Boujenane I, J Anim Res Vet Sci 2023, 7: 058
DOI: 10.24966/ARVS-3751/100058

HSOA Journal of
Animal Research and Veterinary Science

Research Article

# Characterization of the Phenotypic, Morphometric and Productivity Traits of Indigenous Chickens in the Moroccan Region of Drâa-Tafilalet

**Ismaïl Boujenane***

*Institut Agronomique et Vétérinaire Hassan II, PO Box 6202, Rabat-Instituts, 10101 Rabat, Morocco*

## Abstract

The study was conducted in the Drâa-Tafilalet region of Morocco to characterize indigenous chickens based on qualitative traits, body and egg measurements and reproductive and production performance. Five sites in the region with one to five rural districts each were selected. Within each district, one to eleven breeders were interviewed. There were 38 surveys conducted in 21 districts. The qualitative study involved 178 chickens, 142 mature chickens for body weight measurements and 167 fresh eggs for eggs' measurements. Results indicated that indigenous chickens had multicolored plumage. About 98.9% did not have crests, 7.70% were naked necks and all chickens were smooth-feathered and smooth-shanked. Simple combs were most common (98.8%). The white, yellow and black shanks accounted for 50%, 36% and 14%, respectively. The eggshells were white (46.7%), cream (45.3%) or light brown (7.80%), with a smooth (93.8%) or matte (6.20%) texture. Eggs averaged 53.0 ± 4.82 g in weight, 53.8 ± 2.37 mm in length and 39.5 ± 2.02 mm in width. Body weight and shank length averaged 1.86 ± 0.56 kg and 99.2 ± 21.4 mm, respectively. The average age of pullets at first laying was 6.89 ± 3.22 months and the average age of cockerels at first mating was 5.78 ± 2.65 months. Clutch length and inter-clutch period averaged 18.0 ± 9.32 days and 36.7 ± 33.0 days, respectively. During one year, a hen laid 62.4 ± 7.56 eggs. Observed variations in morphometric traits and egg production suggest the possibility of selection within and between local chicken populations.

***Corresponding author:** Boujenane I, Institut Agronomique et Vétérinaire Hassan II, PO Box 6202, Rabat-Instituts, 10101 Rabat, Morocco, Email: ismail.boujenane@gmail.com

**Citation:** Boujenane I (2023) Characterization of the Phenotypic, Morphometric and Productivity Traits of Indigenous Chickens in the Moroccan Region of Drâa-Tafilalet 7: 058.

**Received:** November 19, 2023; **Accepted:** December 05, 2023; **Published:** December 11, 2023



**Keywords:** Clutch length; Eggshell color; Egg production; Plumage color; Shank feathering

## Introduction

Poultry farming is an important source of income for farmers and an important source of animal protein for local populations. The Moroccan poultry production has grown considerably over the past fifty years. The production of poultry meat has increased from 29,000 tons in 1970 to 782,000 tons in 2019, including 50,000 tons from the traditional sector, recording an average annual growth rate of 53%. At the same time, the production of eggs for consumption has increased from 400 million to 6.9 billion units, including 0.8 billion units from the traditional sector, recording an average annual increase of 33% [1]. Moreover, the consumption of poultry meat per capita per year has evolved from 2.3 kg in 1970 to 22.1 kg in 2019, the one of eggs has increased from 21 to 195 units during the same period. Thus, the production of white meat currently contributes to more than 52% of total meat consumption [1]. Under the impulse of dieticians, a renewed interest for the consumption of meat and eggs of Beldi / local / indigenous chickens has been noticed during the last decade among the Moroccan population because of the supposed organoleptic quality of its meat and eggs. Consequently, the price of a kilogram of live Beldi chickens is about 300% higher than that of industrial chickens, and the price of Beldi eggs is about 67% higher than that of industrial eggs. Traditional chicken farming relies on indigenous populations and free-range systems where the birds mostly scavenge for food scraps and insects around the house and in some small farms. In this system, chickens are usually kept with little or no controlled breeding [2] and they are a potential source of genetic variation that should be conserved [3]. However, because of the priority given to improved strains [4], these indigenous populations are currently largely endangered, and their constant disappearance constitutes a disaster for the genetic heritage by eradicating characters that were ignored today but may prove useful tomorrow [5]. Hence, knowledge of indigenous breeds is crucial for preserving them as production animals. In this sense, numerous studies have characterized the indigenous chickens [6-8]. However, except the study of Benabdeljelil and Arfaoui [9], the phenotypic diversity of the indigenous chicken resources in Morocco in general, and in southeast Morocco in particular, has not yet been sufficiently studied.

The objectives of the present study were to characterize the indigenous chicken population found in the Drâa-Tafilalet region of Morocco based on their external appearance and production traits. The information collected in the study would be helpful for future breeding programs and conservation strategies.

