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Local knowledge on Moroccan Siroua sheep management assists its resilience to climate change

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Abstract. Indigenous livestock genetic resources play a significant role in promoting biodiversity and improving ecosystem resilience to climate change in their area. In Center-eastern Morocco, Siroua sheep is a good example of adaptation to harsh environments in high altitudes (1800 m to more than 3000 m) where rainfall is very low and irregular (115 to 260 mm/year) and temperatures vary from –5 to +20 °C in winter and from +30 to +45 °C during summer. The aim of this study was to explore how herders and shepherds manage the Siroua sheep to mitigate climate change impacts. Based on the results of a prospective study and a field survey, sheep feeding is based mainly on rough grazing lands through transhumance between high mountain pastures in summer and lowlands in winter. Thus, the local knowledge on management makes the breed resilient to many drought conditions occurring in Siroua geographical area. Sheep graze a variety of shrubs and herbaceous plants at the rough grazing lands. Additionally, animals are supplemented with cereal grains and straw in case of severe drought or snow. These local practices should be accompanied by a conservation and breeding program to prevent extinction of this indigenous sheep in the future.

Keywords. Sheep – Pasture – Siroua – Management – Climate change – Resilience.

Le savoir-faire local en matière de conduite des ovins marocains de Siroua aide à sa résilience au changement climatique

***Résumé**. Les ressources génétiques animales locales jouent un rôle important dans la promotion de la biodiversité et l'amélioration de la résilience des écosystèmes au changement climatique. Dans le Centre-Est du Maroc, le mouton Siroua est un bon exemple d'adaptation à l'environnement hostile en zone d'altitude (de 1800 à plus de 3000 m) où les précipitations sont très faibles et irrégulières (de 115 à 260 mm par an) et les températures varient de –5 à + 20 °C en hiver et de + 30 à + 45 °C en été. L'objectif de cette étude prospective était de discuter des pratiques mobilisées par les éleveurs et les bergers pour gérer les moutons de Siroua en conditions de changement climatique. Les résultats ont montré que l'alimentation des animaux est principalement basée sur les parcours avec une transhumance entre les pâturages au sommet des montagnes en été et les basses terres en hiver. Ainsi, les connaissances des éleveurs et des bergers en matière de gestion font de la race un élément de résilience à de nombreuses sécheresses survenant dans la zone de Siroua. Les ovins de Siroua sont conduits sur des parcours contenant divers arbustes et plantes herbacées. En outre, une supplémentation en céréales et en paille est fournie en cas de sécheresse sévère ou de neige. Et pour soutenir ces pratiques d'élevage locales, des programmes de préservation et d'amélioration génétique sont nécessaires pour prévenir la disparition de ces moutons indigènes dans l'avenir.*

***Mots-clés.** Ovin – Parcours – Siroua – Conduite – Changement climatique – Résilience.*

I – Introduction

Climate change presents a number of challenges both to livestock rearing practices and to livestock genetic diversity (FAO, 2015). Demand for animal products is foreseen to increase significantly in the near future pushing livestock systems to increase both productivity and efficiency (Boettcher *et*

al., 2015). The challenge is how livestock keepers can take advantage of the increasing demand for livestock products (Thornton *et al*., 2007). The key, to make food-systems climate-resilient, is making livestock systems and grassland use more sustainable to meet improvement of food security, to adapt to climate change and to mitigate greenhouse gas emissions (Hoving *et al*., 2014). Highly productive breeds from temperate regions are not well adapted to high temperatures of south Mediterranean climate (FAO, 2015) and rough grazing conditions. Therefore, livestock genetic resources well adapted, to extreme temperatures, low quality diets and greater disease challenges, are needed to cope with climate change, while increasing food production (Hoving *et al*., 2014).

In Center-Eastern Morocco, Siroua sheep, with about 263,000 heads, is well adapted to an environmental context increasingly impacted by the effects of climate change. This animal genetic resource plays a significant role in promoting biodiversity and improving resilience to climate change. This paper aims to address how the local knowledge on management can strengthen resilience of Siroua sheep livestock system against climate change.

