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Preponderance of Body and Limb Conformational Deformities in Sheep in the Sahel

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ABSTRACT

Ideal conformation is a blend of balance, structural correctness, tracking, musculature/muscling and character. These determinants impact the sheep's health, gait, longevity, and productivity. Existing patchy data show that frequency of body and limb conformational defects in the sheep in the Sahel is high. A survey on the conformational deformities of the body and limbs in sheep in the Sahel show prevalence of 17.92%. Amongst these are curvilinear spine, angular limb deformities, sloppy or straight pastern and hoof overgrowth. Common defects like hoof overgrowth, varus and valgus deformities, cowhock or bowleg tend to cause milder functional disruption. The rarer defects like torticollis, limb paresis, spider lamb syndrome, contracted flexor tendons and congenital joint rigidity occur sporadically but manifest severe consequence. The frequencies of disorders were more in the male than female, higher in limbs than body and more preponderant in the forelimbs than hindlimbs. Faults of conformation continue to be a significant issue that impede the overall development of sheep production system and profitability. In the Sahel schemes for conformation referencing do not exist. Hence the need for comprehensive databank and a reporting system for the preponderant conformational disorders that predispose ruminant livestock to injuries, lameness and eventually loss of productivity. Moreover, livestock population is growing and so is the frequency of conformational anomalies. It is therefore pertinent, using selective breeding programmes, the abundantly available early detection and corrective tools, thorough and effective management practices to mitigate the deleterious effects of conformational defects and allow increased productivity of the sheep.

Keywords: Conformational Deformities, Preponderance, Sahel Region, Sheep.

INTRODUCTION

Good conformation is vital to achieve maximum production efficiency in the sheep. A sheep with good conformation has a wide, straight back, strong head and muzzle, smooth shoulders, fullness through the heart area, a good spring of ribs, even flowing sheen coat, wide leg spacing and a long, well balanced body, with adequate skeletal size (Mitchell, 2007). This translates to optimal balance, structural correctness, and way of going (tracking), muscling /musculature and breed/sex character (also known as type) (Henderson, 1990; Ensminger and Parker, 1986). An important component of optimal conformation is absence of unsoundness where a sheep moves painlessly, efficiently, and productively throughout its life. This may be attained through good body condition, sound feet and standing squarely with body parts in correct position, number and condition (Ensminger and Parker, 1986; Henderson, 1990; Radostits et al., 1994). The ideal conformation through the process of ram selection and ewe classing is often employed to seek out the sheep with optimal body and limb conformations (Ensminger and Parker, 1986). This has evolved over the years to be a highly effective protocol amongst breeders to select and obtain sheep with the right genetics that offer ideal body and limb conformations including overall make and shape, size and constitution (ability to do well).

Ultimately the sheep is classified as "sound", from the inside out" and strides painlessly, efficiently, and productively throughout its life (Kaler et al., 2009; Bokko et al., 2011). As this is rarely attained, an animal may be categorized as "serviceably sound" as having minor structural flaws, but can perform its intended purpose (Kempster et al., 1981). Presence of obvious anomalies will deem an

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animal unfit for its intended use and considered "unsound" (Kaler et al., 2009).

The aetiologies of most of these defects are yet to be understood fully. Conformational deformities are theorized to mainly arise following disrupted genetic, congenital or hereditary developmental processes or even acquired (Clarkson and Faull, 1985; Greber et al., 2013). As such the aetiology may be multifactorial. Additionally, defects may be induced by more than one agent. Disruption or errors in the sequential steps of development may be followed by defects in the musculoskeletal development manifesting as body and limb conformational deformity. Such developmental defects may not become apparent until later in life. It is often difficult to determine what event(s) may have resulted in an anomaly (Murray et al., 1996). Sub-clinical laminitis, digital and inflammation and/or infection of the anatomical structures and glands such as interdigital pouch have been reported to cause conformational deficiency (Jensen, 1974; Murray et al., 1996; Ward, 2001; Berry et al., 2004). Other predisposing factors culminating in poor conformation include deviation of hoof from normal shapes (Clarence et al., 1991). This exposes them to different kinds of hazards.

