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in

López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.). Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125

2021

pages 63-66

Article available on line / Article disponible en ligne à l'adresse :

http://om.ciheam.org/article.php?IDPDF=00007970

To cite this article / Pour citer cet article

El Amiri B., Nassif F. **Revisiting crop and livestock integration in sheep and goat systems of Morocco: new insights.** In : López-Francos A. (ed.), Jouven M. (ed.), Porqueddu C. (ed.), Ben Salem H. (ed.), Keli A. (ed.), Araba A. (ed.), Chentouf M. (ed.). *Efficiency and resilience of forage resources and small ruminant production to cope with global challenges in Mediterranean areas.* Zaragoza : CIHEAM, 2021. p. 63-66 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 125)



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Revisiting crop and livestock integration in sheep and goat systems of Morocco: new insights

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Abstract. Mixed farming with crops and livestock, particularly cereals associated with sheep rearing has been and still is the predominant farming system in Morocco. Because of the high diversity of topography, soils, climate, the extent of arable, rangelands, crop and livestock integration in sheep and goat systems takes a variety of forms. The integration depends on cultivated crops on-farm, available feed sources, breeds, and production objectives. Most studies on Moroccan sheep and goat systems adopt technicist approaches. The aim of this paper is to revisit the main sheep and goat production systems. It is based on specialised studies and field work on sheep and goats in the Middle-Atlas, Azilal and the plains of Settat and Khouribga provinces. The analysis focuses on the pastoral system of the eastern steppes as an example of the occurring shifts in sheep production. It is argued that the use of typologies hides the evolutionary processes underlying the production systems and the extent of diversity and interaction within systems. For a better understanding of crop-livestock integration, multi-disciplinary approaches are necessary.

Keywords. Morocco – Sheep – Goats – Mixed farms – Integration.

L'intégration cultures/élevage revisitée à travers l'étude des systèmes ovins et caprins au Maroc: nouveaux éclairages

Résumé. L'agriculture mixte (cultures et élevage), en particulier les céréales associées à l'élevage ovin, a été et reste le système d'exploitation prédominant au Maroc. En raison de la grande diversité de la topographie, des sols, des conditions climatiques, de l'étendue des terres arables, des parcours et des terres marginales, l'intégration des cultures/élevages (ovins et caprins) revêt de nombreuses formes. D'autres facteurs peuvent définir la nature de l'intégration notamment les cultures pratiquées, les sources d'alimentation supplémentaires disponibles, les races et les objectifs de production. La plupart des études sur les systèmes ovins et caprins marocains adopte des approches technicistes. Dans ce papier, les systèmes de production ovins sont revisités. Le travail est basé sur une revue de la littérature et des travaux antérieurs sur le terrain dans le Moyen Atlas, les provinces d'Azilal, de Settat et de Khouribga. L'analyse se concentre sur le système pastoral des steppes orientales en tant qu'exemple des changements survenus dans la production ovine. Il est avancé que l'utilisation de typologies cache les processus évolutifs sous-jacents aux systèmes de production et l'étendue de la diversité et de l'interaction au sein des systèmes. Pour une meilleure compréhension de l'intégration cultures – élevages, des approches multidisciplinaires sont nécessaires.

Mots-clés. Maroc – Ovin – Caprin – Exploitations mixtes – Intégration.

I – Introduction

According to the 2014 census, the Moroccan population counts 33.8 million with the rural people representing less than 40% (HCP, 2014). Despite the continuous urbanization, agriculture still occupies an important place in the economy with sheep and goats contribution to the country's GDP estimated between 1.5% and 2% (Boujenane, 2005). In the last three decades, agriculture and live-stock husbandry have witnessed an increased intensification with greater interactions between crops and livestock. This resulted in the transformation of extensive pastoralism to semi-intensive mixed farming. The latter is seen as the most efficient and sustainable means of increasing food production and coping with risks. In fact, it is documented that diversification of subsistence agriculture and

livestock activities is a way to cope with climatic risk. Most arable lands and rangelands are located in areas receiving less than 400 mm of rainfall, where cereals and small ruminants mainly sheep are integral components. The aim of this paper is to revisit the main sheep and goat systems in Morocco. The paper builds on specialized works on production systems, namely Guessous *et al.* (1989); Boujenane (2005); Boulanouar (2006); Boulanouar and Benlekhal (2006). The authors also draw from their observations and fieldwork on sheep and goats in the Middle Atlas, Azilal, Chaouia and Khouribga regions (Chriyaa *et al.*, 2011; El Amiri, 2006; El Amiri *et al.*, 2007; Sibaoueih *et al.*, 2019).

