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RESEARCH ARTICLE

PHENOTYPIC CHARACTERIZATION OF GOBRA ZEBU CATTLE OF CENTRE DE RECHERCHES ZOOTECNIQUES OF DAHRA.

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Abstract

Senegalese zebu Fulani (*Bos taurus indicus*), commonly called zebu Gobra, is one of three local cattle breeds. Its socio-economic importance for food security and incomes generation was at the origin of the establishment of the Centre de Recherches Zootecniques (CRZ) of Dahra in 1952 and the initiation of the Gobra cattle breeding program. In order to increase knowledge on local bovine breed, this study aimed to phenotypical characterization of Gobra zebu. Twenty-six (26) phenotypic parameters were measured or described on sixty-six adults animals (six males and sixty females) over 4 years of age chosen from the selection's nucleus herd of the CRZ. Also, weight records on the animals from 2010 to 2016 were also analyzed. Qualitative parameters were expressed as percentages and descriptive analysis were done on quantitative parameters. Means comparison according to the sex of animals was performed using Student's t-test or Wilcoxon test according on results of the Shapiro-Wilk normality test. The main results showed that Gobra cattle is an ellipometrical animal with an average height at the withers of 121.56 ± 5.53 cm, a heart girth of 171.39 ± 11.23 cm and a body length of 127.15 ± 11.29 cm. The body weight's average was 577.5 ± 81.32 kg and 393.81 ± 51.69 kg respectively for bulls and cows. Sexual dimorphism is marked between males and females with significant differences. Low weight performances are reported compared to previous studies in the same research station. Gobra breeding program needs to be reinforced and *ex situ* conservation should be considered.

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Introduction:-

Senegalese zebu Fulani (*Bos taurus indicus*), also commonly named zebu Gobra, is one of three local cattle breeds. Originated from the Sylvo-pastoral area in central northern part of the country, this breed is widely raised in the northern and central part of the country where it assumes most of milk and meat production. It is very appreciated by

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farmers because of its adaptation to drought and long walks, aptitudes necessary for extensive farming system characterized by mobility called transhumance (Magrin et al., 2011; Ba, 2013). According to Thiongane and Denis (1974) and Sow et al. (1988), the meat genetic potential of this breed is underexploited. Its importance in the socio-economic livelihood of people for food security and incomes generation was the reason of the establishment of the *Centre de Recherches Zootechniques* (CRZ) of Dahra in 1952. The major mission of this research station was to improve Gobra breed productivity through mass selection. The breeding program was initiated in 1953 and a closed selection scheme applied on animals of the foundation herd originated from rural herds. Selected bulls from the breeding program were transferred into rural herds to disseminate the genetic progress. In the 1990's due to financial constraints the breeding program slowdown but the selection's nucleus herd has been maintained at the CRZ. Recently, starting in the 2000's, Senegalese Government supported a policy for dairy production improvement through crossbreeding of local cattle with exotic dairy breeds (Holstein, Montbeliard) via artificial insemination campaigns. More and more farmers are convinced that crossbreds are unsuited to pastoral farming exacerbated by climate change. They perceive feed scarcity and mobility as major constraints for the management of crossbreds and local breeds are more adapted to pastoral systems. This was confirmed by Diack et al. (2016) who reported that more than 78% of animals of rural farms of zone Sylvo-pastoral were Gobra. This renewed interest for the local breed is an opportunity for the resuming of the Gobra breeding program. The objective of this study is to phenotypically characterize Gobra breed raised at the CRZ.

Materials and methods:-

Site and study's materials

The study was carried out at the CRZ of Dahra (15°20'53" North and 15°26'41" West) located in the Sylvo-pastoral area of Senegal from October 2016 to March 2017. In this research station, one hundred and thirty-one (131) cattle representing the closed selection's nucleus herd of Gobra breeding program are reared extensively since 1953. Our choice is guided by the fact that Gobra animals are preserved from crosses with others breeds. Their feeding resources are mainly provided by the natural pastures of the station. However, during the dry season when pasture is poor, concentrates (composed mainly by cereals) are distributed to the young animals, sick animals and pregnant and lactating females. If financial resources were available, all animals benefited to supplementary feeding ration. Watering is at *ad libitum*. The animals have regular health monitoring with frequent deworming, treatment of sick animals and vaccinations against common diseases of the area. Each animal is identified with an ear tag and branded number. For all animals, pedigree, weight and reproductive performances are recorded. As required for mass selection evaluation, all animals are weighed frequently depending on their age. Animals are weighed at birth, every month up to 6 months of age, every two months from 6 months to 1 year of age, every 3 months from 1 to 3 years of age and every 6 months from 3 years of age.

