Impacts of food scarcity and irregularities under arid conditions on the body reserves and production of local goat population in the southern of Tunisia

Atoui Ahlem[1]*, Aicha Laaroussi[1], Mouldi Abdennebi[1], Farah Ben Salem[1] & Sghaier Najari[1]

[1] *Laboratoire d'Elevage et de la Faune Sauvage, Institut des Regions Arides, Médenine, Université de Gabes, Tunisie*

Article info

*Corresponding author
ahlematoui@gmail.com

Conflict of Interest: The authors declare no conflict of interest.

Abstract

The study aims to study the impact of environmental factors on adult weight and assess the impact of their use from a genetic point of view to set up the basis for the future improvement of this important component of efficient production. A total of 3000 records of 104 goats were collected over a period of 3 years in the caprine herd of the Arid Areas Institute of Médenine (South East of Tunisia). Significance of environmental effects was tested with ANOVA procedure. The adult weight mean estimated in this study was 24.69kg with a coefficient of variation of 24.34%. Local breed was characterized by a low weight. Such a low weight corresponds to low energetic needs, which could be considered as an epigenetic strategy of adaptation to the difficult environmental conditions. Effects reflecting environmental and management conditions along time were highly significant in studied trait. This effect is especially due to the variations of climate, food nutritional quality and herd management along time which change greatly in extensive conditions. Difficult years do not allow the distinction of the best goats, and this is important for breeders who aim to improve the performance of their herds. In order to optimize the productive potential of the local goat population, it is essential to adopt an appropriate feeding management program addressing the most important individual trait which was directly involved in increasing lifetime productivity. The variability detected in local goat population allows to hold expectations for the implementation of selection programmes for productive traits in arid regions.

1. INTRODUCTION

In arid region, pastoral resources which remain scares and irregular according of climate factors varying largely between months and years conditions. The local goat population are expected to show a good ability to accommodate and adapt to fluctuations in environment. Herd management, year and season were some of the factors that affected adult weight in different studies (Najari, 2005).

Setting the variation scale of goat body reserve according to forage resources which reflect the climate factors, helps to optimise the herds' management and the animal group survival and such is the body weight. The study of adult weight, and its variation, in local goat under arid conditions is an important element (Najari *et al.*, 2007b). Although the Tunisian local goat breed has been extensively studied to describe growth curves and phenotypic performances (Najari 2005), no studies have been carried out that provide the necessary information adult weight in this breed. There is a lack of studies concerning the factors affecting adult weight in local goat in arid regions. Variations in the adult weight of goats are even more important in these difficult regions (aridity, lack of food resources, etc.). Moreover, the weight of the animal and the way in which body reserves are managed are the most important parameters which are closely related to the adaptation of local genetic resources (Najari *et al.*, 2007b).

In this context, the present work aims to study the impacts of the effects on months and year factors, through their direct impact on pastoral vegetation, upon goat mother body conditions during a most critical period which is the kidding

season. Indeed, body reserves during the last gestation period affect the success of the reproductive exercise and the milk production for kids' growth rather the weights of new born. The Information of environmental effects under harsh conditions are scarce since performance recording is difficult under extensive conditions. A goat experimental herd of the Arid Areas Institute of Tunisia has been recording weights of the local goat population, providing valuable information for studying the impact of environment effects on adult weight of local goat population raised under extensive and climate harsh conditions to set up the basis for the future management of the herd.

2. MATERIAL AND METHODS
2.1. Location
All studied animals belong to the goat experimental herd of the Arid Areas Institute of Médenine Tunisia (33°30' N and 10° 40' E), which is located in southeastern Tunisia, between the mountains of Matmata and the Mediterranean Sea. This region is characterized by an arid continental Mediterranean climate; with irregular precipitations with an average annual rainfall of about 200 mm. The summer is normally the hottest and driest season with a maximum temperature of 47°C (Ouni et al., 2007).

