# Physical Characteristics and Selection Criteria of Pare White Goats in Kilimanjaro and Manyara districts, Tanzania

**Msemwa J.L. and S.H. Mbaga**

Department of Animal, Aquaculture and Range Sciences,
Sokoine University of Agriculture,
P.O. Box 3004, Morogoro,
Correspondence e-mail address: *mbagash@yahoo.com;* Phone: *+255 784 521 628*

**Abstract**

*The study was conducted in semi-arid areas of Kilimanjaro and Manyara districts Tanzania to describe the phenotypic attributes, selection preferences and criteria employed by the Pare White Goats (PWG) keepers. A total of 280 does and 140 bucks were measured for live body weight, linear and other morphometric characters. The general linear model (GLM) procedure (SAS, 2002) was used to analyse metric and scored parameters. The bucks were significantly (P<0.001) heavier (33.2±0.5kg) than does (30.4 ± 0.2kg). The heart girth, body length, wither height and rump height were 72.5±0.2, 64.4±0.2, 64.3±0.2 and 64.3±0.2 for females and 75.0±0.4, 66.1±0.4, 67.2±0.3, 67.0±0.3cm for males. Furthermore, the result showed that PWG are predominantly white, with long legs. The percentage of goats with wattles, beards and horns were 33.1, 38.1 and 84.5% respectively. Most of the goats (81.0%) had their ears held horizontally, while 82.4% had straight face and 76.2% of the goats had straight short hairs. Farmers do prefer the PWG because of their ability to deposit fats and high adaptability to semi-arid areas. Thus, the strain can be exploited through selective breeding for hot tropical environments.*

***Key words:*** Pare White goat, Selection criteria, Preference, Morphology

## Introduction

In pastoral and agro-pastoral areas indigenous goats are strategic animal genetic resource and are important in resource-poor communities because they provide tangible benefits such as cash income from animal sales, meat for home consumption, manure, skins, and fiber. They are also a source of intangible benefits, e.g. savings, insurance, and for socio-cultural purposes. The majority of goats in Tanzania belong to the Small East African (SEA) breed, which comprises a number of populations, including Ujiji, Sukuma, Maasai, Gogo, Pare, Sonjo, and Newala goats (Msanga *et al.,* 2001). The SEA goat breeds consists of heterogeneous populations, which exhibit large variability in body measurements such as body size, coat colour and other morphological features (Nguluma *et al.,* 2016). Genetic studies have also demonstrated that Gogo, Pare, and Sonjo populations are intermixed and not differentiated but, these strains are genetically more distant from the Sukuma type, the difference being explained by large geographical separation (Nguluma *et al.,* 2018). The Pare White Goats (PWG) is among the SEA strains that is dominant in pastoral and agro pastoral communities of Kilimanjaro, Arusha and Manyara districts in Northern Tanzania.

One of the Strategic Priority Areas of the Global Plan of Action is the characterisation, inventory and monitoring of trends in animal genetic resources diversity in order to properly assess the value of breeds and to guide decision making in livestock development and breeding programmes (FAO, 2011). In the absence of information about the genetic attributes of each breed available for breeding programme, development of local breeds is often ignored in favour of the introduction of germplasm from exotic breeds, about which more information is generally available. Thus, characterisation of breeds both at the level of animal phenotypes and their interaction with production systems and at the genetic level is most essential (Riva *et al.,* 2004; FAO, 2011). With exception of genetic studies reported recently by Nguluma *et*

*al.* (2016), there is still paucity of information with regard to the production, reproduction and adaptation attributes as perceived by the keepers of the WPGs who are the custodian of this strain. Likewise, little is known about these goats in terms of their phenotypic attributes, population trend and selection criteria adopted by the keepers. The present study was undertaken to document the morphological features of the PWG and the selection criteria adopted by farmers in maintaining the desired characteristics of the strain.

## Materials and Methods

### The study area

The study was conducted in two districts namely Same and Simanjiro. Same district is in Kilimanjaro region and lies on 4°2'S and 37°38'E, while Simanjiro district is in Manyara region and lies between 3°40' and 4°35'S and 35°50'E to 36°20'E. The study areas are semi-arid with bimodal short rains occurring between November and December followed by a dry spell and period of long rains from March to May. Rain averages to about 650mm per year. The mean temperature ranges between 16°C to 27°C. In Same district the study was conducted in two divisions namely Same and Mwembembaga located in the western side of the Pare mountains, while in Simanjiro sampling was conducted in Moipo and Naberera wards.