Data collection and variables studied

Sixty-six (66) adult animals (6 males and 60 females) aged over 4 years are involved in the morphometric characterization. As recommended by FAO's Animal Genetic Resource Characterization Guide (FAO, 2012), data on eleven (11) qualitative and fifteen (15) quantitative variables are collected from animals and recorded on Excel table sheet. The quantitative variables considered are: head length (HL), head width (HW), skull width (SW), skull length (SL), facial length (FL), snout length (SnL), distance between horns from base to base (DBH), ear length (EL), height at withers (HeW), chest depth (CD), body length (BL), chest height (CH), tail length (TL) and body weight (BW). HeW and CH were measured using a sliding metallic ruler. A standard measuring tape was used for other measurements. All of these measurements were taken on immobilized animals (Figure 1). The qualitative variables described after direct observation of the animal are: coat pattern type of hair, shape and colour of horn, muzzle colour, eyelid colour, hoof colour, ear orientation, facial profile, backline profile, shape and position of hump, dewlap aspect and the body hair coat colour pattern (black spots and stripes on the animal's body).

To evaluate the weight performances of animals, the weights recorded on fifty-one (51) cattle (22 males and 29 females) from selection's nucleus herd from 2010 to 2016 have been analysed. Data are reported at different ages of the animal: birth, 3, 6, 12, 18, 24, 30, 36, at 42 and 48 months. Due to reform and mortality, the number of weighed animals is variable depending of age considered. Beyond 2 years of age, few information was available from the database: 35 animals for 30 months, 21 animals for 36 months, 17 animals for 42 months and 10 animals for 48 months.

Statistical analysis

Results for qualitative variables were expressed as percentages and descriptive analysis (with mean, standard deviation, minimum and maximum) was realized for data collected on quantitative variables. According to results of

the Shapiro-Wilk normality test, means comparison according to the sex of animals was performed using Student's t-test or Wilcoxon test (Cornillon et al., 2010). The level of significance was set at 5% for all comparison tests. All analyses were performed using R software version 3.3.1 (R Core Team, 2016).

Results

Phaneroptotic and morphometric description

The herd constituting the selection's nucleus is homogeneous because all the animals have the same appearance: rectilinear facial profile, erect ears, a cervico-thoracic hump, a developed dewlap, uniform coat with short hair (Figure 2). Almost 96% of animals have backline profile rectilinear (Figure 3). The uniform white coat is described in 81.82% of individuals compared to the sand and tawny coloured observed respectively in 13.64% and 4.55% of the sampled animals. All the animals are horned and most of them have lyre-shaped horns (88.36%). White horns described in 68.18% of animals are predominant followed by bicolour -black and white- ones (Figure 3). Black spots and stripes on animal's coat are not frequent in Gobra zebu, they are found mainly in male respectively in 13.63% and 8.20% of sampled animals. Pigmentation of mucous membranes and skin appendages was fairly observed; only 15.15% and 11.64% of individuals show pigmentation respectively on the muzzle and the eyelids. Pigmented hooves were described in 22.73% of sampled animals (Figure 3). Sexual dimorphism is marked and horns, dewlap, hump are more developed in male (Figure 2).

Considering the format (size and weight) classification, the zebu Gobra of CRZ of Dahra is an ellipometric, animal with a HeW's average of 121.56 ± 5.53 cm and BW's average of 399.84 ± 61.48 kg. The average of BL and CD are 127.15 ± 11.29 cm and 171.39 ± 11.23 cm, respectively with a TL average of 95.18 ± 6.17 cm. Bull's measurements are significantly higher than those for cow, underlining marked sexual dimorphism (Table 1). For bull, an average of 129.27 ± 4.38 cm for the HeW is reported with 149.92 ± 12.36 cm and 194.12 ± 7.03 cm respectively for the BL and CD. The BW's average is 577.5 ± 81.32 kg with a minimum of 520 kg and a maximum of 635 kg. In comparison, cow has HeW's average of 120.79 ± 5.04 cm. Her BL and CD means are 124.88 ± 8.33 cm and 169.12 ± 8.77 cm respectively. BW's average of 393.81 ± 51.69 kg is noted with minimum and maximum values of 290 kg and 560 kg respectively. For all these body measurements, significant differences between males and females are observed except for TL (Table 1).

