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Phenotypic characterization of the West Africa dwarf goats and their production system in Liberia

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Data on characterization of animal genetic resources are valuable in the development of breeding and conservation schemes to ensure their sustainable use. A survey was conducted to collect baseline data on the phenotypic characteristics, production system, trait preferences and challenges faced by goat farmers in Liberia. The survey was carried out in the 15 counties of Liberia and covered 1312 animals in their production environments. A pre-tested structured questionnaire, group discussions and in-depth interviews were used in the data collection. Phenotypic descriptors were directly measured using a measuring tape Results indicated that Liberia goats are predominantly West Africa Dwarf (WAD) goats (99%) and either docile or moderate in temperament. The majority of WAD Goats have solid/uniform/plain coat colour pattern (68%) and black or white coat colour (63%). Most goats are horned (70%) and have curved horns (50%). The goats have productive traits such as fast growth and meat production. Average body weight, body length, chest girth and height at withers were 39 kg, 65 cm, 79 cm and 51 cm, respectively.

Key words: Liberia, Phenotypic characterization, West African dwarf goat, production system and AnGR.

INTRODUCTION

Goats (*Capra hircus*) have increasingly become an important source of milk and meat for the resource-poor small-scale farmers who cannot afford cattle (G. Ameha, Alemaya University of Agriculture, Ethiopia, Unpublished M.Sc. Thesis). Further development of goat research and industry is strategic for poverty reduction, especially among poor rural farmers. Goats have multi-purpose roles, providing food, hides, and manure, generating income directly as cash or as goods for bartering and thus benefiting the world's poorest people (Richards, 2002; Perry et al., 2002; Ershaduzzaman et al., 2007). Goats show higher survival rates than cattle under drought conditions (Ndikumana et al., 2000). Their short reproductive cycle and prolificacy coupled with their small size and early maturity makes them suitable for use on small farms as a first step towards wealth creation. Goats perform better than cattle under low input conditions and climatic stress.

They are more tolerant to infectious diseases and parasites as well as heat stress (Philipsson et al., 2006; Kosgey and Mwai, 2007). These traits enable them to cope with the stressful nature of the unproductive and marginal lands in which they are often kept. Indiscriminate crossbreeding of indigenous goats can therefore cause genetic erosion, loss of genetic diversity and reduction of adaptive values and opportunities for efficient utilization of the existing adapted goat genetic resources (Hassen et al., 2012).

Goat meat is a popular livestock product in Liberia and consumption rates have been rising rather quickly in the past few years. There is a huge open market for goat meat in Liberia, as it is eaten by every ethnic and religious group. Some projects are promoting goat production through restocking following years of civil unrest. The hardiness of the local goats has made it a ruminant of choice among many households. Despite the importance of goat production, there is practically no information in Liberia on goat production and research. Investment in livestock research and animal production is a key factor in increasing livestock productivity, stimulating growth, and reducing poverty, enhancing incomes for the poor and alleviating childhood malnutrition. In order to expand livestock production to satisfy domestic demand in Liberia, sustainable livestock research and development, well defined production systems, evaluation and documentation of the local goat genetic resources should be of urgent priority.

Morphometric data are key information to evaluate the characteristics of breeds of animals and provide key insight on the suitability of animals for sustainable breeding and their conservation (Nesamvuni et al., 2000; Mwacharo et al., 2006; FAO, 2012) to ensure food security. The objectives of this study was to carry out phenotypic characterization of the local goats in Liberia, including their morphology, production system and challenges confronting goat farmers and makes appropriate recommendation to address them for increased productivity and wealth creation.

MATERIALS AND METHODS

Scope of characterization

Liberia is a Sub-Saharan nation in West Africa with an estimated population of 4 million. It's located at 6°N, 9°W and borders the North Atlantic Ocean to the southwest (580 kilometres of coastline), and also bordering three countries, Sierra Leone, Guinea and Côte d'Ivoire. In total, Liberia comprises 110,000 square kilometres of which 96,300 square kilometres is land and 15,000 square kilometres is water. Much of Liberia is dominated by flat to rolling coastal plains that contain mangroves and swamps. Those plains slope into a rolling plateau and rainforest-covered hills central, and into relatively low mountains in the northeast.

Prudent planning and management of animal genetic resources (AnGR) require reliable data. In order to overcome this challenge and help improve goat production, the Government of Liberia through a Technical Cooperation Project (TCP) with the FAO implemented by the Central Agricultural Research Institute (CARI) collected baseline data on Liberia's AnGR. This was undertaken through a survey and characterization of available AnGR of the goat breeds and the development of a national Strategic Action Plan on AnGR (NSAP-AnGR).

Data collection

The survey was conducted in 15 Counties in Liberia – Bassa, Bomi, Bong, Cape Mount, Gbarpolu, Grand Gedeh, Grand Kru, Lofa, Margibi, Maryland, Montserrado, Nimba, River Cess, River Gee and Sinoe (Figure 1). It was based on FAO's Guidelines for phenotypic characterization of AnGR (FAO, 2012). Checklists and questionnaires for phenotypic characterization of goats were also developed. Training of supervisors and enumerators for the survey and characterization of Liberia's AnGR took place in February, 2016. The training helped to build human resource capacity on AnGR in Liberia and also provided training and knowledge in the various aspects of phenotypic characterization, thereby helping to standardize data collection procedures. Livestock characterization and production data was collected by the team of enumerators using an electronic data capture system with the EpiCollect software.

The survey collected data for phenotypic characterization of the AnGR of goats in Liberia between April and July, 2016. The farmers were randomly sampled and most of them have multiple species and practice mixed farming of crops and livestock as a means of livelihood. Trained enumerators used pre-tested questionnaires (FAO, 2012) which were loaded unto hand held field tablets. Primary data were collected using in-depth interview, group discussion and structured questionnaire. The data collected included general information on household characteristics, goat production and management practices, as well as the phenotypic characteristics of the goats. For the phentoypic characterization, the descriptors provided by FAO, (2012) were used. Linear and morphological measurements including heart girth, whither height and body length were also carried out using measuring tape.

Data analysis

Data were entered and cleaned in MS Excel and analyses were done using Statistical Analysis Systems (SAS) software (SAS, 2012) and the *Survey* Package in R (R Core Team, 2016).

Figure 1. Political Map of Liberia.

These software tools are also user friendly and have very flexible options for summarizing categorical and quantitative variables and producing clear figures.

RESULTS AND DISCUSSION

Background of Respondents

The number of farmers visited and interviewed by gender, ages, household sizes and educational status are shown in Table 1. The largest number of respondents were from Grand Gedeh County (146), followed by Maryland county (140) and River Gee County (114), respectively. Goat rising in Liberia is very much a male-dominated activity (66.5% of respondents).