Previous studies mainly centered on limb conditions and predisposition of the sheep to lameness, hoof conditions or acquired disease states. Any mention or data on conformational anomalies is usually lumped with other conditions (Egwu et al*.,* 1994; Mohammed et al*.,* 1996; Paul–Bokko and Chaudhari, 2001). In another earlier study, Paul-Bokko and Chaudhari (2001) reported 13.8% limb conformational deformities in Maiduguri. Deformities that were observed included genu valgum, genu varum, offset knees in the forelimbs; excessive angulations of the hock in the hindlimbs and thin wall and sole, steep hoof and sloping pastern of the foot; with more anomalies (61.8%) in the forelimbs. Since the forelimb leads the stride during locomotion, it can be more prone to effects of conformational anomalies, trauma and concussions (Paul-Bokko and Chaudhari, 2001). The actual prevalence may be higher as a significant number may not be reported or recorded. No other report(s) exist on the conformational deformities in sheep prevalent in the Sahel region of Nigeria. Earlier works reported on lameness in relation to limb and hoof conditions (Egwu et al., 1994; Mohammed et al., 1996; Bokko et al., 2003). The frequencies of conformational anomalies were higher in ewes (59.6%) than rams as well as higher in sheep aged 3 years or less (65.2%). This arises because many sheep keepers prefer ewes for the purpose of multiplication.

To date there is no standalone data or work outlining the components of the conformational problems in the sheep in Nigeria. This article is foremost in the explication of the body and limb conformational anomalies in the sheep in the Sahel.

MATERIALS AND METHODS

A survey on the conformational deformities bordering on musculoskeletal function of the body and limbs in sheep was conducted from January 2010 to December 2014 in Maiduguri area of the Sahel located on latitude 11°50'N and longitude 13°09'E (Anonymous, 2007). The climate is characterized by dry and wet seasons. The dry season span from October to April. The average annual temperature is about 28°c with a high of 49 °C during April/May and minimum of 15°c during dry harmattan season in December and January with annual rainfall ranges from 750-1000mm. Designated survey points were: The University of Maiduguri Livestock Farm, Livestock market and selected sedentary flocks at Bolori, Bulumkutu, Fori, Gwange, Jiddari Polo, Mairi, Gomari, Alau/Dalori wards in the Maiduguri metropolitan area. The livestock market was visited twice a

week. Other survey points were visited as required.

The sheep were of either sex and in the age range of 3 months to 6 years. The common sheep breeds include Yankasa, Uda, Balami, west African dwarf and Sudanese Baluchi ecotypes and their crosses (Bokko, 2011). The flocks were intensively, semi-intensively managed or kept under free range system of rearing. Flock history and management information was obtained. Sheep with conformational defects were appraised at rest and during locomotion. Thorough and detailed examination of the defect was performed and the findings recorded. Representative images of the apparent defects were obtained. Sheep were assessed for anomalies indicative of body or limb defect(s).

The types of conformational deformities were broadly categorized, by location, into those affecting the body (located on neck, spine and torso) and those of the limbs. Data showing apparent conformational deficits were further characterised and categorised as flexural, contractural and angulation orthopaedic deficiency phenotypes. Those that did not fit into the categories were assigned to one group. Percentages of each category were calculated and analysed. Comparison was made between the normal conformation and conformational deviations by correlating image samples of normal conformation and abnormal conformational deficits obtained. Bow-legged, Valgus deformity, varus deformity, Cowhocked limbs, Limb angulations, Lateral deviation of a limb, Overgrown hooves, Paresis, Scapular luxation, Sickled hock, Swayback, and twisted hoof.

Results are shown as means ± SD. Bonferroni tests for multiple statistical comparisons and online supplment and Student's *t*-test (two-tailed) for unpaired samples were carried out to identify significant differences. For each experiment, all test results were compared with the control. R^2 is the coefficient of variation and equals the square of the Pearson product-moment correlation coefficient. The significance probability is the probability of the observed results occurring under the null hypothesis that the correlation coefficient was zero.

Table 1: Distribution of conformational deformities based on gender and bodily location in the Sahel sheep from January 2010 to December 2014

Year	Sheep (Male + Female)	Defects (Body + Limb)
2010	7348 (2201 + 5147)	1361 (387 + 974)
2011	5982 (1936 + 4046)	1018 (299 + 719)
2012	6577 (2057 + 4520)	1021 (352 + 669)
2013	7086 (2142 + 4944)	1311 (401 + 910)
2014	7811 (2349 + 5462)	1526 (434 + 1092)
Subtotal	10685 + 24119	1873 + 4364
Total	34,804	6237

RESULTS

Ideal conformation is a blend of balance, structural correctness, tracking, musculature/muscling and character with the ultimate goal that a sheep is classified as "sound", from the inside out (Figure 1)**.** The body and limb conformational survey conducted on 34804 sheep show that 6237 sheep had at least one conformational defect. This translates to a prevalence of 17.92% (Table 1). The frequency of defects was not in sync with the number of animals assessed (Figure 1). The defects recorded were designated as either of the body or limbs. The frequency of occurrence of defects in the limbs was 2 – 3 times more

frequent than on the body in both the sheep (Table 1). The incidence rate of defects on the body and in the limbs was 27.93 % and 69.91% in the sheep (Table 1).

