to sit down in less than five minutes.

Avian Gate Force Plate Research

Another method was developed by (Thapa et al. [58] to define the ground reaction force of birds. While the broilers walked on the experiment setting, the ground reaction force was measured. GRF patterns showed significant growth shifts. The force plate was shown to be an acceptable study instrument for capturing broiler ground response force patterns.

Broiler Lameness May Be Detected Using Precision Livestock Husbandry Techniques

Automatically monitoring broiler chicken activity is one of the simplest techniques to detect lameness in broiler homes. Created

a completely automated monitoring system to track the activity of broilers at various gait scores [26]. An automated video recording system was used to record the activity. The created system then automatically evaluated the pictures of the birds with six various levels of lameness. The findings revealed that there was a strong link between the lameness determined by an expert and the activities captured by an image monitoring technology [26]. There was also a significant decrease in the activity of broilers with a high gait score (GS4&GS5). As a result, it was determined that this approach may be utilized in broiler houses as an indication of high lameness levels (GS4&GS5). Another study [31] used image analysis to establish a novel approach for estimating the geographical usage of broilers. The lameness and the mobility captured by the image monitoring technology had a significant connection in both tests. The findings also revealed that there was a substantial correlation between broiler spatial usage and lameness degree and activity. As a result, it was also determined that the spatial usage of broilers may be used as a sort of activity indicator and criteria for determining lameness [4,60,61].

Conclusion

Leg weakness encompasses a wide spectrum of anomalies related to a variety of etiological reasons, as detailed in this research. It is clearly impacting the development and end-weight of broiler chickens, resulting in a significant financial loss for the farmer. As previously stated, many distinct factors impact broiler chicken leg weakness, which must be taken into account while handling broilers. Leg weakness can be avoided by altering the surroundings and eating habits. Artificial lighting and restricted nutrition can also slow down development rates. However, effective mental management techniques should be used.

Conflict of Interest

There is no conflict of interest.

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