## Materials and Methods

### Study zone

The study took place in the Drâa-Tafilalet region of southeastern Morocco. Details of the region's location, geography and climate are reported by Boujenane [10,11].

### Sampling method and number of surveys

Five pilot sites designed as Z1, Z2, Z9, Z15 and Z17 were identified in the region representing mountain oases, intermediate oases and lowland oases. These five sites cover 17 districts (3 to 6 rural districts per site). In each site, 1 to 4 districts were chosen. In each district, one to five breeders with at least five animals of breeding age at the time of the survey were randomly selected. A total of 38 farmers were interviewed in the five pilot sites (Table 1). Each interview ended with the visit to the shelter of the animals of the surveyed farmer in order to carry out phenotypic description and morphological measurements of the animals that had been collected by the farmer in anticipation of the surveyor's visit.

| Site | Number of districts | Number of breeders | Frequency (%) |
|---|---|---|---|
| Z1 | 4 | 6 | 15.8 |
| Z2 | 4 | 10 | 26.3 |
| Z9 | 4 | 10 | 26.3 |
| Z15 | 4 | 11 | 28.9 |
| Z17 | 1 | 1 | 2.7 |
| All | 17 | 38 | 100 |

**Table 1:** Number of districts and breeders selected in each site.

### Data collection

The fieldwork took place between April 1 and 8, 2021 in Z2 and Z9 sites and between May 25 and June 4, 2021 in Z1, Z15 and Z17 sites. During the fieldwork, breeders were surveyed, some animals were described, and eggs and animals were measured. The survey involved a questionnaire where data on productive and reproductive traits of chickens were collected from households. The information collected included age of pullets at first laying, age of cockerels at the first mating, number of eggs laid/hen/year, clutch length, number of eggs/clutch/hen, inter-clutch period, number of clutches per year, number of incubated eggs/hen/brood, hatchability, age of chicks at weaning and percentage of weaned chicks/hen/brood. The phenotypic description focused on the color and shape of the main external body parts used to characterize the animal population as described by FAO [12], including plumage color, type of feather, head shape, neck feather, shank feather, shank color, skin color, comb type, earlobe color, wattles color, eggshell color and eggshell texture. One hundred seventy-eight chickens were sampled for the qualitative study, 142 mature chickens for body weight and shank length measurements and 167 fresh eggs for weight, length and width measurements. All these measurements were made using a stainless vernier caliper and an electronic scale.

### Data analysis

Data were analyzed using the MEANS procedure of SAS [13] to calculate mean and standard deviation of productive and reproductive traits as well as physical measurements, and the FREQ procedure to compute frequencies of occurrence of each qualitative trait. Moreover, two indices were calculated; the egg shape index, which is the ratio of the width to the length of the egg multiplied by 100, and the bird density index, which is the ratio of the weight (g) on the length of the shank (mm) of the bird. The first index is an indicator of the external quality of the egg and the second index is an indicator of the degree of flesh (meat) in relation to the size of the body.

## Results and Discussion

### Phenotypic and morphological characteristics

The indigenous chicken population found in the study zone was similar to that encountered in other regions of Morocco. It had multicolored plumage (Figure 1), but predominantly red (22.5%), cream (21.5%), white (13.7%), brown (13.5%), black (11.2%), spotted gray (8.75%) and others (8.75%) (Table 2). This variability of colors indicates the genetic diversity of the indigenous chicken population. Moreover, the occurrence of different colors observed might be the result of uncontrolled mating of chickens, since this is the type of breeding that is prevalent in free-range poultry [10]. Further, the absence of a clear predominance of one color in the indigenous chicken population would suggest a relatively high level of interaction between genes through panmictic mating [14]. The findings of the present study are consistent with those of several other authors [6, 7, 9, 14-18], who reported that indigenous chicken populations are characterized by their diverse plumage color that aid them for camouflage against predators.

**Figure 1:** Indigenous chickens of the study region.

According to the current study, 7.70% of indigenous chickens were naked necks. Guni and Katule [18] in Tanzania (5.48%) and Mboumba et al. [14] in Gabon (6.63%) have reported similar findings on occurrence of naked necks in indigenous chicken populations. However, Keambou et al. [6] and Duguma [16] have found lower

| Trait | Type | % |
|---|---|---|
| Plumage color | Red | 22.5 |
| | Cream | 21.5 |
| | White | 13.7 |
| | Brown | 13.5 |
| | Black | 11.2 |
| | Spotted grey | 8.75 |
| | Others | 8.75 |
| Type of feather | Smooth | 99.6 |
| | Frizzled | 0.4 |
| Head shape | Normal | 98.9 |
| | Crest | 1.1 |
| Neck feather | Normal | 92.3 |
| | Naked | 7.70 |
| Shank feather | Normal | 100 |
| | Feathered | 0 |
| Shank color | White | 50.0 |
| | Yellow | 36.0 |
| | Black | 14.0 |
| Skin color | White | 93.5 |
| | Yellow | 6.50 |
| Comb type | Single | 98.8 |
| | Rose | 1.20 |
| Earlobe color | White | 94.4 |
| | Red | 5.60 |
| Wattles color | Red | 100 |
| | White | 0 |
| Eggshell color | White | 46.9 |
| | Cream | 45.3 |
| | Light brown | 7.80 |
| Eggshell texture | Smooth | 93.8 |
| | Matte | 6.20 |