For head measurements, averages are 23.09 ± 2.34 cm for EL, 28.54 ± 2.19 cm for FL and 42.03 ± 3.55 cm for SnL. Also, for DBH and HL averages are 16.32 ± 1.95 cm and 58.09 ± 10.29 cm respectively. For all head measurements only HL and SnL show significant differences between males and females (Table 1).

Weight performances

The results of CRZ of Dahra's database analysis, for weight performances during the period from 2010 to 2016, of the animals from birth to 48 months of age are noted in Table 2. An average birth weight of 21.51 ± 3.6 kg with 14 kg and 31 kg as minimum and maximum values respectively is noted. At three (3) and six (6) months of age, an average weight of 52.08 ± 10.99 kg and 79.2 ± 15.67 kg are reported for young animals respectively. The same tendency was observed for 12 months, 18 months and 24 months of age with respectively 112.44 ± 36.98 kg, 154.72 ± 26.79 kg and 168.36 ± 35.66 kg. As well at 30 months and 36 months of age, the average weights of the animals were 214.96 ± 42.71 kg and 239.19 ± 54.62 kg respectively. For animals of 42 and 48 months old, an average weight of 298.74 ± 33.35 kg and 306.17 ± 29.58 kg are reported. From birth to 3 months of age, no difference was noted between males and females. In contrary from 6 months of age, males had higher average weight compare to females but the difference was significant only for 18 months of age.

Discussions:-

The similar appearance of the animals of selection nucleus is due to closed nucleus scheme applied by the breeding program and certain external characters such as the coat colour, the backline profile, the horn shape has been privileged as selection criteria. External characteristics of animals such as coat colour, presence of horns are important socio-cultural parameters like bioeconomic parameters - weight and milk production - because they are subject to sociological interpretations by farmers. This is way some considerations have been taking in account by the breeding program. We can underline that Fulani pastoralist herders from the northern and central parts of the country prefer horned cattle with white coat. As described by Ndiaye et al. (2018) for ovine, phenotypical characteristics such as coat pattern, format and other external characteristics have sociological interpretation by farmers and they can impact on the commercial value of the animals. Fortunately, they have been taken in account at the beginning of the breeding program.

Since the beginning of the breeding program, weight, reproductive and morphometric parameters data were collected. Unfortunately, morphometric data recorded on adult Gobra (aged over 4 years) at the CRZ of Dahra are sparse and relatively low in number compared to data recorded about young animals. Indeed, before 1965 the Gobra's morphometric measurements were recorded from birth to 36 months of age (CRZD, 1963; CRZD1966). From 1965 to 1980's these measurements were carried out from birth to six years of age. However, because of CRZ difficulties on data collection and herd management, these measurements have been gradually abandoned (Thiongane and Denis, 1974; Chollou et al., 1978; Sow et al., 1988; Sow et al., 1991). In rural farms, latest information was provided by Mime (1981), Pagot (1985) and Missohou et al. (1997). In summary, recent morphometric informations on adult Gobra animals do not exist so it was not easy to compare our results.

Morphological characters reported by this study confirmed observations reported earlier for the breed by FAO (1957), Denis and Thiongane (1973), Pagot (1985), Ndiaye (1990), Ly (1992), Ndiaye et al., (2015). The morphometric measurements for their part are lower than those available in the literature. Indeed, the study of Denis and Thiongane (1973) on zebu Gobra cattle enrolled in the CRZ of Dahra's breeding program, reported a HeW's average from 122 to 133 cm, Mime (1981) and Missohou et al. (1997) described a HeW varying from 135 to 140 cm for the male and from 125 to 135 cm for the female. The sexual dimorphism with a marked superiority of males compared to females was early emphasized by Pagot (1985). This author indicated an average of 184.71 cm and 141.6 cm for CD and BL respectively. Also, Sow et al. (1988) noted on 3 years old animals of the breeding program CRZ of Dahra, a HeW of 123.6 cm, a CD of 168 cm and a BL of 146.2 cm for the male compare to 118.8 cm, 158.9 cm and 139.1 cm for HeW, CD and BL respectively for the female. These measurements are closed to our results where older animals (more than 4 years) have been considered. This corroborates the decline of current format of animals enrolled in the selection nucleus. Concerning weight performances, Mime (1981) reported for animals of the selection nucleus, average weights of 300 to 400 kg for males and 250 to 350 kg for females. These performances close to our results are tightly correlated to feeding practices according to Denis and Valenza (1971). These authors pointed out that well-fed zebu Gobra animals can reach average weights between 500 kg and 600 kg.