II – Materials and methods

1. The study area

The study was carried out in four sites from Siroua zone located in the Center-Eastern Morocco: *Amassine* (30°47 N, 7°29 W, 2100 m altitude), *Iznaguen* (30°34 N, 7°12 W, 1440 m altitude), *Tislit* (30°45 N, 7°17 W, 1610 m altitude) and *Arg* (30°37 N, 7°27W, 2000 m altitude). The climate is arid, with an average maximum temperature of +35.5°C in July and an average minimum temperature of +0.7°C in January. The mean annual rainfall is 123 mm, with an irregular repartition within the year and from one year to another.

2. Data collection, processing and analysis

Three stations were chosen (Askaoun, Ouarzazate and Sidi Hsain) that represent the geographical distribution of Siroua sheep. Several climatic parameters were calculated from data collected from the three stations for the period of 1985 to 2018. These climatic parameters were the minimal average temperature of the coldest month (m, in °C), the maximal average temperature of the hottest month (M, in °C) and the annual rainfall (R, in mm). In addition, we calculated the pluviothermic coefficient of Emberger Q2(Q2=3.43R/M-m) for the three stations (Stewart, 1968).

To describe the context in which Siroua sheep is reared, some environment descriptors were used according to FAO/WAAP (2008). These indicators, related essentially to climate, agro-climatic zones, soil and vegetation, were summarized from Birouk (2009) and enriched by our own field observations and interviews with breeders. The agro-climatic zone of Siroua sheep was defined according to the classification system provided by Seré and Steinfeld (1996) whose agro-climatic part is based on the length of growing period. In fact, the description of the environment in which a breed is kept over time is one approach to characterize its adaptation; otherwise, this trait is complex and difficult to measure (De Pauw *et al*., 2011).

A field prospection was done at Siroua's area in order to gather all the information available on Siroua sheep since the last reference situation provided by Ezzahiri (1981, 1983) and Ezzahiri *et al*. (1987). In addition, a workshop was organized, with all interested actors (developer, breeders and technicians), around the issue of conservation of animal genetic resources of the Southeastern Morocco, including Siroua sheep. Then a survey was carried out in 20 flocks of Siroua sheep on their management in the current context of climate change. The breeders were interviewed about how they manage their livestock in the current year and what changes are used to apply in a wet year and in a dry year. The main elements considered were herd structure, reproduction, transhumance and feeding, animal guarding and reproduction rates.

III – Results and discussion

1. Environment characteristics

According to pluviothermic coefficient of Emberger (Q_2) calculated for the three considered meteorological stations (Askaouen, Ouarzazate and Sidi Hsain), the climate of Siroua area is arid with a cold winter and a very warm summer. The monthly rainfall pattern is typically Mediterranean, with most of the precipitation recorded between September and March (75 percent). The winter, as determined by the mean temperature of the coldest month, is cold, while the summer, based on the mean temperature of the warmest month, is very warm. The soils are generally alluvial and forests are quasi-missing, except for some light/very damaged forests of the foothills. Lowlands of Siroua's mountains are dominated by white wormwood (*Artemisia herba alba)* and slopes by red juniper (*Juniperus phoenicea*). On the high slopes (between 2,500 and 3,300 m altitude), Birouk (2009) reported that the vegetation is of xerophytic type (*Erinacea anthyllis, Alyssum spinosum, Bupleurum spinosum, Astragalus ibrahimianus*) rich in species with high pastoral and ecological value (*Festuca rubra, Poa bulbosa, Nardu ustricta*).