**Table 2:** Frequency distribution of external appearance characteristics of chickens.

frequencies in Ethiopia (0.04%) and Cameroon (1.90%). Almost no chickens (98.9%) in the study region had crests on their head. These results differ from those of Halima et al. [17], Keambou et al. [6] Bembide et al. [19], Guni and Katule [18], Mboumba et al. [14] who reported that 48.8%, 10.7%, 10.4%, 8.66% and 6.03%, respectively of total populations studied were identified as crest-headed. Moreover, Guni and Katule [18] reported that higher proportion of crest-headed birds were observed in females than in males.

All chicken population was smooth-feathered; it did not have frizzled plumage. These findings are opposite to those of Bembide et al. [19], Guni and Katule [18] and Mboumba et al. [14] who found that frizzled feathers in chickens represented 2.3%, 0.72% and 3.62%, respectively. Guni and Katule [18] explained the absence of frizzled plumage in the studied chicken population by the fact that it confers to the birds a bad insulation in a cold climate, disadvantaging them compared to those having a smooth plumage. However, according to FAO [20] the frizzled plumage and the naked neck are very advantageous characteristics in a warm climate because they allow a high heat dissipation and the achievement of speed of growth, egg production and resistance to diseases better than those of birds with smooth plumage and feathered neck. Indeed, according to Horst [21], the naked neck birds need less dietary protein to produce feathers, thereby shifting protein that is a limiting factor in many scavenger feed resource bases to meat and egg production rather than feather production.

Indigenous chickens of the study region were smooth-shanked; they did not have feathered shanks. These findings are consistent with those of Badubi et al. [15] who reported that on average the Tswana chickens have no leg feathers but there are a few with sparse (4.9%) leg feathers. However, they are different from those of Bembide et al. [19] in the Central African Republic, Keambou et al. [6] in Ethiopia and Guni and Katule [18] in Tanzania who revealed that indigenous chickens with feathered shanks represent 5.9%, 22.4% and 9.23%, respectively.

In the indigenous chicken population of the study region, the simple comb was the most common (98.8%), the rose comb was very rare (1.20%), whereas the walnut and pea combs did not exist. These findings are in line with those of several authors who have highlighted the predominance of simple combs in their studies (98%, [7]; 98.2%, [14]), but higher than those reported by others (90.4%, [15]; 81.1%, [6]; 87.4%, [18]). The comb type is due to interactions of different genes responsible for comb expression. According to Crawford [22], chickens have two autosomal pairs of genes (R, r and P, p) responsible for their comb type, which result in the single comb if the genotype is rrpp, the rose comb if it is R-pp, the pea comb if it is rrP- or walnut comb if it is R-P-. Furthermore, the presence of the rose comb type, although at a low frequency (1.20%), might signal the beginning of a fertility problem in the indigenous chicken populations. In this regard, Crawford and Smyth [23] reported that roosters with rose comb and RRpp genotype are less fertile than those with rose comb and Rrpp genotype because of a decrease in sperm viability.

Various shank colors were observed in the indigenous chicken population of the present study. Of the total birds, white shanks represented 50%, yellow shanks 36% and black shanks 14%. In a study by Fotsa et al. [7], 37.4% and 33.8% of animals had white and yellow shanks, respectively, but 17% had black shanks. According to Guni and Katule [18], yellow shanks were most frequent (34.7%), followed by white (25.3%), green (14.4%) and black (11.8%) shanks, with the sexes differing. Keambou et al. [6] reported that white, pink, yellow and black shanks represent 39.6, 2.15, 39.1 and 6.20%, respectively.

The skin color of the indigenous chickens was mostly white (93.5%), while the yellow skin represented 6.50%. The findings of the present study are consistent with those of Guni and Katule [18] who reported that the predominantly frequent skin color in the studied population was white (51.2%) while yellow was the second most predominant skin color (48.8%). They are also in line with those of Mboumba et al. [14] who reported that the color of the skin is either white (69.27%) or yellow (30.73%), regardless of the animal's sex. However, they are different from those of Keambou et al. [6] who reported that the skin is white (39.4%), pink (21.9%), yellow (37.9%) or black pigmented (0.71%). According to Nesheim et al. [24], consumers of developed countries prefer yellow skin coloration, which reflects a diet very rich in carotenoid pigments. The earlobes of indigenous chicken population were white in 94.4% of birds and the wattles were red in all birds. Keambou et al. [6] reported that red and white earlobes are the most common, with 40.3% and 35.6%, respectively, with red earlobe dominating in males (66.8%) while white earlobe is more common in females (48.9%). Concerning the color of wattles, they revealed that they generally follow the coloration of the comb, with

approximately the same percentages; 87.8%, 7.64% and 4.53% for red, pink and black pigmented colors, respectively.