About a third of the goat farmers surveyed have no formal education (Table 1). Such a situation can negatively affect the adoption of innovative animal husbandry practices. This means that two-thirds of respondents had some level of literacy. Education is an approach to help farmers in making informed decisions, solving problems and learning new technologies (IFPRI, 2010). The vast majority of goat farmers in Liberia are not members of any livestock associations. Only 13% of farmers keeping goats belong to livestock associations. This is a common phenomenon in the West African region where such associations for livestock farmers are weak or non-existent. The reason for this may be that farmers are not organized or do not see the benefits of belonging to such an association. The absence of well-organized farmer/breeder associations to support governmental initiatives has hindered efforts to develop an appropriate and integrated livestock recording system for Liberia's AnGR (MOA, 2008). The larger numbers of goat farmers in Grand Gedeh, Maryland, River Gee and Nimba Counties, suggest that these may be the most logical places to establish goat farmer associations or breeder associations. Such associations can safe guard breed conservation and utilization of animal genetic resources.

Phenotypic characterization

The total numbers of goats characterized were 1312 of which 99% were West African Dwarf (WAD) goats (Table 2).

Table 1. Household characteristics of goat farmers.

N= 1206	Male	Female	Chi Square value	Prob	df
Gender of farmers	844 (67%)	423 (33%)			
Educational status					
Illiterate	241 (29%)	136 (32%)			3
Basic (Read and write)	337 (40%)	165 (39%)	4.5024	0.2121	
Secondary	208 (25%)	104 (25%)			
Tertiary	58 (7%)	18 (4%)			
Membership of Livestock Association					
Yes	115 (14%)	56 (13%)	0.0392	0.8431	1
No	726 (86%)	366 (87%)			
Average age of farmer	46.5 ± 0.4				
Average household size	8.7 ± 0.2				

Table 2. Number of goats characterised by breed and sex.

Breed	Sex of animal		Total
	Female (%)	Male (%)	
West African dwarf goat	78	22	1303 (99%)
Guinea goat	100	0	2 (.2%)
Mountain goat	100	0	1 (.1%)
Red Sokoto	100	0	1 (.1%)
Sahelian	80	20	5 (.4%)
Total	78	22	1312 (100%)

Chi Square Value =1.16; df = 4; P = 0.8839.

Table 3. Summary statistics of key qualitative variables of Goats in Liberia.

Variable	Mean ± SE	n	CV (%)	Range
Estimated age of goat (years)	2.6 ± 0.04	13022	49	1.0-14.0
Body weight (kg)	38.7 ± 0.4	1316	37	10.4 – 89.4
Body length (cm)	65.2 ± 0.3	1316	17	43.2 – 94.0
Chest girth (cm)	78.9 ± 0.4	1316	15	50.8 – 114.3
Height at withers (cm)	50.5 ± 0.2	1316	13	22.9 – 83.8
Tail length (cm)	21.5 ± 0.1	1310	24	5.1 – 43.2
Ear length (cm)	14.7 ± 0.2	1315	39	5.1 – 27.9
Horn length (cm)	15.3 ± 0.2	1301	37	2.5 – 50.8

This result corroborates the report by Koikoi (2011) and confirms the WAD as the predominant goat breed in Liberia which should be targeted for improvement and conservation. The WAD has different names across the different counties including *Bablee*, *Weleebla*, *Welee*, *Blabee*, and *Gborkolor*.

The summary statistics of some key quantitative characterization variables on the goats are shown in Table 3. The results obtained on the qualitative variables are higher than those reported by Oseni and Ajaji (2014). These differences could be due to environmental factors such as the availability of forages, good nutrition, adaptation and ecotype. There are two major WAD ecotypes, corresponding to the humid zone and the savanna zone. Liberia WAD goats are of the savannah type which is generally heavier with larger body size (Chiejina et al., 2009; Rotimi et al., 2017) and strong degree of trypano-tolerance. The body weight and linear measurements obtained in the survey are comparable with that of Benis Arrous goats (Hilal et al., 2013).

Regression of these phenotypic measurements on the age of animal indicated that height at withers and horn length were significantly predicted by age. Although most of the other parameters did not show any significant associations with age, there was a general trend of increase in these parameters with age of animal. There were positive and significant correlations between the key qualitative traits studied. The highly significant correlation (86%) between chest girth and body weight indicates that chest girth can be used to predict body weight of WAD goats using appropriate regression models.

Also, the correlation between body length and body weight was moderate (56%), but highly significant. Oseni and Ajayi (2014) observed that chest girth accounted for over 77% of total variability in the weight of WAD goats. This shows that the best prediction model for live weight of WAD goats should include chest girth and body length. According to Cam et al. (2010) morphometric measurements and how they relate to one another can describe roughly the animal's production status and breed characteristics.

Morphological characterization results on goats based on available data for the traits studied are as follows. In terms of coat colour pattern, the WDG goats in Liberia have solid/uniform coat colour pattern (68%), followed by patchy/pied (22%) and spotted (10%) as shown in Table 4. The main coat colour types of the WAD goats (Table 5) were black and white (40%), white (14%), black (9%) and black and brown (5%) and several other mixtures which gives a strong indication of admixture as a result of the uncontrolled random mating in the free range extensive husbandry systems. Both black and white coat colours accounted for 63% of the coat colour.

Table 4. Frequency of coat colour pattern of goats by sex.

Coat colour pattern	Sex of animal		Total
	Female (%)	Male (%)	
Spotted	84	16	134 (10%)
Patch/Pied	77	23	291 (22%)
Solid/Uniform/Plain	77	23	881 (68%)
Total	78	22	1306 (100%)

Chi Square Value = 3.79; df = 2; P = 0.1502.

Table 5. Frequency of coat colour type of goats.

Coat colour type	Sex of animal		Total
	Female (%)	Male (%)	
Black and White	74	26	378 (40%)
White	70	30	134 (14%)
Black	80	20	88 (9%)
White and Brown	95	5	72 (8%)
Black and Brown	84	16	67 (7%)
Black, White and Brown	95	5	56 (6%)
Brown	94	6	49 (5%)
Dark red	79	21	14 (2%)
Fawn and Black	92	8	13 (1%)
Light red	83	17	12 (1%)
Fawn	73	27	11 (1%)
Mixed Colours	77	23	62 (6%)
Total	78	22	956 (100%)

Chi Square Value = 100.30; df = 12; P = 0.0005.