### Sampling and approaches

A multistage sampling technique was employed to select the study sites. Two divisions were purposively sampled for each district depending on the white goat population and two wards were selected from each of the two divisions. Both rapid appraisals and participatory surveying approaches were used. Prior to sampling of goats, focus group discussions (FGD) were held with a group of about ten key informants in each district. At the end of discussion, a list of PWG characteristics were drawn. This was followed by sampling of goats in randomly selected households whereby, a total of 140 does and 70 bucks were sampled from each division based on the agreed descriptors. Thus, in total a sample of 420 goats were evaluated.

### Data collection

Ten morphometric characteristics were taken on each animal sampled in the morning before they were released for grazing. Measurements were taken on adult healthy goats. Body weights were measured using a 100kg spring balance. Linear measurements included body length (BL), height at wither (HW) heart girth (HG), rump height(RH), rump width (RW), head length (HDL), head width (HDW), ear length (EL) and horn length (HNL).

In addition, six qualitative traits (hair type, horns, ears, head, wattles and beards) were evaluated. On the basis of wattles, horns and beards, goats were categorised into wattled and non wattled, horned and polled, bearded and none bearded. The horn shape was scored as strait or curved, even smooth curved or tip curved. The ear orientation was scored as erect, droopy or horizontal and the head profile was scored as convex, concave or straight. Hair type was categorised as straight short, straight long, glossy or dull. All the variables were coded by sexes. The information for selection criteria and preference were collected using a structured questionnaire administered to 50 respondents including both adult males and females. This was corroborated with information derived during FGD discussion on preferences.

### Data Analysis

A general linear Model (GLM) procedure of SAS (2002) was used for analysis of weight and linear measurements. Means (± s.e), total average, minimum and maximum of morphometric characteristics adjusted for sex and district were computed using model 1.

$$Yi\,jk = \mu + \alpha i + \beta j + eijk \quad \text{.....(1)}$$

Where, Yijk = record of body weight and linear measurements of each animal;

$\mu$ = overall mean,

$\alpha i$ = the effect of ith sex of the animal (male and female),

$\beta j$ = the fixed effect of jth district (Same and Simanjiro)

eijk = residual error.

In addition, six more qualitative traits (horns, ears, head, wattles, hair and beards) were scored for their frequency of occurrences. The goats that were polled were removed during computations for percentage of horn structures. Data on selection preference and criteria were analysed and ranked based on total weight scores, while content analysis was used to analyse information from FGD.

## Results and Discussion

### Body weight and linear characteristics

The linear characteristics of the population in this study are presented in Table 1. The average body weights of bucks and does were 33.2 ± 0.5 kg and 30.4 ±0.2 kg respectively, sex average being 31.4 ± 0.2kg. The average body weight was slightly higher compared to value of 29± 0.5 kg reported by Nguluma *et al.* (2016). As expected the body weight differed significantly (P<0.001) between sexes. Linear measurements such as heart girth, body length, wither height and rump width were also significantly (P<0.001) higher in bucks than in does. These results are consistent to those of Hassan and Ciroma (1990) for Red Sokoto strain, Madubi *et al.* (2000) for Dodoma strain and Katongole *et al.* (1996) for Tswana goats. In contrast PWG had larger heart girth compared for Kigoma and Newala Tanzanian goats (Madubi *et al.,* 2000) but compare well with Tswana goats (Khan *et al.* 2006 and Katongole *et al.,* 1996). The difference in body weight and HG values between strains may reflect strain/breed difference or the environment particularly on availability of nutrient and season in which measurements were taken.

Nevertheless, the body lengths of PWG (66.1 ± 0.4 for bucks and 64.4 ± 0.2 for does) are within ranges reported by Jimcy *et al.* (2011) and Hassan and Ciroma (1990) for Red Sokoto