Table 2: Types of conformational deformities in the Sahel sheep

BODY LIMB Defect	Sheep	(Ram + Ewe)
Torticollis	19	(11 + 8)
Swayback/Lordosis	231	(68 + 163)
Kyphosis/roach-back	206	(109 + 97)
Scoliosis	168	(83 + 85)
Synostosis	52	(19 + 33)
Luxation/subluxation	37	(18 + 19)
Spider Lamb Syndrome	9	(5 + 4)
Congenital Joint Rigidity	14	(9 + 5)
Varus deformity	706	(394 + 312)
Valgus deformity	643	(412 + 231)
Cowhock	513	(241 + 272)
Bowleg	476	(197 + 279)
Sickle hocks	305	(134 + 171)
Contracted flexor tendons	104	(69 + 35)
Pastern defect	347	(164 + 183)
Hoof overgrowth	1379	(536 + 843)
splayed-hoof	291	(141 + 150)
Corkscrew hooves	206	(92 + 114)
Limb Paresis	39	(13 + 26)
others	**492**	(173 + 319)
Total	**6237**	(2784 + 3453)

Others like nonspecific defects like flexural, contractural and certain angular limb deformities and flexor laxity recorded were grouped together.

The more frequent defects were hoof overgrowth, varus and valgus deformities. Deformities like torticollis, limb paresis, spider lamb syndrome, contracted flexor tendons and congenital joint rigidity occur sporadically in both sheep but tend to exhibit severe defects (Table 2). In some situations the animals do not survive. Spider Lamb Syndrome afflicted lamb showed pronounced medial deviations of the carpus (with bowed radius and ulna) and the hock with bowed tibiae. The thoracic and lumbar vertebrae are moderately kyphotic, which causes a dorsal rounding of the backline. The sternebrae are dorsally deviated, leading to a flattening of the sternum. Decreased muscle mass was also predominant and the lamb was unable to stand. Congenital joint rigidity (arthrogryposis) was characterized by ankylosed limbs with kyphosis, slightly enlarged head and inability to stand or nurse.

deformities and flexor laxity.

The conformational defects encountered on the body/spine were torticollis (twisted neck), lordosis (swayback) in an ewe (Figure 3), kyphosis (roach-back), scoliosis (lateral deviation of the back) and synostosis (Table 2). The defects recorded in the limbs were varus deformity, valgus deformity (Table2) as well as scapula luxation, limb paresis, crooked hind legs, sickle hocks, spider lamb syndrome, congenital joint rigidity, pastern defect, hoof overgrowth, splayed-hoof and corkscrew hooves (Table 2). Others nonspecific defects like flexural, contractural and certain angular limb deformities and

These conformational defects may occur alone, in combination with other defects or associated with defects of other body systems. The defects ranged from the most obvious to the most obscure. For instance an ewe exhibited severe lateral deviation in the left hindlimb and mild valgus deformity in the right hindlimb. Additionally, the spine was curvilinear (Figure 3). Hoof overgrowth was more severe in sheep growing to an average of 3.4±0.52 cm in sheep and mean of 0.8 ± 0.06 cm per month. Hoof overgrowth showed the highest frequency accounting for 25% of the deficiencies. Overall occurrence was that more cases were recorded in male (59.6%) than in female (40.4%) (Table 1). There was no breed predisposition to occurrence of defect in either the sheep in the Sahel.