In the sub region, although few recent studies on phenotypic characterization of Sahelian, Arab and Fulani zebu have been carried out, it appears that zebu Gobra morphometric measurements are slightly higher than those of others Sahelian Fulani zebus. Indeed, Moussa et al. (2017) indicated for the zebu Bororo an average HeW of 120.50 cm with a mean CD of 156.70 cm and an average BL of 134.80 cm. Also, these authors reported for Benin Fulani zebu, an average HeW of 101.20 cm and 133.70 cm and 118.70 cm for CD and BL respectively. For Burkina Faso Fulani zebu, they indicated, an average of 112.60 cm for HeW with a mean CD of 142.90 cm and a mean BL of 126.80 cm. Unlike Fulani zebus, the Arab zebus in the Sahelian area have higher measurements than those reported for zebu Gobra in our study. For Moorish zebu DNPIA (2016) mentioned that BL varies between 124 and 150 cm and the CD from 160 to 185 cm. For this breed, this study reported for adult males an average weight between 350 and 400 kg with a HeW from 140 to 150 cm while for females, average weight from 250 to 300 kg with a HeW from 125 to 130 cm were noted. For Azawak breed, Dioffo (2004), Oumarou (2004) and DNPIA (2016) reported, average weight ranging from 500 to 600 kg with average HeW of 130 cm for the male and 125 cm for the female. These authors noted also an average CD of 174.11 cm and an average BL of 136.96 cm. The same tendency was noted for zebu Goudali (Atti-Mahamat, 1989). Furthermore, under the same rearing conditions, the exotic zebu Guzarat, Red Sindi and Sahiwal were heavier than zebu Gobra according to Denis and Valenza (1970).

Regarding zebu Gobra weight evolution profile from 2010 to 2016, our results showed low performances compared to those reported by previous studies in the same research station. Indeed, on animals of selection nucleus reared in similar system (extensive system), Denis and Valenza (1971) reported at birth weights of 25 kg and 23.50 kg respectively at males and females. The sexual dimorphism was emphasized by these authors who indicated an average weight of 96.20 kg and 88.10 kg respectively for males and females 6 months old. The tendency was observed for 1 year old animals (average weight for males 144 kg and 129 kg for females) and 3 years old (364.30 kg for males and 309.50 kg for females). Valenza et al. (1971a; 1971b; 1971c) and Calvet et al. (1972) showed that intensive fattening of zebu Gobra during 4 months with local crop residues increased quantity and quality of meat. Furthermore, the study of Denis et al. (1973) on exteriorization of genetic potential of Gobra zebu confirmed the importance of feeding management. These following performances have been reported: 123.30 kg at 6 months, 248.70 kg at 1 year of age and at 3 years at 634.20 kg. All these results showed that when feeding conditions are improved, better weight performance can be achieved. Based on these conclusions, low performances of animals reported by our study were attributable to management. Efficiency of current feeding practices were impacted by combined effects of insufficient funds allocated to purchase feed concentrates and quantity of natural forage available from pastures in the CRZ of Dahra (Diallo et al., 2011; 2012; Ngom et al., 2012; Ndong et al., 2015).

Taking in account these considerations, major challenge of the Gobra breeding program which plays actually a role of *in vivo* breed conservation will be to select and transfer to farmers animals with high performance as requested. For this, current feeding practices at the CRZ need to be improved in order to boost growth of young animals for exteriorization of their genetic potential. Also, data collected during the program need to be secured because our study would be more complete if reproductive performances such as calving interval, age at first calving have been considered in our study. Unfortunately, this problem is common to others breeding program implemented in some West African countries. Also, genetic characterization study is necessary to evaluate level of introgression of exotic blood into pastoral herds and to provide data for future conservation program. Actually, resilience of farmers to climate change depends on their own adaptation strategies in raising local breeds instead of crossbreds or changing their farming system as mentioned by Herrero et al. (2008) and Hoffman (2010). In this context, the lesson learnt is that ex-situ conservation needs to be implemented at national gene bank to preserve “purity” of breed and artificial insemination can be used to disseminate genetic progress of the breeding program into rural herds.