2.2. Animals and management
The local goat population constitutes an animal group adapted to arid conditions. The local goat population shows a large variability both in morphology and growth performances (Fig.1). The Characteristics of the local goat population include the small body size with an average height of 76 cm for the male and 60 cm for the female (Atoui et al.,2019) and the ability to walk long distances. Fertility rate was about 87% and prolificacy rate was about 110-130% (Najari, 2005).
The season of kidding begins in November and continues until March, with a concentration during November and December. Throughout the study, replacement animals were selected based on weaning weight and physical conformation. Animals grazed on natural pastures during the day. In general, pasture grasses production covered about 70% of breeding animals feed requirements. The remaining 30% was covered by a supplementation of barley provided during the mating (600 g/day), the last month of pregnancy and the beginning of lactation (750g/day).

Goats received about 1 kg per day of concentrate mixture during lactation. All animals were provided with water allowed twice a day, before and after grazing.

Fig. 1. Local goat population.

2.3. Data recording and studied traits
The data used in present study were collected between 2019 and 2021 from a total of 104 local goats. Data taken at experimental farm of the Arid Areas Institute of Médenine. The Tunisian local goat population is very polymorphic (Najari, 2005), but it is generally characterized by its small body size with average height of 76cm for the male and 60cm for the female (Ouni *et al.*, 2007a). This local goat breed is famous for its walking ability, resistance to hydric restrictions and high temperature stress and good productivity in harsh conditions.
Goats were weighed once every three weeks. For each individual goat, a record sheet with full details of each parameter along with pedigree information were maintained the goat number; the year of recording; the month of recording and the weight corresponding to each record.

2.4. Statistical analysis
The ANOVA Procedure (SPSS, 20) was carried out for determining the effects of the year and the month of recording and their first order interactions on the weight of goat (adult and young goats).

The general model can be represented as follows:

$$Y_{ijk}= \mu + Mo_i + Ye_j + Mo_i \times Ye_j + e_{ijk}$$

Where: Y_{ijk}: performance to be analyzed (weight of goats); μ: general mean, Mo_i: effect of month of recoding (i= January, February, March…. December), Ye_j: effect of year of recording (j=2019-2020;2020-2021;2021-2022), x: interaction and e_{ijk}: residual error.

After variance analysis, a means comparison test (SNK, α=0.05) was applied to identify homogenous class of studied factors on the studied variable.

3. RESULTS AND DISCUSSION

Table 1 shows statistics describing the weights of local goats. The adult weight mean estimated in this study was 24.69kg with a coefficient of variation of 24.34%. Local breed was characterized by low weights. Similar results have been reported in most breeds under arid environments (Atoui et al., 2018; Al-Shorepy et al., 2002). Such a low weight corresponds to low energetic needs, which could be considered as strategy of adaptation to the difficult environmental conditions (Najari, 2005; Djemali et al., 1994).

The genetic potential of indigenous parental lines, the physical environment, and the variation of flock management could explain the variability across studies.

Table 1. Basic statistics for adult weight of Tunisian local goats

Variable	No. of record	Min	Max	Mean	SD	CV
Weight (kg)	3000	12	51	24.69	6.01	24.34

SD: std. deviation; CV: coefficient of variation

Therefore, it seems that a better feeding program increases the minimum weights and reduces the range of variation. In extensive, the variation which turns out to be significant expresses, in addition to individual variability, the diversity of food and climatic conditions both in time and in space and this reflects that the standard deviation of the live weight relative to

the first case is greater than the second (Najari,2005). Nevertheless, the adult goat reveals an exceptional ability to overcome arid conditions and ensure a fairly heavy weight than that in semi-extensive (49kg).

Adult weight is one of the most important traits in genetic improvement schemes for goat production. A number of non-genetic factors affects this trait and directly obscures recognition of genetic potential. Table 2 shows the results of the ANOVA analyses to test the significance of the year and month effect on adult weight. A relatively high coefficient of determination attests indicates to the importance of these fixed effects included in the adopted model.

Effects reflecting environmental and management conditions along time were highly significant in studied trait. This effect is especially due to the variations of climate, food nutritional quality and herd management along time which change greatly in extensive conditions.

