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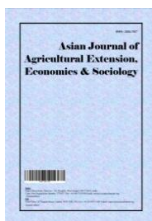
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Sustainable Development of the Steppe in the Region of El Bayadh, Approach to a New Fattening System

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Authors' contributions

This work was carried out in collaboration among all the authors. Authors MMB and TN designed the study, carried out the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MMB and MK managed the analyzes of the study. Author MI managed the documentary searches. All authors have read and approved the final manuscript.

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ABSTRACT

The objective of this research is to follow the evolution and sustainability of the natural resource management systems adopted by different breeders found in the Al Bayadh region in Algeria. Using a stratified sampling method, 52 farms were surveyed between 2010 and 2015 to capture the diversity of farming systems and identify changes in land use patterns. The findings of the research reveal a predominance of sedentary and semi-transhumant farming systems with a sharp decline in nomadism. This study enabled us to identify three types of breeding: sedentary breeding systems with short-term fattening (type 1), semi-sedentary systems with medium-term fattening (type 2), and transhumant/nomadic systems with long-term fattening (type 3) that therefore reflect a diversity of actions in the management of the risk that threaten livestock production.

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1. INTRODUCTION

The steppe routes that cover about 8% of Algeria and support about 12 million sheep HCDS-GTZ, [1] are degraded; this degradation has occurred for several decades and may be attributed to the breakdown of customary and traditional management systems developed based on a tribal organization model. The breakdown of this model may, in turn, be attributed to interventions by the state. Decision-makers often consider customary and tribal organization models as backward Mekhloufi et al. [2]. The breakdown of customary and traditional livestock management systems as a negative influence or impact on livestock production and breeding systems. Such social changes influence the way space and routes are used.

Livestock farmers use both crop resources and concentrate feed Bourbouze, [3], though the development of grassland-based systems seems limited van Vuuren and Chilbroste, [4]. Facing rapid changes, livestock farmers engaged in breeding activity have developed different coping strategies. These changes are mainly due to a reduction in biodiversity and pastoral biomass, which are a source of livelihoods of people living in the steppe.

Transhumant herds consist of sheep and goats. Because these sheep and goats are contained in a single mixed herd running the same routes, the observation unit selected is the flock. A herd is composed of animals (in this case, sheep and goats) managed by the same breeder or shepherd, living and moving together. Breeders may own animals in other herds and may have in their flocks animals from herds belonging to other owners.

1.1 The Study Area

The case study area of El Bayadh is divided into three geographical bands composed of three different zones: the High Plains, the Saharan Atlas, and the Saharan Platform. From north to south, the regions are the high steppe plains area, the Saharan atlas zone, and the pre-Saharan zone. It includes 08 dairates and 22 communes. It is a predominantly semi-arid territory with an arid tendency.

The El Bayadh test territory forms a boundary delimited in longitude by 0° (Greenwich meridian)

at 2°E and in latitude by 3° at 34°N. It is divided into three geographical bands parallel to the sea. These are, from north to south, the high steppe plains (which are an immense endorheic closed basin in which the rainwater flows towards the chott chergui or the dayates), the mountainous area (the Saharan Atlas), and the desert Saharan zone (which forms the southern piedmont of the Saharan Atlas).

The vegetation in the region of El Bayadh, like the whole of the Algerian steppe territory, is strongly linked to geomorphology. Three important physiographic forms emerge in connection with the geological structure and the nature of the rocks that constitute the geological substratum: (1) the jebels, hills, and peaks; (2) the more or less flat surfaces; and (3) the depressions Regagba [5].

According to Aidoud [6], one of the main characteristics of the arid climate is its extreme interannual variability. Generally, in arid and semi-arid zones, the rainfall is marked by great irregularity in frequency and abundance with a coefficient of variability of the order of 30–40%. The average annual rainfall of the region of El Bayadh is relatively low: 326 mm/yr in El Bayadh, 208 mm/yr in El Kheiter, and 129 mm/yr in El Abiodh Sidi Chekikh. This rainfall exhibits strong interannual and spatial variability and decreases from north to south. The rains are concentrated in the cold season, and the hottest months are also the driest. There are around 20 thunderstorm days per year in El Bayadh. The average snowfall for El Bayadh is 13 days per year with an average thickness of 10 cm.