Conclusion:-

This study highlighted the results of a breeding program which preserved the local Gobra breed of Senegal. Well adapted to extensive land-based production this breed plays an important role in food security and incomes generation for populations. The phenotypic characterization results have contributed to a better knowledge of this breed in the current context where crosses with exotic breeds are ongoing. In the same way, genetic characterization would help comparison between animals of the selection nucleus with those raised on rural herds. Also, the results of this study pointed out improvement needs for feeding practices and tight selection of animals to be maintained into the nucleus. Gobra breeding program needs to be reinforced and ex situ conservation should be considered.

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Table 1:-Morphometric measurements of adult zebu Gobra.

Measures		Overall (n=66)		Males (n=6)		Females (n=60)		p-value
		Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	
Head	HL (cm)	48.68±2.92	42.6-63.3	52.42±6.77	42.7-63.3	48.3±1.99	42.6-52.6	*
	HW (cm)	21.69±2.24	16.4-33.6	22.65±2.87	19.5-26.8	21.59±2.18	16.4-33.6	-
	SW (cm)	20.14±1.67	15.5-26.5	21.78±3.27	18-26.5	19.97±1.37	15.5-22.3	-
	SL (cm)	19.21±1.34	14.9-23	19.6±1.97	17-23	19.18±1.28	14.9-21.2	-
	FL (cm)	28.54±2.19	22-36.8	30.63±5.67	22-36.8	28.33±1.43	24.2-31.8	-
	SnL (cm)	42.03±3.55	35.8-58	50.55±3.99	47-58	41.18±2.11	35.8-46.8	***
	HL (cm)	58.09±10.29	38.2-82.4	56.45±8.63	46.3-68	58.25±10.49	38.2-82.4	-
	DBH (cm)	16.32±1.95	11.2-24.3	15.88±4.23	13-24.3	16.37±1.63	11.2-19.7	-
Body	EL (cm)	23.09±2.34	18-29.2	22.35±1.25	21-24.2	23.17±2.41	18-29.2	-
	HeW (cm)	121.56±5.53	110.1-134.5	129.27±4.38	122.7-134.5	120.79±5.04	110.1-130.5	**
	CD (cm)	171.39±11.23	142.2-200.3	194.12±7.03	180.8-200.3	169.12±8.77	142.2-200.3	***
	BL (cm)	127.15±11.29	108.2-160.7	149.92±12.36	130.4-160.7	124.88±8.33	108.2-149.2	***
	CH (cm)	62.09±4.04	51.6-70.5	66.6±4.95	57.2-70.5	61.64±3.69	51.6-69.6	*
TL (cm)		95.18±6.17	80.2-105.6	99.8±4.75	95.2-105	94.72±6.14	80.2-105.6	-
BW (Kg)		399.84±61.48	290-635	577.5±81.32	520-635	393.81±51.69	290-560	*

HL = head length; HW = head width; SW = skull width; SL = skull length; FL = facial length; SnL = snout length; DBH = distance between horns from base to base; EL = ear length; HeW = height at withers; CD = chest depth; BL

= body length; CH = chest height; TL = tail length; BW = body weight; SE: Standard Error; Min: Minimum; Max: Maximum; n: Number of animals; -: p-value ≥ 0.05 ; *: p-value between 0.01 and 0.05; **: p-value between 0.001 and 0.01; ***: p-value ≤ 0.001 .

Table 2:- Average weights at different ages of zebu Gobra.

Overall				Males			Females			p-value
Ages	n	Mean \pm SD	Min-Max	n	Mean \pm SD	Min-Max	n	Mean \pm SD	Min-Max	
Birth	51	21.51 \pm 3.6	14-31	22	21.18 \pm 3.25	15-26	29	21.76 \pm 3.88	14-31	-
3 M	51	52.08 \pm 10.99	30.04-75	22	51.78 \pm 11.57	30.04-73	29	52.3 \pm 10.72	33.58-75	-
6M	51	79.2 \pm 15.67	53.65-120.51	22	80.82 \pm 18.31	53.65-120.51	29	77.97 \pm 13.54	57.79-109.23	-
12M	49	112.44 \pm 36.98	61.19-276.15	21	121.15 \pm 44.67	76-276.15	28	105.91 \pm 29.14	61.19-170	-
18M	46	154.72 \pm 26.79	104.98-219.39	20	163.91 \pm 26	115.22-219.39	26	147.66 \pm 25.65	104.98-203.53	*
24M	41	168.36 \pm 35.66	120.93-251	17	176.25 \pm 38.13	122.75-235.77	24	162.78 \pm 33.49	120.93-251	-
30M	35	214.96 \pm 42.71	101.79-300	13	217.73 \pm 39.46	131.7-290	22	213.33 \pm 45.34	101.79-300	-
36M	21	239.19 \pm 54.62	166-333	07	237.98 \pm 54.16	175.1-318.42	14	239.8 \pm 56.88	166-333	-
42M	17	298.74 \pm 33.35	237.11-365.81	05	307.82 \pm 34.91	275.29-365.81	12	294.95 \pm 33.48	237.11-360	-
48M	10	306.17 \pm 29.58	268.13-352.92	04	316.79 \pm 24.69	300.87-352.92	06	299.09 \pm 32.54	268.13-347.8	-