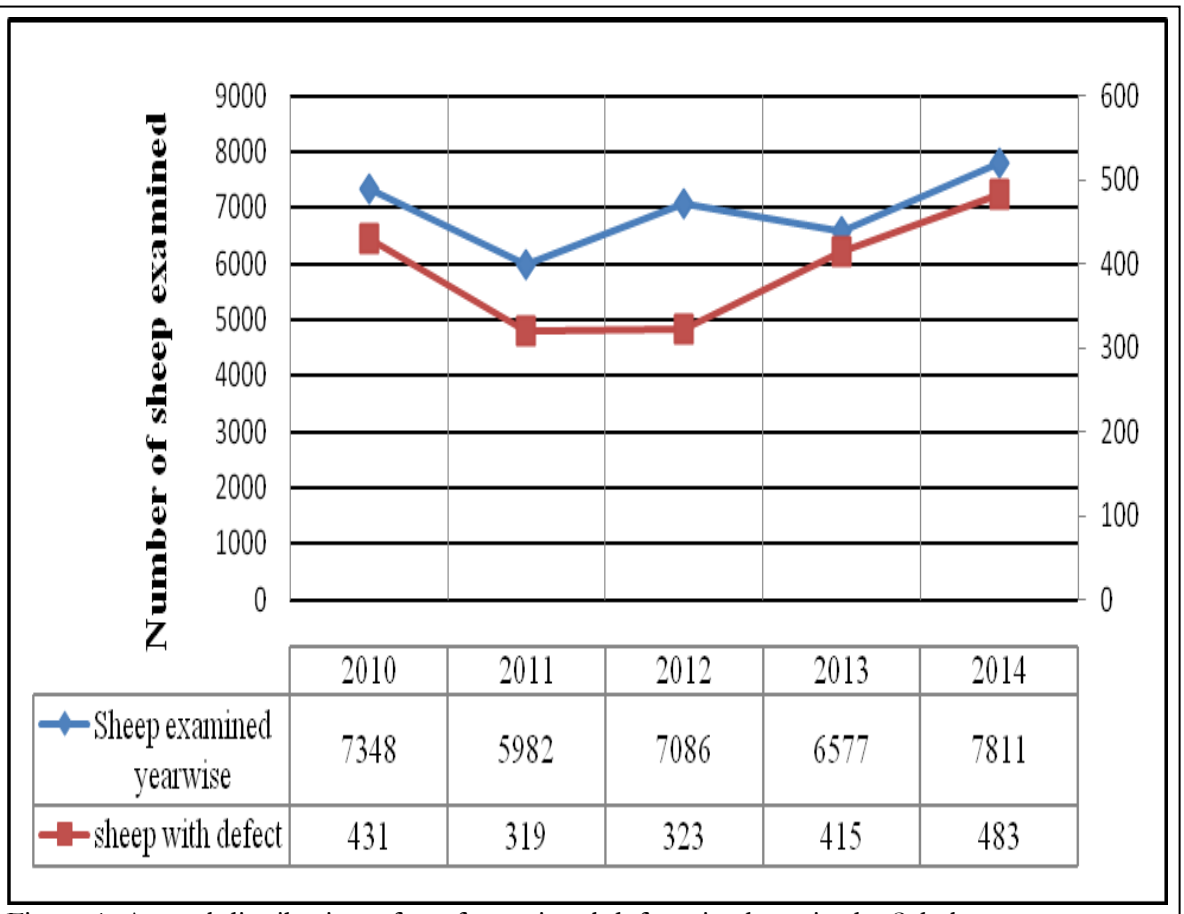

Figure 1: Annual distribution of conformational defects in sheep in the Sahel.

DISCUSSION

Conformational deformities are a range of flaws in the musculoskeletal system (Edelstein *et al.*, 2001) that impede the attainment of desirable limb and body conformation. It would actually be unusual for a sheep to live-out its entire life-span without experiencing defect of one degree or another. The degree of conformational anomalies tolerated by sheep would be unacceptable in other species (Anous, 1991). A prevalence of 17.92% in the sheep subtly hampers small ruminant production systems. The actual prevalence of conformational deformities may be higher as a significant number may not be reported or recorded. Moreover, as the population of livestock grows so will the conformational defects.

The conformational defects recorded in this study were spine and limb flexural, contractural, angulation, malformation, growth and developmental deficiencies. Those showing high prevalence were mild to moderate in severity; often subtle or self-limiting causing minimal functional disruption. The affected sheep gradually adapt to the defects or the defect gradually disappear altogether as the animal develops (Paul-Bokko and Chaudhari, 2001). On the other hand sporadic deformities like torticollis, limb paresis, spider lamb syndrome, contracted flexor tendons and congenital joint rigidity exhibit severe defects. Lordosis affects the spine whose vertebral joints fail to develop properly. Kyphosis (an upward curving of the spine) is also occasionally seen. Both of these conditions contribute to back weakness or damage to the delicate spinal cord resulting in permanent paralysis (Kacar et al., 2008). Additionally varus and valgus deformities affect downstream functions of associated tissues. Valgus deformities tend to be associated with knock-knee and splay-foot condition in the front legs as well as outward rotation of the cannon bone, fetlock or pastern (Meynaud-Collard et al., 2009). Sheep with varus deformities are often narrow in their stance and medial hooves rub against each other and interfere with locomotion. A cowhocked sheep has the hooves turned outward while bowleg has the feet turned in. These observations are similar to earlier reports (Peltonen et al., 1984; Bonniwell et al., 1988; Anous, 1991; Lindqvist, 2002; Meynaud-Collard et al.,

Figure 2: Normal conformation of the head (A, C), body (B) and forelimbs (A) and hindlimbs(D) in the Sahelian sheep.