The hens laid eggs with white (46.9%), cream (45.3%) and light brown (7.80%) shells, with a smooth (93.8%) and matte (6.20%) texture. Guni and Katule [18] reported that most eggs (50.3%) had whitish color shells, brownish shelled eggs were the next most frequent (38.1%) and cream shelled eggs were the least frequent (11.6%). Halima et al. [17] stated that all hens laid light brown or cream colored eggs. Fotsa et al. [7] reported that eggshell color is mostly creamy white and rarely brown, but 100% of eggs have a matte texture.

## Body and egg measurements

Body weight and shank length of the indigenous chickens (both sexes combined) in the study sites averaged 1.86 ± 0.56 kg and 99.2 ± 21.4 mm, respectively, resulting in a bird density index of 20.4% (Table 3). This relatively high index indicates that in relation to body size, the indigenous chickens have good genetic potential for meat production under free-range feeding. The current study's average body weight is larger than the 1.65 kg reported by Guni et al. [25] and the range of 1.2-1.4 kg found by Benabdeljelil and Arfaoui [9]. This disparity might be explained by the age of birds measured in the present study that is older than 10 months. The body weight of indigenous chickens is generally low. Potential causes include genetic, dietary, and parasite issues [26]. Moreover, the body weight is homogeneous among birds, probably due to the low nutritional state of the flock [8]. Bembide et al. [19] compared body weights of birds with different external phenotypes. They concluded that the local shank feathered chickens were the heaviest (1546 ± 321 g), the crested chickens were the lightest (1067 ± 172 g), whereas the frizzled and naked neck birds were intermediate. The average shank length observed in this study is higher than that of Guni et al. [25] (65.8 mm), similar to that of Fotsa et al. [7] (96.9 mm), but lower than that of Halima et al. [17] (110.6 mm).

The eggs' dimensions of local hens in the current study averaged 53.0 ± 4.82 g in weight, 53.8 ± 2.37 mm in length and 39.5 ± 2.02 mm in width (Table 3). The mean egg weight is higher than values reported by Mwalusanya et al. [26] (44.4 g), Badubi et al. [14] (48.5 ± 5.7 g), Fotsa et al. [6]) (44 g), Guni et al. [25] (43.9 g) and Wambui et al. [27] (46.5 g). However, it is lower (19.8%) compared to the commercial egg weight (63.5g) reported by Wambui et al. [27]. The mean egg length obtained in the current study was slightly higher than the value reported by Guni et al. [25] (50.4 mm). However, the value was lower than that reported by Wambui et al. [27] for indigenous and commercial chicken eggs (54.7 mm and 56.9 mm, respectively). The egg width is lower than that found by Wambui et al. [27] (40.5 mm), but higher than that of Guni et al. [25] (36.0 mm). The egg shape index was 73.4%. It is similar to that reported by Wambui et al. [27] (74.0%), but higher than the one found by Guni et al. [25] (71.6%). The egg shape index provides information on the eggs' external quality. It is a useful indicator of uniform egg packaging during transportation and a significant factor in influencing market choice. The eggs of indigenous chicken population had a normal form according to the study by Duman et al. [28], who classified eggs on their shape index (SI) as sharp (SI < 72), normal (SI = 72-76) or round (SI > 76). As a result, the eggs of the indigenous chicken population look excellent and are less likely to break when being transported.

| Trait | Number | Mean | Standard deviation | Coefficient of variation (%) |
|---|---|---|---|---|
| Body weight (kg) | 142 | 1.86 | 0.56 | 30.1 |
| Shank length (mm) | 142 | 99.2 | 21.4 | 21.6 |
| Egg weight (g) | 167 | 53.0 | 4.82 | 9.09 |
| Egg length (mm) | 167 | 53.8 | 2.37 | 4.40 |
| Egg width (mm) | 167 | 39.5 | 2.02 | 5.11 |
| Egg shape index (%) | 167 | 73.5 | 3.81 | 5.18 |
| Bird density index (%) | 142 | 20.4 | 3.99 | 19.6 |