II – Predominant forms of crop/livestock integration and changes

The first comprehensive work on sheep in Morocco classified production systems according to the type of feed resources, namely the pastoral, the agro-pastoral and the oasis system (Guessous et al., 1989). Later, the research program on small ruminants at the National Institute of Agricultural Research, in collaboration with the German Technical Cooperation, established a typology of sheep production systems in 1992 (Boulanouar, 2006). The four systems identified were the pastoral, the agro-pastoral, the agro-sylvo-pastoral and the oasis systems. For the classification of Guessous et al. (1989), the pastoral system was defined based on the predominance of range forages contributing over 50% of total feed resources with herds spending from 8 months to all year around on rangelands. Geographically, the pastoral system is characteristic of the Middle-Atlas, the high plateau and the Moulouya basin. Boulanouar and Benlekhal (2006) reported that the pastoral system is dominant in mountains with forest and non-forest rangelands, the arid steppes where agriculture is uncertain, the High Plateaux of Eastern Morocco, the southern side of the High Atlas, and Chaouia and Rhamna regions. The agro-pastoral system prevails in areas producing cereals and legumes, namely Gharb, Doukkala, Chaouia, Abda, Taounate, Khemisset (Guessous at al., 1989). Sheep flocks rely significantly on on-farm production including cereal and legume grains as well as their by-products. When necessary the market provides a variety of feed products. The oasis system is confined to oasis particularly in the Drâa-Tafilalet region and Figuig oasis. Cereal by-products, alfalfa and date by-products are the major feeds for sheep consisting of small size flocks of all year around penned and highly prolific D'man breed.

Over the last three decades, Morocco has experienced complex processes of change including all spheres of the economy, the society and the natural environment. Sheep production systems have had their part of transformation and change. While the concepts of agro-pastoral and oasis systems continue to be relevant today, the concept of pastoral sheep production is increasingly losing its empirical grounds. As indicated in Table 1, cereals and cereals by- products, crop residues of all kinds are increasingly generalized as feeding stuffs across the country including the conventionally defined as pastoral areas, namely the eastern steppes and the Middle-Atlas. This implies that sheep production is relying less on range pastures and more on crops and crop by-products whether from on-farm production or acquired through the market. In the eastern steppes of Morocco, cropping activities were marginal particularly among the nomadic herders. With the settlement of most nomads, growing cereals and forage crops are becoming of paramount importance. According to the 2014 population census, the nomadic population in Morocco stands at 25,274 people compared with 68,540 in 2004. This 63% decline over a decade is a clear indicator about the direction of change in sheep production in the future. At the regional level, Drâa-Tafilalet accounted for 61%, the Guelmim-Oued Noun counted for 21% and the region of the Oriental recorded 2% of all nomads (HCP, 2016). The eastern steppes are traditionally considered the center of pastoral nomadism.

With respect to goats, the contribution of range feeding is rather substantial, varying from 75% to 97% of annual animal requirements, depending on climatic conditions of the year and/or regions (Boujenane, 2005). In the north of the country, Chentouf (2018) reported that pastoral resources covered about 96% of the animal needs in the extensive goat meat production system. The meat and milk system relies on both pastoral resources (from 49 to 78% of total needs) and other feed resources from the farm or the market (Chentouf, 2018).