This result is not in agreement with Odubote (1994b) who reported that the predominant colour observed among WAD goats in Nigeria is black (53.3%). The frequency of the spotted coat colour pattern was not high (10%) among the goats. Coat colour may vary through adaptation of animals to climatic zones and may influence the performance for other traits (Odubote, 1994a). Coat colour plays an important role in the evolved adaptation of goat type. Reproductive fitness as manifested by prolific breeding is a major factor of adaption (Daramola and Adeloye, 2009).

Table 6 shows that the Liberia WAD goats showed high presence of horn (70%). This result is in agreement with those of Odubote (1994a) and Abebambo et al. (2002). Ozoje (2002) also reported high presence of horns (87%) among WAD goats in Nigeria. Kolo et al. (2015) reported 100% horn among local goats in Niger State in Nigeria. In this survey, the female shows higher frequency of horn (69%) compared to the male (31%). Redero et al. (1992) found very high frequency of both populations (horned and polled) in Blanca Serrana breeds.

Table 6. Frequency of horn presence in goats.

Horn presence	Sex of animal		Total
	Female (%)	Male (%)	
Present	69	31	908 (70%)
Absent	96	4	383 (30%)
Total	77	23	1291 (100%)

Chi Square Value = 111.24; df = 1; P < 0.0001.

Table 7. Frequency of horn shape of goats.

Horn shape	Sex of animal		Total
	Female (%)	Male (%)	
Curved	74	26	392 (50%)
Straight	63	37	273 (35%)
Scurs	64	36	97(12%)
Spiral	100	0	13(2%)
Corkscrew	40	60	5(1%)
Total	69	31	780(100%)

Chi Square Value =17.14; df = 4; P = 0.0042.

The WAD goats of Liberia were characterized as having mostly curved (50%), straight (35%) horns with some scurs (12%; Table 7). The vast variety of horn shapes in the population may indicate the presence of sexual dimorphism in horn shape as confirmed by the significant chi square value. This finding is in agreement with that reported by Sykes and Symmons (2007) that horn shapes are sexually dimorphic.

Table 8 indicates that WAD goats in Liberia have straight facial profile (82%), followed by concave (17%) with a few goats having convex facial profiles (1%).

The backline profile of the goats was either straight (72%), sloping up (20%) and slopping down (7%). For the straight backline profile, male exhibited 65% and female 17.4%. The WDG goats in Liberia showed variation in rump profile.

Flat rump accounted for 47%, followed closely by slopping rump 44% and roofy rump 9%. Male goats showed 38% flat rump and female goat 9%.

Table 8. Frequency of facial profile of goats.

Facial profile	Sex of animal		Total
	Female (%)	Male (%)	
Concave	72	28	224 (17%)
Straight	79	21	1073 (82%)
Convex	78	22	9 (1%)
Total	78	22	1360 (100%)

Chi Square Value =5.4930; df = 2; P = 0.0642.

Table 9 shows the frequency of hair types of goats in Liberia.

Table 9. Frequency of hair type of goats.

Hair type	Sex of animal		Total
	Female (%)	Male (%)	
Smooth	89	11	61 (65%)
Curly	50	50	10 (11%)
Glossy	64	36	11 (12%)
Dull	80	20	5 (5%)
Straight	14	86	7 (7%)
Total	71	23	94 (100%)

Chi Square Value = 17.14; df = 4; P < 0.0001.

Goats have mostly smooth hair (61%), glossy (12%) and curly hair (11%) with the rest having straight or dull hair types. This finding is in agreement with that of Ozoje (2002) who reported that the predominant coat type found among goats in Nigeria is smooth hair. The wide variation in goat hair types seems to suggest polymorphism among WAD goats on hair types. Hagan et al. (2012) also reported smooth hair as the predominant hair type among WAD goats in the Coastal Savannah and Forest Eco-zones of Ghana.

It was shown from the survey that the WDG goats in Liberia have erect ears (59%), followed by horizontal (21%) and semi-pendulous ears (16%) (Figure 2). This finding agrees with that of Hahan et al. (2012) who reported that erect ears (40%) and horizontal ears (48%) among goats in Ghana. It is well known that West Africa Dwarf goats have erect ears and it is the predominant goat breed in Liberia.

It was observed that majority of the WDG goats in Liberia are docile and moderate in temperament (Figure 3). This is not surprising given the fact that there is one major goat breed in Liberia, the WAD goat, which is not known to be wild in temperament. Common to local animal genetic resources of the tropics, goat farmers in Liberia reported disease, drought and heat tolerance as the major adaptive traits of their animals. Over forty percent of goat farmers (41%) reported diseases tolerance as an important adaptive trait followed by drought tolerance (33%) and heat tolerance (26%) as shown in Figure 4. This result agrees with the report of Adedeji (2012) that heat tolerance is the attribute of WAD goats reared extensively. Odubote (1994b) reported that heat tolerance is directly related to the degree of coat pigmentation. The adaptive features of WAD goats such as disease and heat tolerance, efficiency of feed use enable them to thrive on natural resources left untouched by other domestic ruminants (Daramola and Adeloye, 2009).

Production system characterization

The production system for goats in Liberia is basically subsistence. Goats are kept by peasant farmers and close to half of the farmers (46%) reported ranching, the grassland based management system, tethering (27%) with pastoralism accounting for 25%. Majority of farmers kept their goats on free range (82%) or shepherd (10%), while only 8% of farmers practiced zero grazing, referred to as cut and carry (Figure 5). Oseni and Ajayi (2014) also reported such production system, mainly extensive, among goat farmers in Nigeria.

As shown in Figure 6, In Liberia 87% of the farmers indicated that income generation is the main motivation for raising goats, followed by source of meat (8%) and socio-cultural values (5%). This strengthens the need to purposely develop pasture and grasslands for the genetic resources in Liberia. This finding is not in agreement with that of Oseni and Ajayi (2014) who reported that WAD goats are raised principally as a source of meat. This result is in disagreement with that reported by Webb and Mamabolo (2004) that the principal reasons for raising goats by farmers in the Moutsi district of Mpumalange, South Africa, are for prestige and status. The determination of markets price for goat in Liberia depends on many factors (Figure 7). The farmers indicated that the price of goat depends either on the market value because they sell when the animal is ready for market or when there is financial need. The determinants of price for goats were financial need (49%), market readiness (33%) and problem/trouble (18%). The WAD goats of Liberia have very high reproductive efficiency with the ability to produce twins and triplets in the litter, but due to poor housing (Figure 8) and kid management, mortality can reach as high as 50% in some situations and this negatively affects productivity. Webb and Mamabolo (2004) reported high mortality (40.6%) in goats in communal systems in South Africa.

Liberia's AnGR particularly the ruminants are mostly kept extensive with little or no provision for housing facilities. About 67% of goat farmers provided no housing, 15% had a permanent structure and 18% provided some shed for their goats (Figure 8). Figure 8.
Bar graph showing housing type by gender of farmer for goats.