**Table 3:** Body measurements and egg dimensions of chickens.

## Reproductive and production performance

According to the farmers surveyed, the age at first laying of indigenous pullets was 6.89 ± 3.22 months (Table 4). This result is in agreement with the 6 and 8 months interval age at which hens laid their first egg reported by Mwalusanya et al. [26]. However, it is higher than the age at first egg reported by Melak et al. [29] in Southern Ethiopia (6.14 ± 0.15 months), Yadessa et al. (2017) in south western Ethiopia (5.8 months), Benabdeljelil and Arfaoui [9] in Morocco (5.8 months) and Wambui et al. [27] in Western Kenya (5 months). In contrast to the findings of our study, Guni et al. [25] found that female chickens were 7.48 months old when they laid their first egg. Wambui et al. [27] reported that the age at which hens lay their first egg is usually influenced by a number of factors such as breed, lighting regime, feeding and quality of feed among other environmental factors. In addition, they reported that scavenging chickens and poor feeding strategies delay maturity, leading to delayed point of lay and egg size. Moges et al. [30] stated that late maturity was an expression of low productivity of indigenous chickens. The age of cockerels at first mating was 5.78 ± 2.65 months. Melak et al. [29] reported that the average age at sexual maturity for males was 5.33 ± 0.13, whereas Guni et al. [25] showed that the overall mean age at first mating of male chickens was 7.02 months.

The mean clutch length and inter-clutch period of indigenous chickens obtained in the present study were 18.0 ± 9.32 days and 36.7 ± 33.0 days, respectively. These findings are higher than results of Guni et al. [25], which were 17.8 and 14.0 days for clutch length and inter-clutch period, respectively. However, they are lower than those of Moges et al. [30] in Ethiopia, which were 26.2 and 25.6 days, respectively.The number of clutches per year averaged 4.2 (ranging from three to 5). The observed mean number of clutches per year in the present study is similar to those which have been reported from other studies by Farooq et al. [31] and Wambui et al. [27] who reported 4.6 and 4 clutches, respectively, but differs from the findings by Mwalusanya et al. [26], Hossen [32], Moreki [33], Petrus [34] and Guni et al. [25] (3.3). Guni et al. [25] reported that differences observed between countries with respect to number of clutches per year might be due to both genetic and environmental differences between populations.

The overall number of eggs/clutch/hen in the present study was 13.9. These results are similar to those found by several authors ([9] (14 eggs, from eight to 20) depending on egg size and hen body size, [35]; [7] (13 eggs), [33]; [25] (13.7 eggs)). However, they are higher than the mean clutch size of 11.2 and 12.5 eggs obtained by Melak et al. [29] and Wambui et al. [27], respectively, but lower than the average number of eggs per clutch reported by Farooq et al. [31] (15.1), Badubi et al. [15]and Yadessa et al. [36] (14.4 ± 3.87).

Over the course of a year, a hen laid 62.4 ± 7.56 eggs. The total annual egg number per hen reported in the present study is similar to the average number of eggs laid by indigenous hens (61.7± 0.95) reported by Melak et al. [29], higher than those reported by Halima et al. [17], Fotsa et al. [7] (51 eggs), Hossen [32], Moreki [33], Guni et al. [25] (45.2 eggs) and Wambui et al. [27] (50 eggs), and lower than those reported by Benabdeljelil and Arfaoui [9] (78 eggs per hen per year, from 49-150). It has been concluded by Wambui et al. [27] that indigenous chickens produce low levels of eggs per hen compared to commercial breeds, which have a potential of 140 eggs per year and an egg size of 60 grams. Furthermore, the number of incubated eggs/hen/brood averaged 12.8 ± 2.88. According to a belief of the breeders, the number of eggs incubated should be odd. The average number of eggs incubated was 11.3 in the study area [25]. After incubation, the hatchability averaged 82.9 ± 26.8%. This result is similar to that recorded by Benabdeljelil and Arfaoui [9] (78%, from 46-100%) and Fotsa et al. [7] (84.3%), higher than that reported by Farooq et al. [31] (61.2%) and Badubi et al. [15] (75%) and the hatchability interval of 50–80.3% [16], but lower than that reported by Guni et al. [25] (88%). The average age at weaning of chicks recorded in the current study was 72.9 ± 36.4 days. It is closer to the weaning age of 2.59 months reported by Guni et al. [25]. The percentage of chicks weaned was 64.2 ± 42.4%, indicating that the mortality rate between hatching and weaning was 33.8%. The numerous diseases that affect poultry, the hostile climate (especially the cold) that prevails in the study sites and predators, might have caused this high mortality. Benabdeljelil and Arfaoui [9] reported chick mortality rates ranging from 46 to 76% under extensive system, Farooq et al. [31] (24.1%) and Guni et al. [25] (30.2%). Moreover, the mortality rate of growing young and adult animals averaged 18.4 ± 14.4% and 7.29 ± 6.21%, respectively.