Production	Administrative	Predominant breed in numbers Major feed resources				
Agro-pastoral in the central plains	 Settat El Kelâa des Saghna Rhamna Beni Mellal 	Sardi (2.1 million heads) represents 13% of Morocco's total	Barley grain, straw, weedy fallow, stubble, crop residues, cultivated forages			
Agro-pastoral in the eastern steppes-Figuig	– Taourirt – Guercif – Jerada	Beni-Guil (1.9 million heads) represents 12.5% of Morocco's total	Range pastures, barley grain, cereal straw and stubble, wheat bran, crop residues			
Agro-sylvo- pastoral in the Middle-Atlas	– Ifrane – Boulemane – El Hajeb – Sefrou	Timahdit (1.5 million heads) represents 10% of Morocco's total	Forest / highland pastures, cereal straw, stubble, weedy fallow, crop residues			
Agro-pastoral of the Atlantic (irrigated and ainfed areas)	– Kénitra – El Jadia – Safi	Local sheep populations	Cereal straw, fallow, stubble, alfalfa, sugar beet by- products, bran, crop residues			
Agro-pastoral	– Khouribga (Oued Zem-Boujâd) – Beni-Mellal (Tadla)	Boujaâd (230 000 heads)	Cereal straw, fallow, stubble –alfalfa, sugar beet by– products,other crop residues			
Argan forest- farming system	– Essaouira – Taroudant – Agadir Ida– Ou-Tanan	Local sheep populations	Argan sub-products, cereal by products, crop residues			
Oases	– Errachidia – Ouarzazate –Zagora	D'man (260 000 heads)	Alfalfa (fresh-hay), dates by-products, cereal by-products, crop residues			

Table	1. Sheep	systems in	Morocco,	main	characteristics,	breeds	and feed	resources
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Source: compiled by authors.

III - Main constraints

Natural diversity is a major characteristic of Morocco displayed in the presence of mountain ranges in the Rif and Atlas, central plains, steppes and Saharan environments. This results in climatic zones varying from warm, dry in summer and mild in winter to hot desert. Average annual precipitations vary from over 1,200 mm in the North with two seasonal peaks in winter and spring, to below 100 mm in the South. Across the country, crop and livestock activities are climate dependant. The availability of feed resources and animal species are closely associated with rainfall patterns. The analysis of the evolution of sheep and goat population over the last 50 years reveals the close relation between the extent of fluctuations in stock numbers and drought episodes in Morocco. In 1982, Morocco lost 35% of its national sheep flock and 25% of the goat flock because of the drought.

As highlighted in the literature, local sheep breeds are known by their rusticity, diversity and adaptation to prevailing environmental conditions (Boujenane, 2005; Boulanouar and Benlekhal, 2006). Table 1 indicates that these breeds are integral parts of particular climate, environmental and production zones. Herders and farmers select not only the animal breeds that are likely to withstand the prevailing environmental conditions but they also grow most adapted crops to prevailing conditions.

IV – Prospects

Between the 1982 and the 2014 population censuses, the rate of urbanisation in Morocco moved from 42.7% to 60.3%. This means that urban consumers represent the largest share of the current and future demand for sheep and goat products, grains, vegetables and fruits. The tendency to respond to market driven products for an increasing urban population needs to be considered in apprehending the occurring shifts in sheep and goat production systems. Pastoral activities are increasingly associated with cropping activities through shifts in land use, irrigation and modernisation of farming practices. For example, cultivation of forages covered 128,000 hectares against 441,718 hectares in 2005. The future is likely to unravel a greater diversification of feed sources, less reliance on range-lands and more use of crops by products and concentrates, and more integration in the market.

A better understanding of the directions of these changes requires the availability of national agricultural statistics. Since independence in 1956, Morocco conducted two general agricultural censuses, the first one in 1973 and the second in 1996. Since 2015, the ministry of agriculture has been talking about the National Agricultural Register. Until today, there are not any information accessible to the public. Besides, it is not clear whether or not that the initiative is an alternative to the general agricultural census. Without longitudinal updated data of wide coverage, it is very difficult to apprehend the evolving links between land use, livestock numbers and distribution.

V – Conclusion

In Morocco, farmers and herders are diversifying their activities as coping strategies to face unreliable climate and market requirements. Mixed farms allow more flexibility and more resilience in face of risks. The use of typologies hides the evolutionary processes underlying the production systems and the extent of diversity and interaction within systems. For a better understanding of crop-livestock integration, multi-disciplinary approaches are necessary.

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