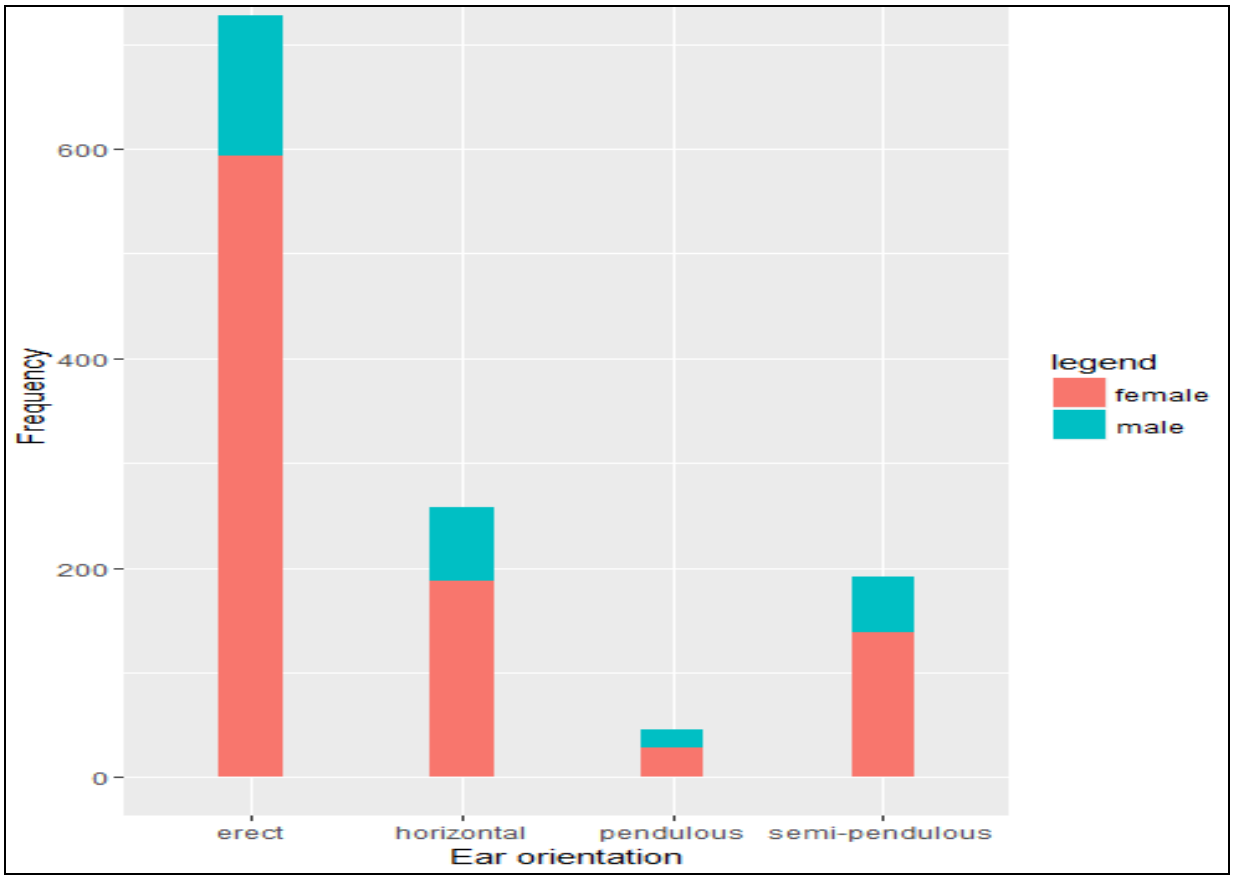

Figure 2. Ear orientation by sex of goats.

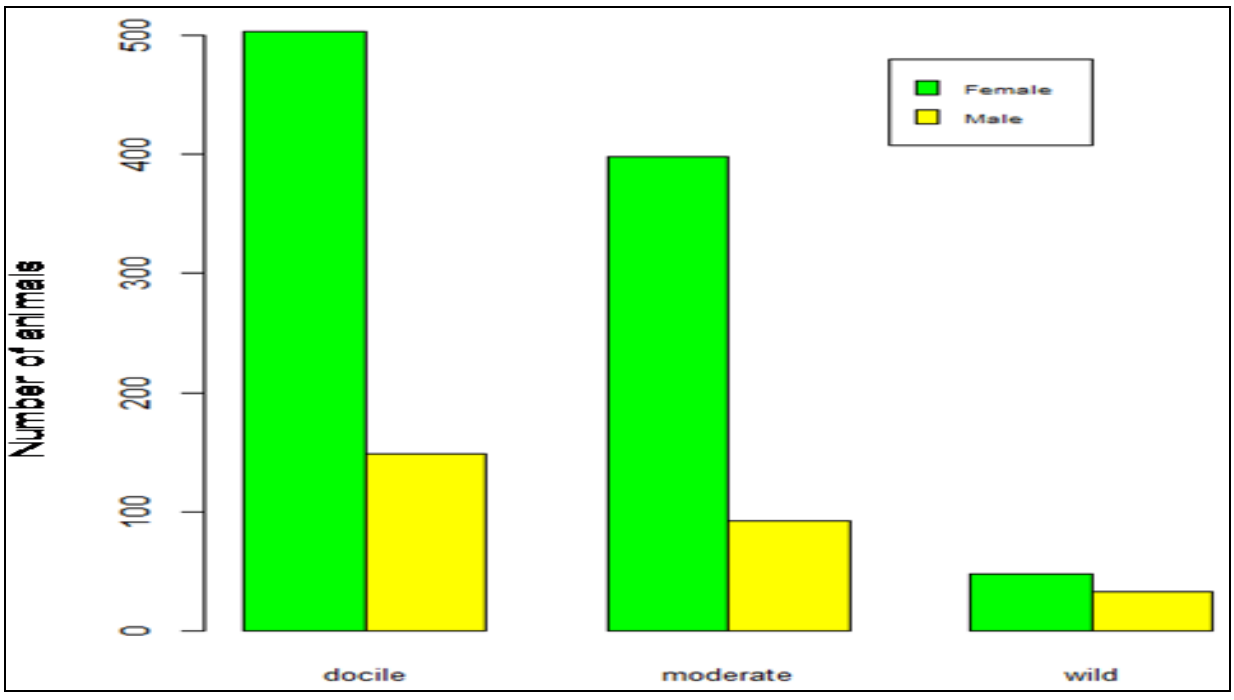

Figure 3. Basic temperament of goats.