| Trait | Number of respondents | Mean | Standard deviation | Coefficient of variation (%) |
|---|---|---|---|---|
| Age of pullets at first laying (months) | 37 | 6.89 | 3.22 | 46.7 |
| Age of cockerels at the first mating (months) | 37 | 5.78 | 2.65 | 45.8 |
| Number of eggs laid/hen/year | 38 | 62.4 | 7.56 | 12.1 |
| Clutch length (days) | 37 | 18.0 | 9.32 | 51.8 |
| Number of eggs/clutch/hen | 36 | 13.9 | 1.89 | 13.6 |
| Inter-clutch period (days) | 33 | 36.7 | 23.0 | 62.7 |
| Number of clutches per year | 36 | 4.20 | 0.91 | 21.7 |
| Number of incubated eggs/hen/brood | 36 | 12.8 | 2.88 | 22.5 |
| Hatchability (%) | 36 | 82.9 | 26.8 | 32.3 |
| Percentage of weaned chicks/hen/brood (%) | 36 | 64.2 | 42.4 | 66.0 |
| Age of chicks at weaning (days) | 35 | 72.9 | 36.4 | 49.9 |
| Mortality rate of chicks (%) | 36 | 33.8 | 21.3 | 63.0 |
| Mortality rate of growing young (%) | 13 | 18.4 | 14.4 | 78.3 |
| Mortality rate of adults (%) | 16 | 7.29 | 6. 21 | 85.2 |

**Table 4:** Reproductive and production performance of local chickens.

## Conclusion

The results of current study indicate that the indigenous chicken population had various plumage forms, colors, and morphometric attributes that may indicate the existence of subpopulations. Additionally, there are significant differences in productive and reproductive performance among the studied indigenous chickens. Thus, the phenotypic diversity and performance variability of indigenous chicken resources can be utilized for the valorization of local resources and the genetic improvement through selection of the best performing animals.

## Acknowledgement

The author thanks the FAO for funding the research presented in this article (Project GCP/MOR/046/GFF). Sincere appreciation is extended to the FAO (Rabat), OASIL, ORMVAO Tafilalet and ORMVAO Ouarzazate officers who provided him with assistance. The author gratefully acknowledges the team that conducted field surveys. His sincere thanks go out to the breeders who consented to take part in this study.

## Conflicts of interest

The author declares that there is no conflict of interest.

## References

1. MAPMDREF (2019) Agriculture en chiffres. Ministry of Agriculture, Fisheries, Rural Development, Water and Forests, Rabat, Morocco.
2. Horst P (1990) Research development perspectives. In: U Riest (editor) CTA-Seminar Proceedings: Smallholder Rural Poultry Production, Thessaloniki 1990: 61-69.
3. Gueye EF (1998) Village egg and Fowl meat production in Africa. World Poultry Science Journal 54: 73-86.
4. Bessadok A, Khochlf I, El Gazzah M (2003) Etat des ressources génétiques de la population locale du poulet en Tunisie. Tropicultura 21: 167-172.
5. Audiot A (1995) Races d'hier pour l'élevage de demain. INRA Editions, Paris, France.
6. Keambou TC, Manjeli Y, Tchoumboue J, Teguia A, Iroume RN (2007) Caractérisation morphobiométrique des ressources génétiques de poules locales des hautes terres de l'ouest Cameroun. Livestock Research for Rural Development 19.
7. Fotsa JC, Rognon X, Tixier-Boichard M, Coquerelle G, Poné Kamdem D, et al. (2010) Caractérisation phénotypique des populations de poules locales (Gallus Gallus) de la zone forestière dense humide à pluviométrie bimodale du Cameroun. Animal Genetic Resources 46: 49-59.
8. Haoua MT, Keambou CT, Poutougnigni MY, Manjeli Y (2015) Characterisation of indigenous chicken production systems in the Sudano-sahelian zone of Cameroon. Livestock Research for Rural Development 27.
9. Benabdeljelil K, Arfaoui T (2001) Characterization of Beldi chicken and turkeys in rural poultry flocks of Morocco: Current state and future outlook. Animal Genetic Resource Information 31: 81-95.
10. Boujenane I (2023a) Breeding practices and selection criteria on livestock farming in the Drâa-Tafilalet region of Morocco. Journal of Animal Science and Veterinary Medicine 8: 131-143.

11. Boujenane I (2023b) Husbandry practices of livestock farming in the Drâa-Tafilalet region of Morocco. Journal of Animal Science and Veterinary Medicine 8: 144-152.

12. FAO (2012) Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines 11.

13. SAS (2009) User's Guide, Release 9.2. SAS Institute Inc., Cary, NC, USA.

14. Mboumba S, Maganga GDC, Ndzighe MA, Keambou TC (2020) Caractérisation morphobiométrique de la Poule locale de deux régions du Gabon. Journal Interdisciplinaire de la Recherche Scientifique 1: 26-34.