2. Breed characteristics

Sheep in Siroua area/mountain, located between the High Atlas and the Anti-Atlas (see Environment characteristics above), has been described for the first time by Ezzahiri (1981) as "Siroua breed" with its two main variants, white and black. It formed with Saghro sheep the two main populations of rangedland's system in Ouarzazate Province, with a total census of 600,000 heads (Ezzahiri, 1983). Currently, the white variant is called "White of mountain" (Jannoune and Fagouri, 2011, 2012) while the black one is called "Black of Siroua" (Jannoune and Fagouri, 2012). Its census is about 263,000 heads and it is a small size slender with a body length ranging from 60 to 70 cm, while the rump height range from 55 to 65 cm. Body weight is 25-40 kg for rams and 20-30 kg for ewes (Ezzahiri, 1981). Despite the improvement program carried out by ANOC (Breeders sheep and goat association), body measurements seem to remain invariable as reported by Jannoune and Fagouri (2011) and Kandoussi (2017). In fact, this program, which concern only 152 breeders and 22,000 ewes until now in Siroua's zone, consists of the selection for one color (black or white) in the aim to have more homogenous herds in the future. Interviews with different stakeholders confirmed the social and economic roles of both white and black Siroua sheep for their livelihood through its direct contribution to farm's economy and in the Taznakhte local carpet. In addition to its wool quality, the Siroua sheep is also appreciated for its tasty meat that seems to be linked to the quality of pastures. Lamb carcasses having an average weight of 15 kg, are very popular for family celebrations and official events for the preparation of "*Mechoui*"; a well-known grilled meat in Morocco.

3. Siroua's livestock system

The Siroua's livestock system was largely described by Ezzahiri (1981, 1983) and Ezzahiri *et al*. (1987). Given the environment and breed characteristics described above, Siroua Sheep are housed in highlands during the summer and move between what we call "Azib" or "Azbane (Plural form)". This term, refers to the territory in which the shepherd spends the summer with the flock. Here, the whole family lives in a very modest house, a tent near their herds (sheep and goat), which are kept in the "Tagrourte"; a kind of stone fence. In the winter, the whole family move again with their animals from mountains to zones near their permanent house or "Douar". Generally, the owner himself or one of his sons guards livestock, but we found also collective flock shepherds (recruited by a group of owners) and private shepherds. Ewes always give a maximum of one lamb per year, but in a wet year, some ewes who have given so-called "*Bekri*" lambs (in winter) can give another one in the same year (July-August). Livestock feeding is based on rangelands throughout the year.

Therefore, from October to April, animals exploit collective pastures near settlements. In the summer, collective "*Agdals"* are open for browsing during 5 to 7 months. In addition, grass is collected in the private "Agdal" of each farmer, dried and used to fill the feeding gap observed from October to April. The private "*Agdal"* can also be browsed by sheep from September to October and the entering date depends on the date of the last grass cut. During lambing, ewes receive supplementation based on corn grain, alfalfa hay, grass hay and straw. In case of severe drought, feed supplementation is provided for all the animals.

4. Changes in husbandry practices in response to climate change

In general, Siroua's livestock system has not really changed compared to what has been described by Ezzahiri (1981, 1987) and by Jannoune and Fagouri (2012); it is still based on rangelands. However, some changes can be operated by the breeders depending on the climatic conditions and the vegetation status (see Environmental characteristics above).

A. New transhumance start dates

Generally, early in November, sheep are moved towards lowland pastures near the main residence of breeders. In these rangelands, dominated by wormwood, forbs and grasses, animals spend the entire cold period (December-March). However, if autumnal rainfall is delayed, the journey in the mountains will extended until the first snow (December-January). Similarly, time for moving from lowland pastures to highlands in Siroua's Mountain can be deferred in case of extension of the cold period or the late availability of grass on lowlands. Ezzahiri (1983) already has noted that generally sheep start browsing dried plants in the plains and Saharan zone from October to March or April depending on climatic conditions and vegetation status.

B. Longer transhumance journey

As described in Section 3, the feeding of Siroua sheep is based on rangeland vegetation according to two main movements. One is occurred in April or May, depending on climate conditions, while the herds move to highlands to browse the pastures called "Agdals". Early in the autumn, another move is planned from Siroua's Mountain to lowlands near settlements. These two main transhumances are exercised only within Ouarzazate Province between Mountain pastures, pastures of plains and plateaus and Saharan pastures, as reported already by Ezzahiri (1983). Nevertheless, our survey showed that some breeders, especially from Taznakhte, achieve long transhumance journeys from there to Saharan rangelands (ex. Province of Tata, 29° to 30° N, 7° to 9° W) or subhumid rangelands (ex. Provinces of Agadir and Tiznit, 29° to 30° N, 9° to 10° W). This situation is totally contradictory with was observed in the Middle Atlas by El Aich (2018), who reported a reduction and/or disappearance of herd transhumance in response to reduction of vegetation annual production on rangelands due to recurrent drought.