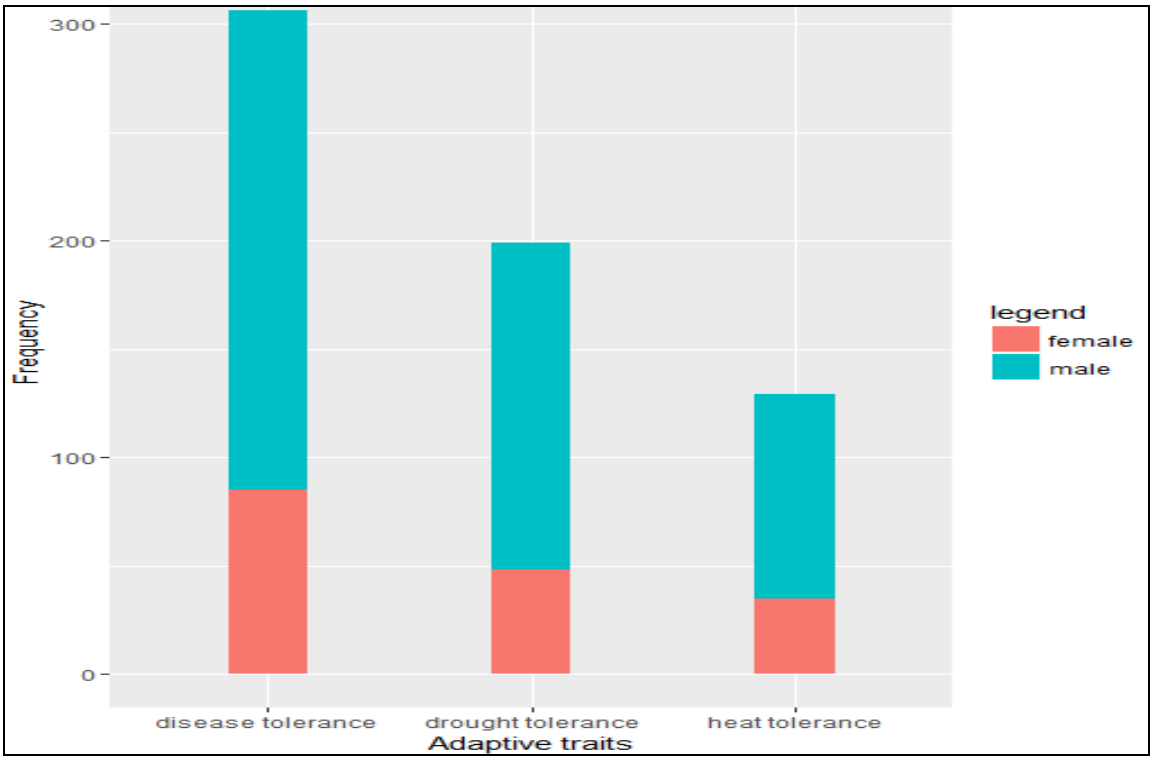

Figure 4. Adaptive traits of goat by sex.

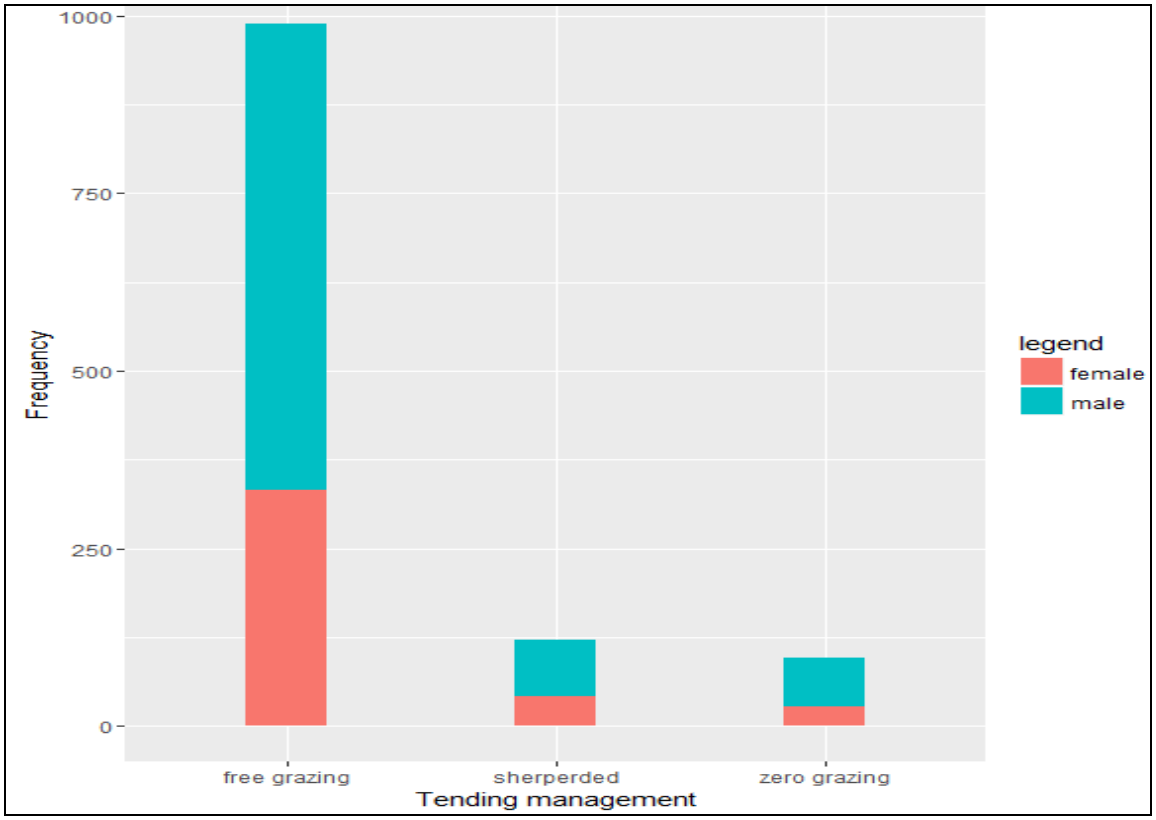

Figure 5. Tending management by sex of goat farmer.