2009). Furthermore, angular defects place additional strain on the leg, joints and lameness can ensue (Anous, 1991).

Too straight pastern causes increased jarring of the joints, pain and stilted walk (Anous, 1991; Lindqvist, 2002; Greber et al., 2013). Post legged sheep has hardly any angle to the hip and hocks (Yoganandan et al., 2008; Greber et al., 2013). This abnormality causes the stifle muscle making the sheep to take a shorter choppier stride (Kempster et al., 1981; Yoganandan et al., 2008). These conformational anomalies may result in fetlock hitting the ground upon impact and/or heel and sole bruising (Kempster et al., 1981; Berry et al., 2004; Saunders et al., 2009). Long or excessively short even claws may indicate too much or not enough pastern angle, causing both claws of the hoof to grow or wear excessively (Jackson and Mansour, 1974). The way the hooves grow often indicates structural problems further up the limbs (Anous, 1991).

Multiple conformational defects can occur together and/or along with diseases in other body systems. For instance, spider lamb syndrome manifest as a rounding of the dorsal silhouette in the skull, producing a "Roman nose" appearance with the thoracic and lumbar vertebrae moderately kyphotic. The sternebrae are dorsally deviated, leading to a flattening of the sternum. The carpus and the hock joint are medially deviated with a bowed radius and ulna as well as tibia wtih irregular thickening of the growth plate cartilage. Arthrogryposis in

Figure 3: Conformational defects in the Sahelian sheep. A) swayback: down-ward curving of the spine in the lower back (arrow) in an ewe; B) Hoof overgrowth in a ram (arrow), C) Re right carpal joint varus angulation in a lamb (arrow).

addition to causing ankylosis of the limbs also has joints fixed in abnormal positions and frequently has scoliosis and kyphosis. Arthrogryposis may also cause cleft palate, hydrocephalus and necrosis of neurons of the white matter in the spinal cord. These were also reported earlier (Kacar et al., 2008).

Flexural, contractural and angular limb conformational deformities amplify strain disproportionately to different regions of the limbs with asymmetrical line of concussion travelling up the leg disproportionately and damaging the area that absorbs more concussion more severely (Manske, 2002; Kaler and Green**,** 2008a; Kaler and Green, 2008b). Some cause the animal to stumble during stride, paddle the limbs or lift it high enough to avoid paddling or stumbling (Bokko et al., 2015). Conformational deformities contribute to occurrence of conformational unsoundness, incoordinated gait, stumbling and lameness (Alemu, 2009). Orthopaedic deficiencies may also contribute to occurrence of arthritis (Lindqvist, 2002; Kaler and Green, 2008a).

Conformational deformities that cause or predispose sheep to unsoundness and/or lameness are of great concern due to the frequency of occurrence (Clarence et al., 1991; Bokko et al., 2003; Fisher, 2011) and reduce mobility and prevent productive behaviour (Singh et al., 1993; Itty et al., 1997), inefficient grazing, feed utilization and breeding performance amongst small ruminants (Sprecher et al., 1997; Garbarino et al., 2004). Economic implications of conformational deformities is the reduction of market value and decline in overall productivity of the sheep and goat (Bokko et al., 2003), increased culling rate (Booth, 2004; Juarez et al., 2003; Hernandez et al., 2005) and increased production costs (Cha et al., 2010).

The conformational assessment in sheep can be performed on flock–basis instead of individual sheep. Sheep owners can have and own conformation assessment outlet or several breeders work together to hold a routine conformation assessment of the flock, rather than until disorders arise.

All conformational anomalies should be investigated. A structured system of reporting and recording, beginning with accurate clinical and pathologic descriptions is necessary to centralize data and focus on physical and physiologic abnormalities. When a condition appears to have an underlying genetic component, appropriate techniques to assess pedigree information and identify the mutated homozygous phenotype should be explored. Identification of molecular signals that guide sequential development of organs and organ systems, coupled with molecular diagnostic tools and genomic testing, allow a more detailed understanding of many observed conformational defects. It is likely that as these technologies improve, the etiologies will be identified.

CONCLUSION

The frequency of body and limb conformational deformities in the sheep in the Sahel region is high yet schemes used for conformation referencing do not exist. Faults of conformation have been and continue to be a significant issue affecting the overall development of sheep production system and profitability. It is therefore pertinent for a comprehensive databank and a reporting system for the preponderant body and limb conformational disorders in the sheep. This along with thorough and efficient management practices, accurate and early detection using a multifaceted approach with an array of diagnostic tools and adequate treatment of conformational deformities can satisfactorily alleviate these conditions and allow optimum productivity of the sheep in the Sahel.

CONCLUSION

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