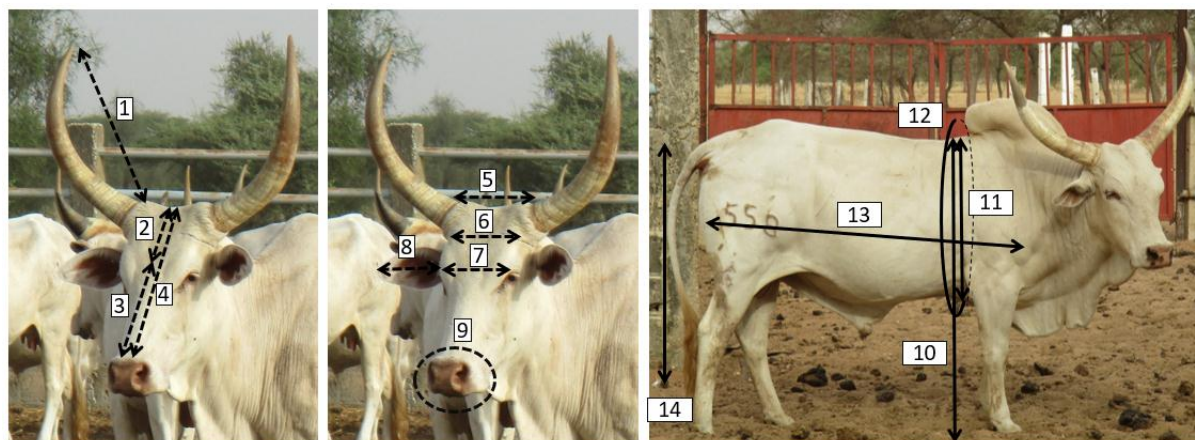
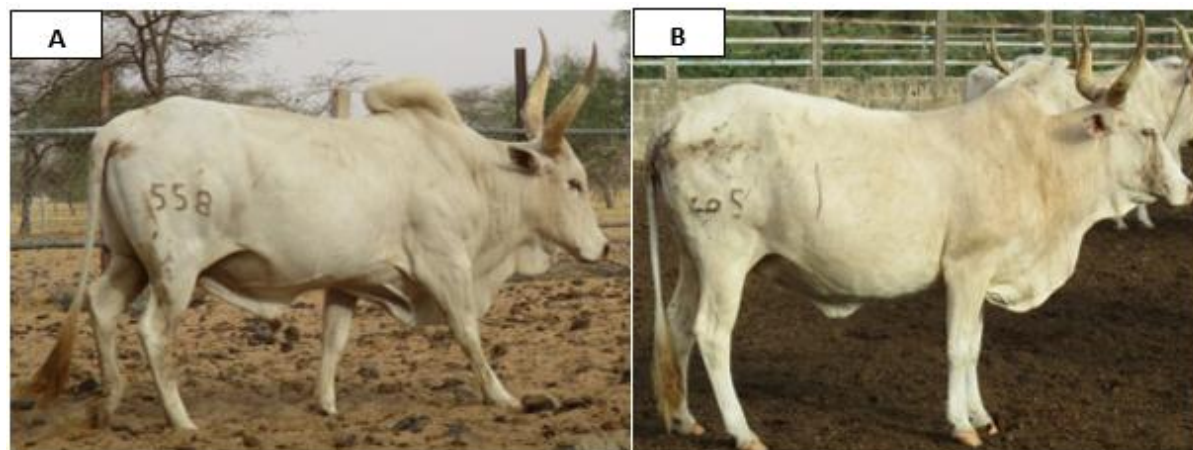