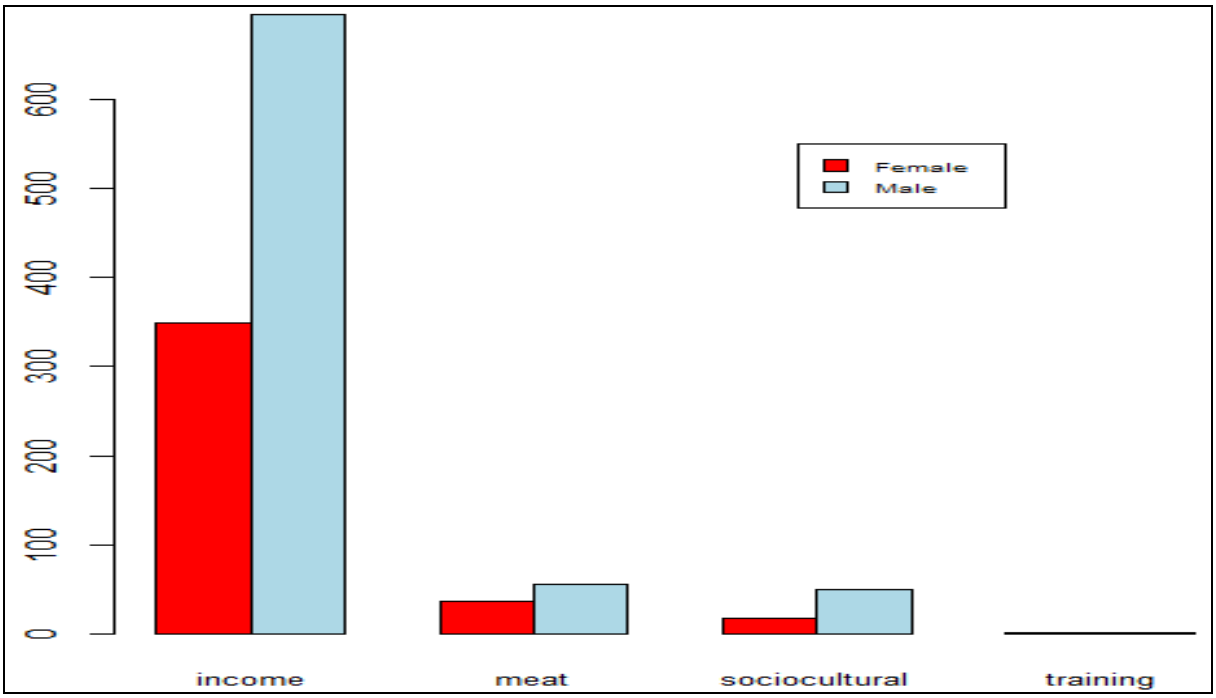

Figure 6. Motivational factors for keeping goats.

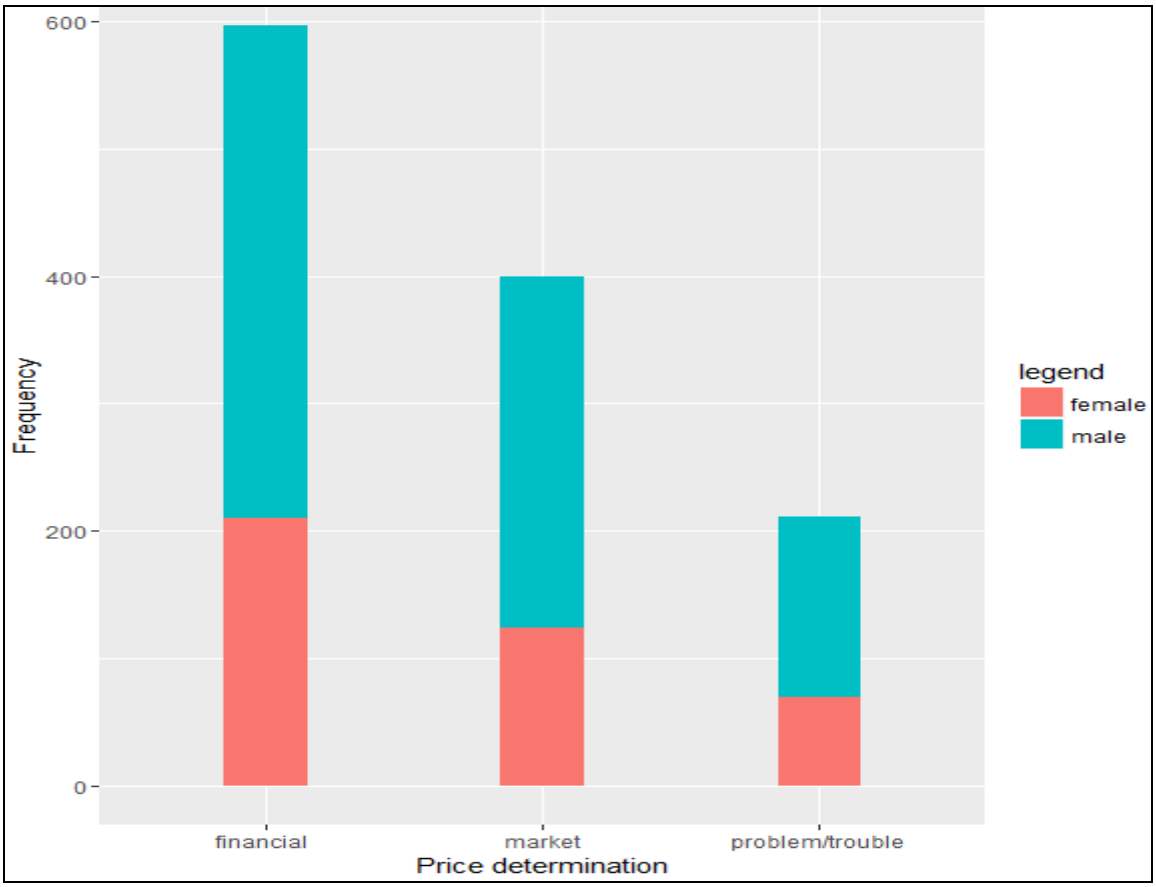

Figure 7. Price determinants of goats by gender of farmer.