Table 2. Test of significance from ANOVA analyses and coefficient of determination (R2) of a model including environmental factors on adult weight of local goats

Sources of variation	Year	Month	Year×Month	R²
DF	2	11	----	----
Weight	**	**	**	61%

DF: degrees of freedom; **: significant (p<0.01)

The significant effect of the year of recording might be due to fluctuations in availability of feeds from year to year or to instability of management practices related to feeding regimes and changes in climatic factors. Result is substantiated by the findings of Alexander et al., (1997) and Najari et al., (2007). Najari (2005) reported that the higher variation on adult weight due to year of recording can be explained by variations in amount of annual rainfall which in turn influenced pasture production and availability of feed for the dam especially in late pregnancy.

Fig.1. llustrates the monthly variation of adult weights of goats that gives birth during the three-year of recording. During the difficult

period from March to beginning of August, the adult weight varies considerably over the years.

On the other hand, a significant inter-year variation in the weight of the adult goat is observed between the end of August and the month of February. The individual differences appear only during favourable conditions and that the greatest variation of weight was observed at the end of pregnancy and at the beginning of lactation (Najari, 2005).

The seasonal patterns for adult weight, indicating that the worst weight are obtained with goats kidding in the winter season. The harsh summer conditions affect the weight of females, both by high temperature peaks and food scarcity.

Under our breeding extensive mode, where kids are not weaned, a late kidding month means a milking period until the following mating period in summer, and these tardive goats do not benefit from a period of physiological repose at the beginning of summer to restore their body reserves.
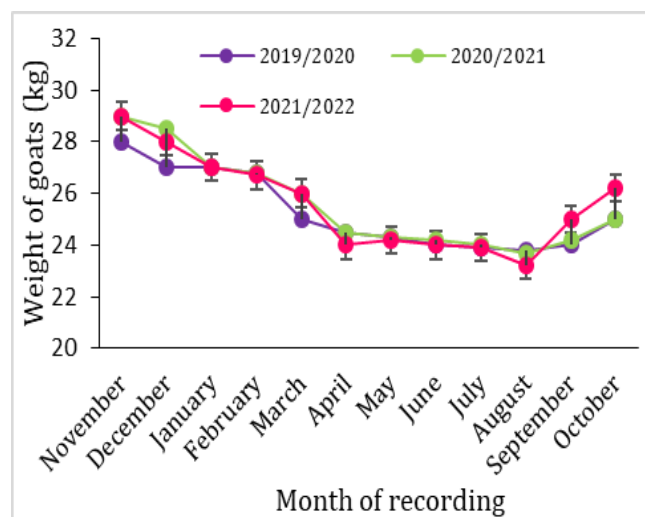

Fig.1. Monthly evolution of the weights of adult goats according to the years of recording.

Difficult years do not allow the distinction of the best females, and this is important for breeders who aim to improve the performance of their herds. Moreover, it seems that local goats relatively assimilate the effects of heat stress by reducing their impact on weight, but especially outside critical physiological stages such as the end of gestation and the start of lactation. During these later stages, it is necessary to correct through management and reduce resources through supplementation.

Hence, the performance variation between year and season is due to the inconsistency of the management, variability of climatic conditions which determine the availability of feed resources and disease distribution thereby influences the performances of both dam and kids.

For does (Fig.2), the most significant variation was obtained in January and July. During this period, the weight decrease following the introduction of does. The increase of weights which begins in January, is related to the food resources available in this period which are better than those of summer and to the physiological stage of goats which have not been in lactation.

Najari (2005) mentions that the breeding of young female during the first year of age does not seem to have a negative effect on growth to reach adult weight. The local goat can be bred when its weight is 62.5% of the adult weight. This is an important adaptive characteristic. The way to entergoats in reprduction, from their first year of age, helps these females to reach their adult weight earlier than the goats that are not covered at this same age, provided that they give importance to their needs to ensure their own growth. Weight continues to change until the age of five, when the weight remains practically constant (Najari,2005).

The environmental factors affect the weight of goats directly or through combined action illustrated by the interaction impacts importance revealed upon all studied performances traits. It seems that the environment factors effects no have the same impacts on all animal groups.

So, modelling animal performances under arid conditions needs a deep review to optimize the phenotype decomposition in the aims to correct genetics values. Non-genetic factors, and their levels, consideration as fixed factors no reflect their real nature as it is observed on phenotypes. An unbiased genetic evaluation of local population under arid conditions needs some appropriate models to perform the adequate genetics values prediction as a step to the genetic improvement.