**Table 1: Mean (±Se) for Bodyweight (kg) and Linear Body Measurement (cm) of Adult PWGs by Sex**

| Trait | Sex | N | Mean ± se | Min | Max | Average |
|---|---|---|---|---|---|---|
| Body weight | F | 280 | 30.4 ± 0.2a | 24 | 47 | 31.4 ± 0.2 |
| | M | 140 | 33.2 ± 0.5b | 25 | 52 | |
| Heart Girth | F | 280 | 72.5 ± 0.2a | 65 | 87 | 73.3 ± 0.2 |
| | M | 140 | 75.0 ± 0.4b | 59 | 92 | |
| Body length | F | 280 | 64.4 ± 0.2a | 53 | 75 | 65.0 ± 0.2 |
| | M | 140 | 66.1 ± 0.4b | 55 | 81 | |
| Wither height | F | 280 | 64.3 ± 0.2a | 55 | 82 | 65.3 ± 0.2 |
| | M | 140 | 67.2 ± 0.3b | 58 | 79 | |
| Rump height | F | 280 | 64.3± 0.2a | 50 | 71 | 65.2 ± 0.2 |
| | M | 140 | 66.9 ± 0.3b | 59 | 75 | |
| Rump width | F | 280 | 15.7± 0.1 | 12 | 20 | 15.5 ± 0.1 |
| | M | 140 | 15.3 ± 0.2 | 11 | 25 | |
| Head length | F | 280 | 18.0 ± 0.1 | 12 | 25 | 18.1 ± 0.1 |
| | M | 140 | 18.3 ± 0.2 | 12 | 23 | |
| Head width | F | 280 | 13.6 ± 0.1a | 11 | 18 | 14.2 ± 0.4 |
| | M | 140 | 15.4 ± 1.0b | 11 | 16 | |
| Ear length | F | 280 | 11.5 ± 0.1 | 6 | 16 | 11.5 ± 0.1 |
| | M | 140 | 11.4 ± 0.1 | 8 | 16 | |
| Horn length | F | 280 | 8.0 ± 0.1 | 4 | 16 | 8.8 ± 0.3 |
| | M | 140 | 9.5 ± 0.4 | 4 | 23 | |

goats. Wither height differed significantly (P<0.001) between sex and males had high values of wither height than females similar to findings that were reported by Paul *et al.* (2011). Contrasting findings were reported by Madubi *et al.* (2000) for Dodoma, Kigoma and Newala Tanzanian strains where the WH values were lower than those obtained in this study. The rump heights (67 ± 0.3 cm for males and 64.3 ±2 cm for females) observed in this study lie within the range reported by Yakubu *et al.* (2010) that is 45.96 cm to 66.59 cm. Rump width did not differ between males and females. In general, the PWG have been shown to have relatively higher values for most of linear body measurements compared to Sonjo, Sukuma and Gogo strains (Nguluma *et.al.,* 2016).

The difference in head length between sexes was not significant while, head width differed significantly (P<0.01). Ear lengths of PWG ranged from 6.0 cm to 16.0 cm with an overall mean of 11.5 cm similar to results reported by Paul *et al* (2011), Chacón *et al.* (2011), Yakubu *et al.* (2010) and Hassanat *et al.* (2003). The horn length was of medium size and the values are within the range reported by Madubi *et al.* (2000) for Tanzanian strains.

**Other physical features**

Majority of PWGs were white and most of them had straight short hair i.e. 61.3% and (91.0%) for bucks and does respectively (Fig 1&2). Few had straight long hairs (32.7%) for bucks and does (7.7%). The straight long hairs were noticed at low frequency in bucks on hind quarters and along the backline. These features are similar to those reported by Katongole *et al.* (1996) for Tswana goats.

However, both sexes of PWG were observed to have wattles (toggles) (Table 2). The wattled condition existed at slightly higher proportion in male (35.1%) than in female goats (31.1%). In contrast Nguluma *et al.* (2016) recorded zero frequency for this trait. High frequency of wattled males was also reported in Nigerian indigenous goats whereby the frequency of the trait was 31.6% in males compared to 5.8% for does (Yakubu *et al.,* 2010). However, Manzi *et al.* (2011) and Katongole *et al.* (1996) reported low frequency of 14% and 9.0% for Rwanda SEA and Tswana goat respectively.

**Fig. 1: A Pare White buck**

**Fig. 2: A Pare White Doe**

Conversely, Adedeji *et al.* (2006) reported high frequencies of 64.3% and 68.59% for the presence of wattles in male and female West African Dwarf (WAD) respectively. Possession of wattles has been associated with adaptation to hot environment in the tropics (Adedeji *et al.* 2006).

Both sex had beards although more males (59%) were bearded that females (17.3%). Nguluma *et al.* (2016) also reported a frequency of around 54% for bearded WPGs. The possession of beards is a secondary male sexual characteristic and does exhibiting the trait might have more secretion of androgen, a male hormone (Adedeji *et al.,* 2006). However, the incidence of beards revealed in this study is higher than that reported by Adedeji *et al.* (2006) for bucks (11.5%) and does (7.3%) in WAD goats and Manzi *et al.* (2011) for Rwanda SEA goats. In addition to beards, both sexes were horned but the proportion of horned males was higher (89.3%) compared to females (79.6%). However, horn curvature was manifested more in does (62.8%) than in bucks (50.4%). The frequency of horn pattern is similar to the findings reported by Katongole *et al.* (1996) for Tswana goats who also observed low frequency of horns possession in females compared to males. The combined average frequency (84.5%) for hornness found in the current study is slightly lower than the frequency 91.0% and 97.0% reported by Manzi *et al.* (2011) for the SEA of Rwanda and for Somali Galla goats (FAO, 2007). However, findings from current study differed from what was reported by Adedeji *et al.* (2006) who reported higher frequency of straight horned