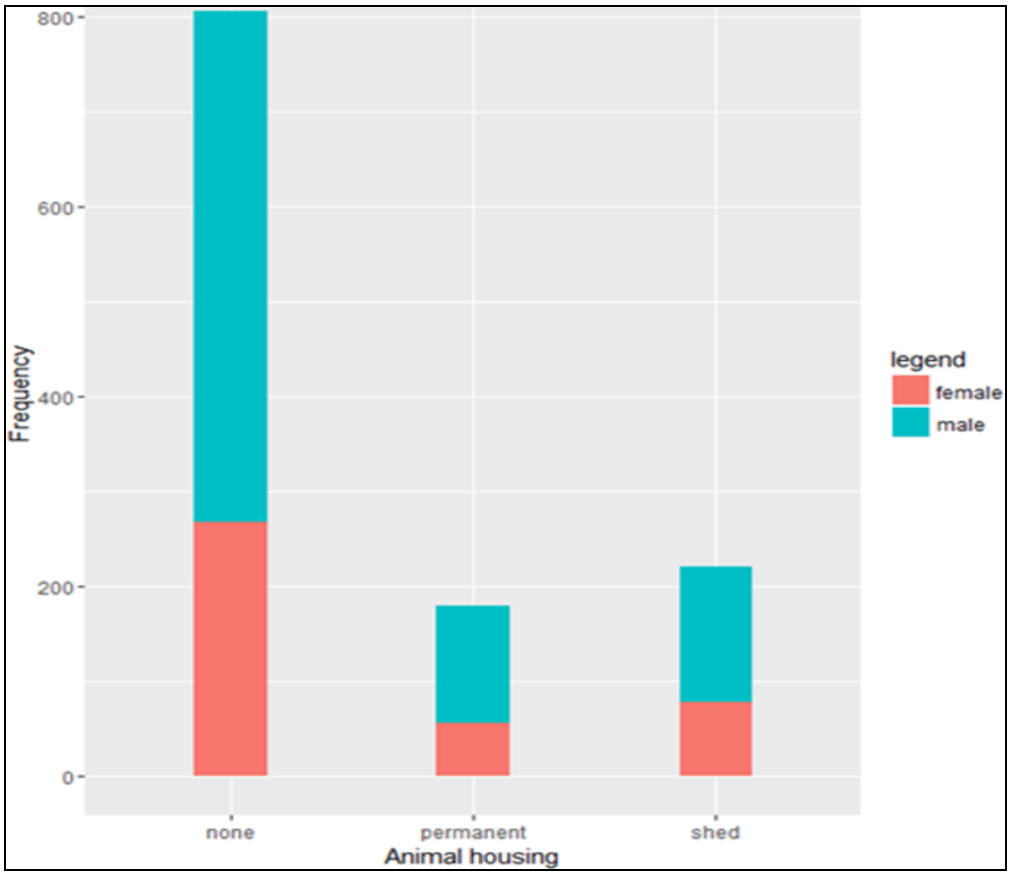

Figure 8. Housing type by gender of farmer for goats.

Figure 9. Variation in phenotypic attributes and production environments of West African Dwarf Goats in Liberia.

The type of mating system practiced by the goat farmers in Liberia was uncontrolled, non-seasonal, natural mating with multiple sires. This type of mating practice was reported by 91% of the goat farmers. Due to the free-range husbandry system, there is no control in which male of preference can be crossed with female of preference and this explains the high proportion of uncontrolled year-round natural mating of AnGR in Liberia. The traits of economic importance among the goat farmers were fast growth and meat production. The goat farmers indicated that fast growth and meat production (65%) as the most preferred production traits with the rest indicating either meat production (19%) or fast growth (16%) as essential.

The predominant source of water for goat production in Liberia is river, followed by deep well. These are relatively less expensive and sustainable sources of water which should be a motivation for potential goat farmers. It was noted that pipe-borne water is not a major source of water for animal genetic resources in Liberia. Pipe-born water in Liberia is treated and pumped from the well up to the water tank/towel and distributed via pipe or pumped directly from the water plant.

The degree of phenotypic variations among the WAD goats was reflected among others in body size and color pattern as shown in their natural environment (Figure 9).

Challenges of goat production in Liberia

The main challenges of goat farmers in Liberia included cost and availability of feed, housing and fencing, and disease conditions. Goat farmers indicated feed cost and availability (42%), diseases (28%), housing and fencing (16%) and cost of veterinary medicines (6%) as the major challenges in their production (Table 10).

Table 10. Frequency of back profile of goats.

Back profile	Sex of animal		Total
	Female (%)	Male (%)	
Straight	79	21	941 (72%)
Slopes up	76	24	263 (20%)
Slopes down	72	28	93 (7%)
Dipped/curved	55	45	11(1%)
Total	78	22	1308 (100%)

Chi Square Value = 30.2396; df = 2; P < 0.001.

This result agreed with the report of Ademosun (1988) that lack of veterinary care also raises problems of diseases and parasitic infestation leading to heavy mortality and low productivity. The problem of feed availability and costs is more acute with livestock farming in Liberia and these challenges need to be addressed not only to increase productivity, but motivate more farmers to go into livestock production. The cost and accessibility of veterinary services and medicines is a huge challenge to livestock farming (MOA, 2008). Animal diseases are a major constraint to livestock development and there is little information available on major diseases of goat. In addition, there is limited or no research programs on animal diseases or on the improvement of animal productivity in Liberia. Lack of veterinarian medicine and farm inputs also needs to be addressed urgently (MOA, 2008). The Liberian goat production is also beset with the poor housing and fencing facilities resulting in theft of goats on one hand and damages to crop farms on the other hand. An improvement in the housing and fencing infrastructure for goats will help curb these challenges. Record keeping was also a great challenge as most of the respondents could not supply the basic production data and this may require building up their capacity through training workshops and regular monitoring.

Conclusion

The WAD goats of Liberia are kept in subsistence husbandry systems. Family labor is the main source of labor and the main reasons for raising goats are for income and as source of meat. Goats in Liberia are docile to moderate in temperament, with black coat color pattern and black and white coat color. Most of the goats are horned with curved horn morphology. The goats are also known to have productive traits such as fast growth and meat production and are disease and drought resistant in terms of adaptive traits.

Many farmers do not provide adequate feed (forage and pasture), housing, and veterinary care to their animals. All of these affect production and productivity of AnGR. This poor environment does not allow the full genetic potential of the breed to be achieved and this has a negative effect on productivity and profitability of AnGR. Traditional livestock management system is practice where does and bucks run together all year round. Potential productivity of the goats is limited by poor management and strategies for improved natural resource management which leads high mortality.

The MOA should address the issue of feed, access to veterinary care and medicines, disease control and also assist farmers to put up housing and fencing for their animals. There is a need for the government to improve policies on AnGR management in Liberia. In particular, the recently adopted NSAP on AnGR which provides a clear framework for the development of the livestock sector should be validated and implemented by the MOA/CARI and other stakeholders.

To ensure that Liberia's valuable local AnGR are never lost, both *in situ* and *ex situ* conservations should be pursued. On transboundary breed like WAD, there is a need to have national breeding and conservation centers to ensure that these breeds are maintained. In terms of breeding programs, community-based breeding program for small ruminants is a viable option.

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REFERENCES

Adebambo AO, Ozoje MO, Anumuda CO, Peters SO (2002). Visible genetic profiles and phenotypic variation jn the West African Dwarf goats. Proc. 7th nn. Conf., Anim. Sci. Ass. Of Nig. (ASAN), held at Univ. of Agric. Abeokuta, Nigeria. Pp. 4-8.