C. Agriculture and complementation parts in livestock feeding vary considerably

Herds are fed on rangelands all year round both in highlands and lowlands. Moreover, crops, mainly cereals, contribute to animal feeding through exploitation of stubble for one or two months. In addition, grass can be collected from "private rangelands" and dried to be used during the winter. In this period, breeders supplement their animals, since most lambing takes place in winter. Feeds are mainly straw, barley and corn grain. However, some breeders use other industrial by-products like dry beet pulp, wheat bran and composite concentrate feeds. Ezzahiri (1983) has reported that in a wet year, the maintenance of animals is covered only through browsing in the plains and Saharan pastures, but in a dry year, the breeders offer supplements (barley, corn, alfalfa hay, etc.) to their animals. However, our survey showed that the use of alfalfa hay in sheep feeding is almost

absent. This can be explained, on the one hand, by the reduction in the area cultivated for alfalfa in favor of apple tree and saffron, and on the other hand by the allocation of alfalfa for cattle feeding. In the context of the Middle Atlas Mountains, El Aich (2018) showed that other external resources and agricultural by-products (straw, stubble) are offered partially instead of rangelands contributions that make the system heavily dependent on agriculture.

D. Changes in flock size and reproduction rates

In our studied livestock herds, the mean number of ewes per breeder is about 130 ewes, varying from 30 to 225 ewes. This number can be raised on average to 150 ewes in a wet year or reduced to 80 ewes in a dry year. Besides sheep, 75 percent of interviewed breeders have goats in their farms; their census vary from 20 to 300 heads. The lambing rate of sheep varies according to climatic conditions; 0.84 in the year of study, 0.95 in a wet year and 0.52 in a drought year. These results are in concordance with Ezzahiri and El Maghraoui (1983) who reported that, as a result of drought, in1981 and 1982, the lambing rate in sheep fell from 0.82 (1980) to 0.46 (1982). Most lambing takes place between November and January. According to some breeders, in a wet year, additional lambing can take place in summer, and are generally ewes who are mating a second time in March-April. This shows the direct effect of weather and feed availability on ewe prolificacy. Mortality rate of young lambs is about 0.17, but can reach 0.81 when climatic conditions are difficult and vegetation in rangeland is critical. Moreover, in drought conditions breeders relieve ewes of their suckling lambs, by slaughtering them, to reduce their feed requirements to maintenance level. In fact, in winter, which usually matches with the lambing period, keeping sheep alive depends on climate conditions (Ezzahiri, 1983).

IV – Conclusion

Siroua sheep is a small sized animal that lives in (and is named after) the Siroua Mountain between the High Atlas and the Anti-Atlas of Morocco. It is managed according to an extensive breeding/low-input system in which feeding is based on browsing on rangelands. Given Siroua's climate is arid with a cold winter and a very warm summer, some changes are noted in livestock husbandry in response to climate change from one year to another. In this context, breeders modulate time of transhumance between lowlands and mountains depending on climate conditions and vegetation status. In addition, some livestock keepers achieve a long transhumance journeys toward Saharan and sub humid rangelands. This demonstrates that management local knowledge makes the Siroua sheep resilient to many droughts occurring in Siroua area. Its transhumant system provide feeding on various trees, herbaceous plants and shrubs. In addition, supplementation with grains and straw is provided in the case of severe drought or snow for maintaining animals alive. In response, Siroua sheep, which are well adapted for browsing, are able to regain its cruising reproduction rates after a period of drought characterized by a decrease in lambing rate and growth. They represent an important case of sheep resilience to climate change, thanks to successful combination of flexible husbandry practices and a well-adapted indigenous breed. Further investigations of genetic bases under pinning local adaptation and plasticity to harsh climate and low-input breeding system are needed in the near future to elucidate the mechanisms of this resilience.