Factors affecting the floristic composition of the steppes include texture, salinity, limestone and gypsum content, useful water reserve, and organic matter content. These factors have been studied in Tunisia Le-Houero, [7] and the Algerian steppes Pouget, [8], Djebaili, [9]. Soil-vegetation relationships have been discussed by several authors Killian, [10]. Multivariate analysis is used in the most recent studies, such as Bonnin and Thinon [11], Sari [12], Merzouk et al. [13]. In the steppe environment of North Africa, we often find lands with salinities that are significant either on source rocks with a high salt content or in endoreic depressions (Chotts and Sebkhas). The halophilic vegetation can cover large areas. According to Smail [14], successive droughts and the deterioration of living conditions

in scattered areas are the main factors explaining this rural exodus. Furthermore, Bedrani [15] indicates that agro-pastoralism since the 1950s, due to the persistence of low productivity and high population growth. The latest census results indicate that the total population of the Bayadh region increased from 71,413 in 1966 to 278,100 in 2010, an average annual increase of 3.88%.

1.2 The Pastoral Context: the Sustainability of Pastoral Systems

The term rangeland refers to any area that can be grazed, including fallows and crop residues after harvest. Access to grazing areas is becoming more monetized.

The "improved courses" are rangelands (pasture land) with improved fodder that is accessible only upon payment of access fees and during dry periods. The payment rate for improved courses is higher than that for natural courses.

Grazing on cereal stubble on private land is widely practiced by livestock breeders and farmers and hence, the price for grazing on cereal stubble on private land depends on four conditions: i) weather conditions, ii) the type of crop grown, iii) location of the farm area, and iv) personal relationships between the buyers and sellers. Prices usually increase during dry seasons.

The term "sustainability" does not imply the preservation of natural resources, which would force humans to stop using them because most of them are not inexhaustible. Rather, the term refers to the reduction of environmental damage so that development remains environmentally sustainable. *the United Nations Environment Program (UNEP).*

2. METHODS

A semi-open questionnaire made it possible to collect information on access to land, the herd, farming practices, the problems expressed by farmers and their vision of the future for their activity Dervin, [16]. From the data, 18 qualitative variables were designed, to carry out a typology, thanks to a factorial analysis of multiple correspondences (AFCM), followed by an ascending hierarchical classification (CAH). We verified that, for each of the variables, the distribution of farms according to the terms of the variable was not independent of the type of

farming system, using the Pearson chi-square test.

Data on specific issues, such as livestock management, rangeland use, equipment and farm characteristics were collected using a survey questionnaire. The sampling unit of the survey is a flock. the survey carried out on Fifty-two flocks of breeders (units) present in the pastoral system of the El Bayadh region. The research should identify the knowledge and technical know-how of livestock producers, as well as their shortcomings, as well as other limiting factors and future strategies to address these limiting factors.

Using multiple correspondence factorial analysis and hierarchical ascending classification, 18 variables were identified. The analysis also revealed the expenses incurred by different livestock rearing systems.

We have estimated the annual maintenance and fattening costs per ewe and per lamb to assess the reproductive capacity in different farming systems. We used the market price or the average price of breeders in the survey model.

3. RESULTS

3.1 Typology of Systems of Rearing

The projection of the 52 individuals on the factorial plane (1, 2) of the FCM (Fig. 1) shows the three types identified. Axis 1 presented by farms that fatten transhumant farms that raise these sheep on routes and sell their lambs after weaning. Axis 2 presented by semi-transhumants using public land for grazing. Sedentary farmers own farmland and practice a rancher.

3.2 Types of Livestock Rearing Systems

The sedentary breeding system with short-term fattening (type 1): This type of livestock breeding system focuses mainly on fattening. The key strategy is to purchase weaned lambs for fattening for two months before being sold. A family member or a hired employee guards the flocks. This type of breeder usually keeps between 10–20 heads of cattle that graze in a grazing area with a 10 km radius. Besides livestock rearing and fattening, those who practice this type of livestock breeding usually grow agricultural crops and pursue other income-generating activities.