Ademosun AA (1988). Appropriate management systems for the West African Dwarf in humid tropics. https://cgspace.cgiar.org/handle/10568/70786.

Adedeji TA (2012). Effect of some qualitative traits and non-genetic factors on heat tolerance attributes of extensively reared West African dwarf (WAD) goats. J Appl. Agri. Apicultural Res. 8 (1): 68-81.

Cam MA, Olfaz M, Soydan E (2010). Possibilities of using morphometric characteristics as a tool for body weight prediction in Turkish hair goats (Kilkeci). Asian J. Anim. Vet. Adv. 5 (1): 52-59.

Chiejina SN, Behnke JM, Nnadi PA, Ngongeh LA, Musongong GA (2009). The response of two ecotypes of Nigeria West African Dwarf goat to experimental infections with Trypanosoma brucei Haemonchus contortus. Small Rumin. Res. 85(2-3):91-98.

Daramola JO, Adeloye, AA (2009). Physiological adaptation to the humid tropics with special reference to the West African Dwarf (WAD) goat. J. Tropical Anim. Health Prod. 41(7):1005-1016.

Ershaduzzaman M, Rahman MM, Roy BK, Chowdhury SA (2007). Studies on the diseases and mortality pattern of goats under farm conditions and some factors affecting mortality and survival in Black Bengal kids. Bangladesh j. Vet. Med. 5:1 & 2.

FAO (2012). Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No. 11. Rome, Italy.

Hagan JK, Apori SO, Bosompem M, Mawuli A (2012). Morphological characteristics of indigenous goats in the Coastal Savannah and Forest Eco-Zones of Ghana. J. Anim. Sci. Adv. 2 (10): 813-821.

Hassen H, Baum M, Rischkowsky B, Tibo M (2012). Phenotypic characterization of Ethiopian indigenous goat populations. Afri. J. Biotechnol. 11(73): 13838-13846.

Hilal B, El Otmini S, Chentouf M, Boujenane I (2013). Morphological characterization of local goat population. "Beni Arrous". Option Mediterraneennes A, 108.

International Food Policy Research Institute (IFPRI) (2010). Impact of farmers field schools on Agriculture Production and Poverty, East Africa.

Koikoi KK (2011). Review of the livestock sector with respect to smallholder dairy livestock and meat sub-sector development in Liberia. Consultancy report submitted to FAO. Monrovia, Liberia.

Kolo PS, Egena DA, Adisa-Shehu M (2015). Phenotypic and genetic categorization of qualitative in extensively managed local goat (Capra aegagrus) population of Nigeria.

Kosgey IS, Okeyo AM (2007). Genetic improvement of small ruminants in low-input smallholder production systems: Technical and infrastructural issues. Small Rumin. Res. 70 (1):76-88. Nig. J. Genetic 28:38-43.

Ministry of Agriculture (MOA) (2008). Production Estimates of Major Crops and Animals. Monrovia, Liberia.

Mwacharo JM, Okeyo AM, Kamande GK, Rege JEO (2006). The small east African shorthorn zebu cows in Kenyua: 1-Linear body measurements. Trop. Anim. Health Prod. J. 38:65-76.

Ndikumana J, Struth J, Kamidi R, Ossiya S, Marambi R, Hamlett, P (2000). Coping mechanisms and their efficacy in disaster-prone pastoral systems of the Greater Horn of Africa. Effects of the 1995–1997 droughts and the 1997–1998 El Niño rains and the responses of pastoralists and livestock. ILRI Project Report. A-AARNET (ASARECA-Animal Agriculture Research Network), Nairobi Kenya, GL-CRSP LEWS (Global Livestock Collaborative Research Support Program Livestock Early Warning System), College Station, Texas, and International Livestock Research Institute, Nairobi, Kenya. Pp.112.

Nesamvuni AE, Mulaudzi J, Ramanyimi ND, Taylor GJ (2000). Estimation of body weight in Nguni-type cattle under communal management conditions. South Afr. Anim. Sci. J. 30 (Supplement 1): 97-98.

Odubote IK (1994a). Characterization of West African Dwarf goats for certain traits. Nig. J. Anim. Prod. 21:37-41.

Odubote IK (1994b). Influence of qualitative traits on the performance of West African Dwarf goats. Nig. J. Anim. Prod. 21:25-28.

Oseni SO, Ajayi BA (2014). Phenotypic characterization and strategies for genetic improvement of WAD goats under backyard systems. J. Anim. Sci. 4:253-262.

Ozoje MO (2002). Incidence and relative effects of qualitative traits in West African Dwarf goats. Small Ruminat Research. Technical note. 43:97-100.

Perry BD, Randolph TF, McDermott JJ, Sones KR, Thornton PK (2002). Investing in Animal Health Research to alleviate poverty. International Livestock Research Institute (ILRI), Nairobi, Kenya (2002). Pp.148.

Philipsson J, Rege JEO, Okeyo AM (2006). Sustainable breeding programs for tropical farming systems. In: Ojango JM, Malmfors B, Okeyo AM (eds.), AGTR-version 2, International Livestock Institute, Nairobi and Swedish University of Agricultural Sciences, Uppsala, Sweden.

Rodero S, HerreraGarrcia EM, Gutierrez Cabeza JM (1992). Morphostructural evolution of the Blanca Serrana caprine breed based on their crossing foe milking aptitude. Arch. Zootec. 14 (extra):519-530.

Richards JI (2002). Sheep and goats, their importance to livelihood and researchable issues. In: Smith T, Godfrey HS, Buttery PJ, Owen E (Eds.), Helping Small stock Keepers Enhance their livelihoods: Improving Management of smallholder Owned Sheep and Goats by utilizing Local Resources Proceedings of the Second DFID livestock Production Program Link Project (R7798) Workshop for Small stock Keepers. Sokoine University of Agriculture, Morogoro, Tanzania, 8–10 January 2002, Natural Resources International Ltd., Aylesford, Kent, UK (2002). Pp.1–6.

Rotimi EA, Egahi JO, Adeoye AA (2017). Body characterization of West African Dwarf (WAD) goats in Bassa local government area of Kogi State. World Scientific News (WSN). 69:179-189.

SAS Institute Inc. 2012. Base SAS® 9.4 Procedures Guide. Cary, NC: Copyright © 2012, SAS Institute Inc., Cary, NC, USA

Sykes N, Symmons R (2007). Sex cattle horn-cores: progress and problems. Int. J. Osteoarcheol. 17:514-523.

Webb EC, Mamabolo MJ (2004). Production and reproduction characteristics of South Africa indigenous goats in communal farming systems. South Afr. J. An. Sci. 34 (Supplement 1).