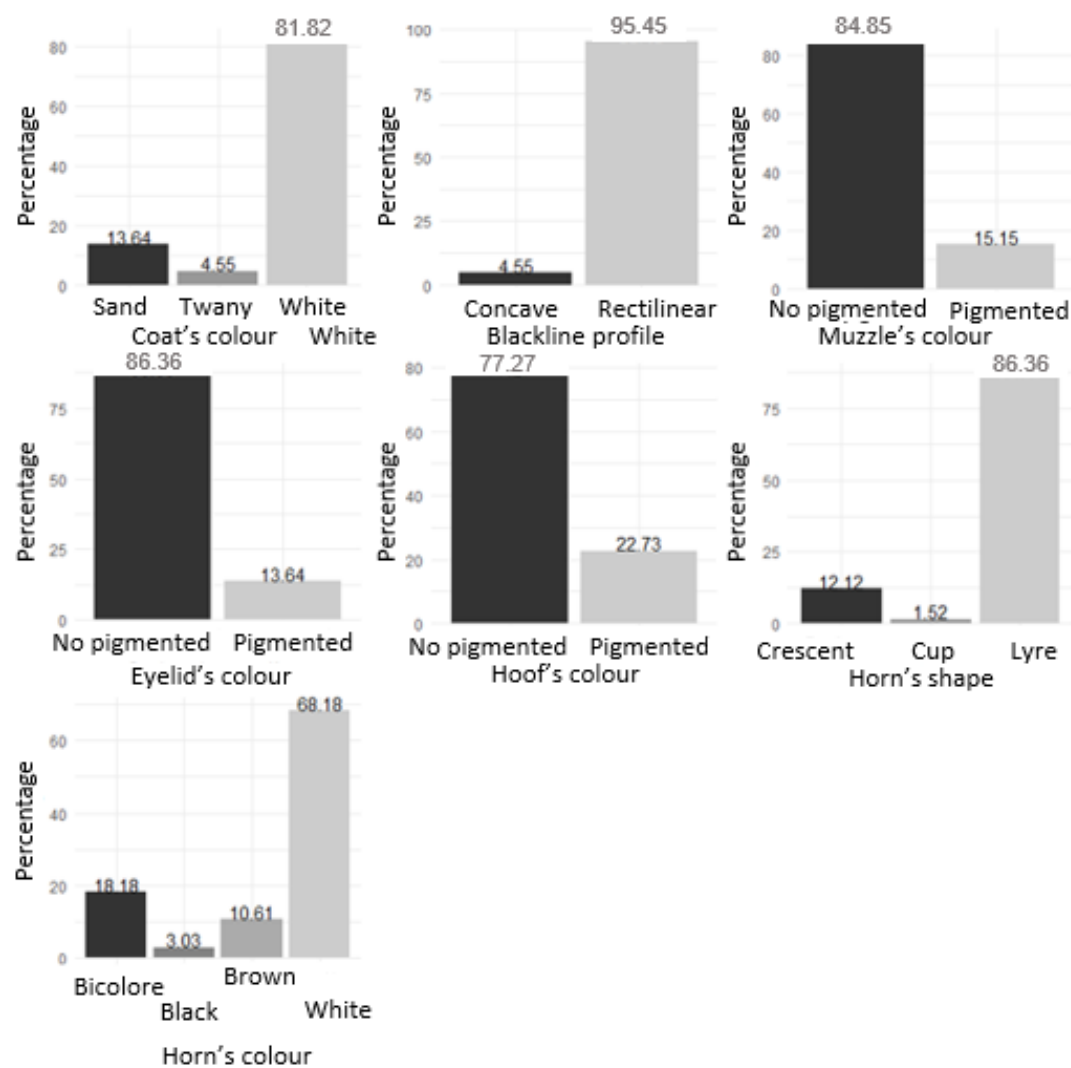
Figure 1:-Measurements collected for morphometric characterization of Zebu Gobra.

1: horn length - 2: skull length - 3: facial length - 4: head length - 5: distance between horns from base to base - 6: skull width - 7: head width - 8: ears length - 9: snout length - 10: height at withers - 11: chest height - 12: chest depth - 13: body length - 14: tail length.



A- male of 6 years old

B – female of 9 years old

Figure 2:-Gobra zebu cattle from *Centre de Recherches Zootechniques* of Dahra.**Figure 3:-**Frequencies of external characters and appendages of zebu Gobra.

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