15. Badubi SS, Rakereng M, Marumo M (2006) Morphological characteristics and feed resources available for indigenous chickens in Botswana. Livestock Research for Rural Development 18.

16. Duguma R (2006) Phenotypic characterization of some indigenous chicken ecotypes of Ethiopia. Livestock Research for Rural Development 18.

17. Halima H, Neser FWC, van Marle-Koster E, de Kock A (2007) Phenotypic variation of native chicken populations in northwest Ethiopia. Tropical Animal Health and Production 39: 507-513.

18. Guni FS, Katule AM (2013) Characterization of local chickens in selected districts of the Southern Highlands of Tanzania: I. Qualitative characters. Livestock Research for Rural Development 25.

19. Bembide C, Hako TBA, Manjeli Y, Keambou TC (2013) Caractérisation morphobiométrique de la poule locale en Centrafrique. Animal Genetic Resources 53: 33-44.

20. FAO (2010) Chicken genetic resources used in smallholder production systems and opportunities for their development, by P. Sørensen. FAO Smallholder Poultry Production Paper No 5 Rome.

21. Horst P (1989) Native fowls as a reservoir of genomes and major genes with direct and indirect effect on the adaptability and their potential for tropically oriented breeding plans. Arch. Geflugelk 53: 93-101.

22. Crawford RD (1990) Poultry Breeding and Genetics. Elsevier Amsterdam.

23. Crawford RD, Smyth JR (1964) Studies of the relationship between fertility and the gene for rose comb in the domestic fowl. 2. The relation between comb genotype and duration of fertility. Poultry Science 43: 1018-1026.

24. Nesheim CM, Austic ER, Card EL (1979) Poultry production. Lea and Febiger, Philadelphia. 58-92.

25. Guni FS, Katule AM, Mwakilembe PAA (2013) Characterization of local chickens in selected districts of the Southern Highlands of Tanzania: II. Production and Morphometric traits. Livestock Research for Rural Development 25: 190.

26. Mwalusanya NA, Katule AM, Mutayoba SK, Mtambo MMA, Olsen JE, et al. (2002) Productivity of local chickens under village management conditions. Trop Anim Health Prod 34: 405-416.

27. Wambui CC, Njoroge EK, Wasike CB (2018) Characterisation of physical egg qualities in indigenous chicken under free range system of production in Western Kenya. Livestock Research for Rural Development 30: 122.

28. Duman M, Sekeroglu A, Yildirim A, Eleroglu H, Camci O (2016) Relation between egg shape index and egg quality characteristics. European Poultry Science 80: 1-9.

29. Melak A, Kenfo H, Aseged T, Hailu A (2021) Production system and breeding practice of indigenous chickens in selected districts of Dawro zone and Konta special district, Southern Ethiopia. Asian Journal of Agriculture 5: 72-83.

30. Moges F, Tegegne A, Dessie T (2010) Indigenous chicken production and marketing systems in Ethiopia: Characteristics and opportunities for market-oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 24 Nairobi 1-26.

31. Farooq M, Gul N, Chand N, Durrani FR, Khurshid A, et al. (2002) Production performance of backyard chicken under the care of women in Charsadda, Pakistan. Livestock Research for Rural Development 14.

32. Hossen MJ (2010) Effect of management intervention on the productivity and profitability of indigenous chickens under rural condition in Bangladesh. Livestock Research for Rural Development 22:192.

33. Moreki JC (2010) Village poultry production in Serowe-Palapye sub-district of Botswana. Livestock Research for Rural Development 22 : 46.

34. Petrus NP (2011) Characterisation and production performance of indigenous chickens in Northern Namibia regions. PhD Dissertation, University of Namibia.

35. Kugonza DR, Kyarisiima CC, Iisa A (2008) Indigenous chicken flocks of Eastern Uganda: I. Productivity, management and strategies for better performance. Livestock Research for Rural Development 20: 137.

36. Yadessa E, Tulu D, Bogale A, Mengistu G, Aleme M, et al. (2017) Characterization of smallholder poultry production systems in Mezhenger, Sheka and Benchi -Maji zones of south western Ethiopia. Academic Research Journal of Agricultural Science and Research 5: 10-19.