**Table 2. Frequency of qualitative traits in adult PWG by sex**

| Traits | | Phenotypic frequency | | | | |
|---|---|---|---|---|---|---|
| | | N(male) | N(female) | Male (%) | Female (%) | Combined average (%) |
| Wattles | Present | 49 | 87 | 35.1 | 31.1 | 33.1 |
| | Absent | 91 | 193 | 64.9 | 68.9 | 66.9 |
| Beards | Present | 82 | 48 | 58.9 | 17.3 | 38.1 |
| | Absent | 58 | 232 | 41.1 | 82.7 | 61.9 |
| Horns | Horned | 112 | 250 | 89.3 | 79.6 | 84.5 |
| | Polled | 28 | 30 | 10.7 | 20.4 | 15.5 |
| Horn shape | Straight | 69 | 105 | 49.6 | 37.2 | 43.4 |
| | Curved | 71 | 175 | 50.4 | 62.8 | 56.6 |
| Horn curvature | Tip curved | 18 | 272 | 12.7 | 97.1 | 54.9 |
| | Even curved | 122 | 8 | 87.3 | 2.9 | 45.1 |
| Ear orientation | Droopy | 26 | 55 | 18.5 | 19.6 | 19.1 |
| | Horizontal | 114 | 225 | 81.5 | 80.4 | 81.0 |
| Head profile | Straight | 109 | 243 | 78.0 | 86.8 | 82.4 |
| | Concave | 23 | 24 | 16.1 | 8.7 | 12.4 |
| | Convex | 10 | 13 | 6.9 | 4.5 | 5.7 |
| Hair type | Glossy | 0 | 0 | 0 | 0 | 0.0 |
| | Dull | 140 | 280 | 100 | 100 | 100.0 |
| Hair shape | Curly/rough | 8 | 4 | 6.0 | 1.3 | 3.7 |
| | Straight long | 46 | 22 | 32.7 | 7.7 | 20.2 |
| | Straight short | 86 | 255 | 61.3 | 91.0 | 76.2 |

goats for West African Dwarf (WAD) (89.8%) and a few (10.2%) with curved horns.

Furthermore, the result showed that most of the goats had horizontal ears (81%) and there was relatively lower frequency for droopy ears (19.6%) for does and (18.5%) for bucks. The findings are in concordance with what was reported by Adedeji *et al.* (2006) in WAD goats whereby 92.0% had horizontal orientation but, slight lower than value of 68% for horizontal ears reported by Nguluma *et al.* (2016) in PWG, which the later conform to what was reported for Tswana goats (Katongole *et al.,* 1996). Higher values ranging from 63-88% have been reported for other Tanzania goat strains (Madubi *et al.* 2000, Nguluma *et al.,* 2016). The other characteristic studied was face profile whereby the results revealed that more than three quarters of the sampled goats had straight face. The findings in this study are similar to that reported by (FAO, 2007) for Red Sokoto and Msanga *et al.* (2001) for Maasai, Kigoma and Newala strains of Tanzanian goats and Nguluma *et al.* (2016) for Pare goats.

**Preference to Pare White Goats**

Based on ranked weights, the PWGs were mostly preferred compared to other local goat breeds due to their ability to deposit fat, the ability to walk long distance and adaptability to hot and dry environment. PWGs were also said to sale easily in local markets compared to coloured goats (Table 3) due to their relatively good body conditions, which stem from ability to deposit generous amount of fat despite of the often harsh environment in which they are raised. Having a white coat colour in this regard is an adaptive feature whereby, animals with light coat coloring tends absorb less heat than those with darker

coats (Asres, and Amha, 2014). Acharya *et al.* (1995). The authors also reported lower rectal temperature in white goats compared to black, brown or light brown. Although feed intake and rectal temperature were not measured in the current study, observation from focus group discussion showed that white coloured goats tended to seek shed less during hot weather compared to coloured goats signifying their ability to withstand hot environment. As a result, white goats are likely to have more feed intake that explain their better body condition and easy marketing compared to coloured goats of similar age. This observation is in concordance with the report of Yakubu *et al.* (2010) and Adedeji *et al.* (2006) that white colouration in goats is advantageous in place where there is intense radiation due to its reflectance property. heat than animals with short, squat bodies. Thus, having taller legs is an evolutionary process which has enabled these goat breeds to adapt to feeding behaviour, disease and environmental stress of a particular geographical region.