It is better for the breeder to take advantage of the sexual precocity of his does. However, he must pay attention to the body conditions of these young females on the one hand and to the establishment of a suitable breeding plan on the

other. The advantage of this plan is to first have early kidding so that these kids can be covered during the following breeding season (Tamboura and Berté, 1996). The supply of a well-balanced diet to the goats, both during the first fight and the fight that precedes it, is essential to avoid weight loss and therefore the decrease of growth.
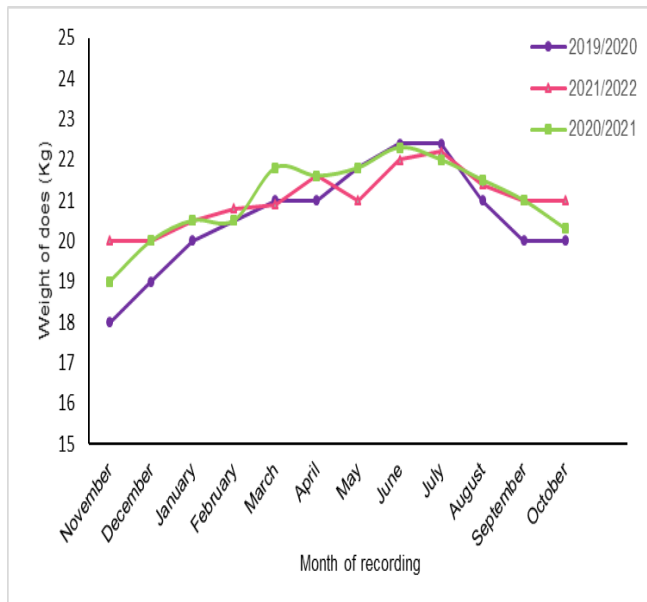

Fig.2. Monthly evolution of the weights of does according to the years of recording.

4. CONCLUSION

The adult weight of goats is mainly influenced by factors affecting pastoral resources scarcity due to climate stress which affect dam survival and herd performances. Live weight is strongly affected by the year for adult goats in which the food needs are high. Furthermore, no significant effect was observed for does since their needs were relatively limited. A correct feeding plan remains crucial for the sustainable development animal husbandry and genetic improvement of local goat population raised on arid rangelands.

REFERENCES

Alexandre, G., Aumont, G., Fleury, J., Mainaud, JC., Kandassamy, T. (1997). Performances zootechniques de la chèvre Créole allaitante de Guadeloupe. Bilan de 20 ans dans unélevage expérimental de l'INRA. *INRA Production Animale* 10, 7-20.

Al-Shorepy, SA., Alhadranu, GA., Abdul Wahab, K., (2002). Genetic and phenotypic parameters for early growth traits in Emirati goat. *Small Ruminant Research* 45, 217–223.

Atoui, A., Jesús-Carabaño ,M., Díaz, C., Najari, S., (2019). Genetic analysis of live weight of local kids to promote genetic evaluations in the arid areas of Tunisia. *Tropical Animal Health and Production* 52,955–968.

Djemali, M., Aloulou, R., Ben sassi, M., (1994). Adjustment factors and genetic and phenotypic parameters for growth traits of Barbarine lambs in Tunisia. *Small Ruminant Research* 13 , 41-47.

El Ouni, M., Najari, S., Gaddour, A., Andrea, C., (2007). Early growth of morphometric traits of local goat population in Tunisian arid zone .*Journal of Biological Sciences* 3 , 1194-1200.

El Ouni, M., Najari, S., Gaddour, A., Andrea, C., (2007). Early growth of morphometric traits of local goat population in Tunisian arid zone .*Journal of Biological Sciences* 3 , 1194-1200.

Najari, S., (2005). Caractérisation zootechnique et génétique d'une population caprine. Cas de la population caprine locale des régions arides tunisiennes. Thèse de doctorat d'Etat. Institut National Agronomique, Tunisie, p 214.

Najari, S., Gaddour, A., Ouni, M., Abdennabi, M., Ben Hamouda, M. (2007). Non genetic factors affecting local kids growth curve under pastoral mode in Tunisian arid region. *Journal of Biological Sciences* 7, 1005-1016.