HERALD

Advances In Industrial Biotechnology | ISSN: 2639-5665

Advances In Microbiology Research | ISSN: 2689-694X

Archives Of Surgery And Surgical Education | ISSN: 2689-3126

Archives Of Urology

Archives Of Zoological Studies | ISSN: 2640-7779

Current Trends Medical And Biological Engineering

International Journal Of Case Reports And Therapeutic Studies | ISSN: 2689-310X

Journal Of Addiction & Addictive Disorders | ISSN: 2578-7276

Journal Of Agronomy & Agricultural Science | ISSN: 2689-8292

Journal Of AIDS Clinical Research & STDs | ISSN: 2572-7370

Journal Of Alcoholism Drug Abuse & Substance Dependence | ISSN: 2572-9594

Journal Of Allergy Disorders & Therapy | ISSN: 2470-749X

Journal Of Alternative Complementary & Integrative Medicine | ISSN: 2470-7562

Journal Of Alzheimers & Neurodegenerative Diseases | ISSN: 2572-9608

Journal Of Anesthesia & Clinical Care | ISSN: 2378-8879

Journal Of Angiology & Vascular Surgery | ISSN: 2572-7397

Journal Of Animal Research & Veterinary Science | ISSN: 2639-3751

Journal Of Aquaculture & Fisheries | ISSN: 2576-5523

Journal Of Atmospheric & Earth Sciences | ISSN: 2689-8780

Journal Of Biotech Research & Biochemistry

Journal Of Brain & Neuroscience Research

Journal Of Cancer Biology & Treatment | ISSN: 2470-7546

Journal Of Cardiology Study & Research | ISSN: 2640-768X

Journal Of Cell Biology & Cell Metabolism | ISSN: 2381-1943

Journal Of Clinical Dermatology & Therapy | ISSN: 2378-8771

Journal Of Clinical Immunology & Immunotherapy | ISSN: 2378-8844

Journal Of Clinical Studies & Medical Case Reports | ISSN: 2378-8801

Journal Of Community Medicine & Public Health Care | ISSN: 2381-1978

Journal Of Cytology & Tissue Biology | ISSN: 2378-9107

Journal Of Dairy Research & Technology | ISSN: 2688-9315

Journal Of Dentistry Oral Health & Cosmesis | ISSN: 2473-6783

Journal Of Diabetes & Metabolic Disorders | ISSN: 2381-201X

Journal Of Emergency Medicine Trauma & Surgical Care | ISSN: 2378-8798

Journal Of Environmental Science Current Research | ISSN: 2643-5020

Journal Of Food Science & Nutrition | ISSN: 2470-1076

Journal Of Forensic Legal & Investigative Sciences | ISSN: 2473-733X

Journal Of Gastroenterology & Hepatology Research | ISSN: 2574-2566

Journal Of Genetics & Genomic Sciences | ISSN: 2574-2485

Journal Of Gerontology & Geriatric Medicine | ISSN: 2381-8662

Journal Of Hematology Blood Transfusion & Disorders | ISSN: 2572-2999

Journal Of Hospice & Palliative Medical Care

Journal Of Human Endocrinology | ISSN: 2572-9640

Journal Of Infectious & Non Infectious Diseases | ISSN: 2381-8654

Journal Of Internal Medicine & Primary Healthcare | ISSN: 2574-2493

Journal Of Light & Laser Current Trends

Journal Of Medicine Study & Research | ISSN: 2639-5657

Journal Of Modern Chemical Sciences

Journal Of Nanotechnology Nanomedicine & Nanobiotechnology | ISSN: 2381-2044

Journal Of Neonatology & Clinical Pediatrics | ISSN: 2378-878X

Journal Of Nephrology & Renal Therapy | ISSN: 2473-7313

Journal Of Non Invasive Vascular Investigation | ISSN: 2572-7400

Journal Of Nuclear Medicine Radiology & Radiation Therapy | ISSN: 2572-7419

Journal Of Obesity & Weight Loss | ISSN: 2473-7372

Journal Of Ophthalmology & Clinical Research | ISSN: 2378-8887

Journal Of Orthopedic Research & Physiotherapy | ISSN: 2381-2052

Journal Of Otolaryngology Head & Neck Surgery | ISSN: 2573-010X

Journal Of Pathology Clinical & Medical Research

Journal Of Pharmacology Pharmaceutics & Pharmacovigilance | ISSN: 2639-5649

Journal Of Physical Medicine Rehabilitation & Disabilities | ISSN: 2381-8670

Journal Of Plant Science Current Research | ISSN: 2639-3743

Journal Of Practical & Professional Nursing | ISSN: 2639-5681

Journal Of Protein Research & Bioinformatics

Journal Of Psychiatry Depression & Anxiety | ISSN: 2573-0150

Journal Of Pulmonary Medicine & Respiratory Research | ISSN: 2573-0177

Journal Of Reproductive Medicine Gynaecology & Obstetrics | ISSN: 2574-2574

Journal Of Stem Cells Research Development & Therapy | ISSN: 2381-2060

Journal Of Surgery Current Trends & Innovations | ISSN: 2578-7284

Journal Of Toxicology Current Research | ISSN: 2639-3735

Journal Of Translational Science And Research

Journal Of Vaccines Research & Vaccination | ISSN: 2573-0193

Journal Of Virology & Antivirals

Sports Medicine And Injury Care Journal | ISSN: 2689-8829

Trends In Anatomy & Physiology | ISSN: 2640-7752