**Selection criteria**

In order to maintain desired characteristics in PWG, various selection criteria are used depending on sex of the animal. Bucks were selected based on body size, growth rate, coat colour, birth type, conformation and dam history while in selecting for breeding does, farmers pay more attention to birth type, milk production, growth rate and body size, kid survival, conformation and tits length in that order (Table 4). High score on body size, fast growth rate and ability to sire multiple kids

**Table 3: Preference to Pare White Goats**

| Criteria | Rank 1 | Rank 2 | Rank 3 | Sum (1,2,3) |
|---|---|---|---|---|
| Fat deposit | 31 | 8 | 4 | 43 |
| Disease/parasites resistance | 1 | 1 | 3 | 5 |
| Low water requirement | 2 | 1 | 9 | 12 |
| Walk long distance | 4 | 10 | 5 | 19 |
| Marketability (easy to sale) | 1 | 2 | 4 | 7 |
| Ability to survive in drought | 2 | 7 | 2 | 11 |
| Docility | 0 | 1 | 2 | 3 |

Another reason for the preference for PWG as argued by farmers was the ability to walk long distance and tolerance to thirst than other coloured goats. In the study areas, goats have to walk long hours in search of feeds and water especially during period of drought. Normally, goats are watered once per week during this period and the PWGs have been noted to endure without losing body condition for relatively longer time compared to other non-Pare white goats (Table 3). The ability to walk long distance can also be corroborated with the higher values for height at wither compared to other Tanzanian local breeds as reported by Nguluma *et al.* (2016). The authors reported values of 61.4 cm for height at wither for WPG compared to values of 58.7cm (Gogo), 57cm (Sonjo) and 55cm for Sukuma type. Mwacharo *et al.* (2006) also reported that taller animals dissipate more have also been reported as selection criteria in Uganda goats (Ssewannyana *et al.,* 2004 and Jimmy *et al.,* 2010). However, this study observed that farmers pay less attention on colour of the dam especially when the flock size is small. For household with large goat herd none white bucks were often castrated or disposed off through sale or slaughter. This selection practice ensured propagation of white gene and probably other desired features of PWG in the herds.

Breeding bucks were mainly bred from within the flock and occasional bought from neighbours or livestock markets. Similar ways of goat acquisition had been reported in Uganda by Jimmy *et al.* (2010) and Ssewannyana *et al.* (2004). Other methods used to acquire desired characteristics include exchange where, livestock keepers may use sire from different

herd to provide infusion of "fresh blood" to maintain the vitality of otherwise closed gene pool (FAO, 2009).

**Table 4: Acquisition of breeding buck and selection criteria**

| Parameter | | | | | Frequency | | | Percent (%) |
|---|---|---|---|---|---|---|---|---|
| i) Acquisition of breeding buck | | | | Bred in herd | 24 | | | 56 |
| | | | | Buy | 19 | | | 44 |
| ii) Selection criteria: Selection of Bucks | | | | | Selection of dams | | | |
| **Criteria** | **Ranks (%)** | | | | **Ranks (%)** | | | |
| | **1** | **2** | **3** | **Total weight** | **1** | **2** | **3** | **Total weight** |
| Body size | 7 | 16 | 2 | 25 | 5 | 3 | 8 | 16 |
| Conformation | 4 | 4 | 2 | 10 | 2 | 2 | 3 | 7 |
| Colour | 1 | 3 | 14 | 18 | 0 | 0 | 0 | 0 |
| Birth type | 2 | 3 | 7 | 12 | 13 | 6 | 3 | 22 |
| Growth rate | 14 | 6 | 1 | 21 | 4 | 7 | 5 | 16 |
| Milk | 4 | 2 | 5 | 11 | 5 | 4 | 11 | 20 |
| Kid survival | - | - | - | - | 6 | 5 | 3 | 14 |
| Tits length | - | - | - | - | 1 | 2 | 2 | 5 |

## Conclusion

The PWGs are an integral part of the pastoral and agro-pastoral economy in semi-arid areas of Northern Tanzania. The strain has features similar to those of most African goats although some differences were observed. They are predominantly white, with large body size and highly adapted to hot and dry environment. They sale easily due to better finish compared to coloured goats and therefore, can be exploited through selective breeding in hot tropical areas.

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