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References

Birouk A., 2009. Renforcement des capacités locales pour développer les produits de qualité de montagne – Cas du safran. Assistance de la FAO au Projet FAO/TCP/MOR/3201. Rapport de mission, 128 pages.

Boettcher P.J., Hoffmann I., Baumung R., Drucker A.G., McManus C., Berg P., Stella A., Nilsen L.B., Moran D., Naves M. and Thompson M.C., 2015. Genetic resources and genomics for adaptation of livestock to climate change. Frontiers in genetics, vol. 5, art. 461.doi: 10.3389/fgene.2014.00461.

De Pauw E., Rischkowsky B., Abou-Naga A., Ansari-Renani H.R., Boujenane I., Gursoy O., 2011. Use of GIS tools for the integration of production environment descriptors of animal genetic resources. Final Report of Project "Practical Application of Production Environment Descriptors for Animal Genetic Resources – country case studies for sheep and goat breeds" (Letter of Agreement of FAO with ICARDA PR 43410). 136 pages.

El Aich A., 2018. Changes in livestock farming systems in the Moroccan Atlas Mountains. Open Agriculture 3, 131-137.

Ezzahiri A., 1981. La race Siroua: mouton à laine. O.R.M.V.A. d'Ouarzazate.

Ezzahiri A., 1983. Impacts de la sécheresse sur les zones à vocation pastorale: Cas de la Province d'Ouarzazate. O.R.M.V.A. d'Ouarzazate.

Ezzahiri A., El Maghraoui A., 1983. Effets de la sécheresse sur les productions du bétail et les pertes enregistrées durant les années 1981 et 1982. O.R.M.V.A. d'Ouarzazate.

Ezzahiri A., El Maghraoui A. and El Abbassi M., 1987. Etudes des agdals de la zone d'action de l'O.R.M.V.A Ouarzazate. O.R.M.V.A. d'Ouarzazate.

FAO, 2015. Coping with climate change – the roles of genetic resources for food and agriculture. Rome. ISBN 978-92-5-108441-0. 130 pages.

FAO/WAAP, 2008. Report of the FAO/WAAP Workshop on Production Environment Descriptors for Animal Genetic Resources, held Caprarola, Italy, 6-8 May 2008. Edited by D. Pilling, B. Rischkowsky& B.D. Scherf. 2008, Rome, 103 pp.

Hoving I.E., Stienezen M.W.J., HiemstraS.J., Van Doorenen, H.J. De Buisonjé F.E., 2014. Adaptation of livestock systems to climate change; functions of grassland, breeding, health and housing.Wageningen, Wageningen UR (University & Research centre) Livestock Research, Livestock Research Report 793.

Jannoune A., Fagouri S., 2011. Caractérisation morpho-biométrique de la race «Blanche de Montagne». L'éleveur n° 19.

Jannoune A., Fagouri S., 2012. Etude morpho-biométrique de la Siroua. L'éleveur n° 20.

Kandoussi A., 2017. Etude de la variabilité génétique de la race Blanche de Montagne à travers le polymorphisme de l'ADN mitochondrial. Mémoire IAV, Hassan II, Rabat, Maroc.

Seré, C., Steinfeld, H., 1996. World livestock production systems: current status, issues and trends. FAO Animal Production and Health Paper 127, Rome.

Stewart Ph., 1968. Quotient pluviothermique et dégradation biosphérique quelques réflexions. Bull. Soc. hist. Nat. Afr. Nord, Alger. 59: 23-36.

Thornton P., Herrero M., Freeman A., Mwai O., Rege E., Jones P. and McDermott M., 2007. Vulnerability, Climate change and Livestock – Research Opportunities and Challenges for Poverty Alleviation. SAT eJournal (ejournal.icrisat.org), December 2007, Vol. 4 (Issue 1).