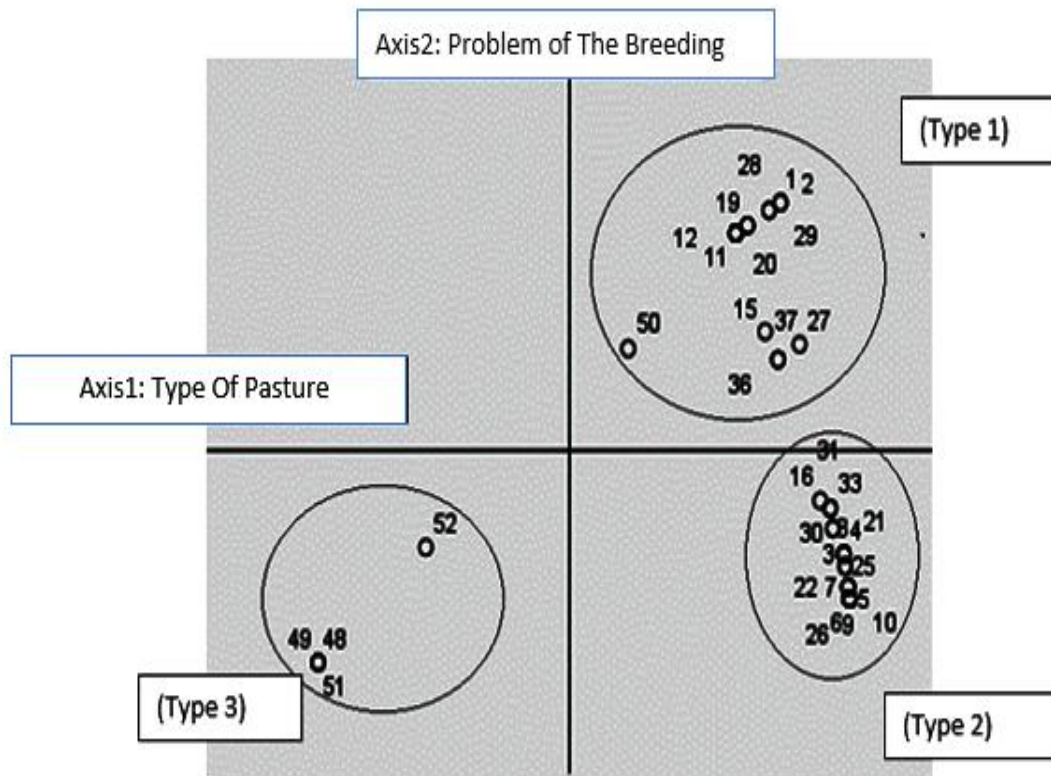


Fig. 1. Projections of individuals (52 farms) on the factorial plane (1, 2)

The semi-transhumant system with medium-term fattening (type 2): This type of livestock breeding system is practiced by pastoralists who rear and fatten lambs for butchers. Lambs are fattened for six to seven months. Grazing areas have a 10–30 km radius, and family members guard their flock. However, seasonal workers are employed during times of increased work load.

The transhumant and nomadic system with long-term fattening (type 3): Transhumant and nomadic livestock rearing is an extensive/semi-extensive system that depends on natural rangelands. On average, livestock may travel between 30 and 90 km in search of natural pastures. However, droughts often force them to travel longer distances in search of pasture and water resources in autumn and winter months.

3.3 Cost of Lamb Production

Sedentary, semi-transhumant, transhumant and semi-nomadic livestock systems using pasture on public or private land. The production cost of

one lamb per ewe per year is between 1500 and 2000 dinars (approximately 10 euro). The Type 1 system has the highest cost due to grazing in neighboring areas. The cost of producing one lamb per ewe per year is shown in Table 1. The sedentary livestock system has the lowest production cost for lambs mainly for two reasons: i) lamb production is highly productive and ii) grazing costs are low because the costs are largely dependent on lamb production and concentrated feed that accounts for nearly 80% of the production cost. The cost of production of lamb under the transhumant breeding system is the highest due to the high cost of pasture coupled with low productivity.

Semi-transhumant breeding has a moderate cost of production since mainly extensive grazing on natural rangelands is practiced. However, the cost of feeding supplementary concentrates represents 60% of the cost of production. This system uses feed concentrates at the rate of 50 kg/ewe to produce one lamb (Table 1, Table 2).

Table 1. Characteristics of the three types of systems of breeding

Types of systems	Sedentaries with a fattening at short time (type I)	Semi transhumant fattening with lasted average (type II)	Transhumant and nomad with fattening at long life (type III)
Many breedings	26	14	12
Median number of sheep	150	210	450
Stockbreeders having of the agricultural lands (%)	52	42	6
Stockbreeders practitioners allotement (%)	85	15	0
Stockbreeders practitioners watering with the pasture (%)	5	40	0
Stockbreeders practitioners watering with the cattle shed (%)	65	33	0
Distribution of the stockbreeders of a system according to the type of grazed resources (%)			
Thatches	25	40	100
Natural and improved courses	40	60	15
Natural courses and thatches	12	0	0
Distribution of the stockbreeders of a system according to the period of complementation (%)			
From June to January	60	14	50
All the year	18	80	40
Distribution of the stockbreeders of a system according to the concentrates used (%)			
Barley	65	5	0
Its of wheat	30	10	0
Barley and its of wheat	55	85	97

Table 2. Annual loads of grazing ground per ewe according to the types of breeding

Types of systems	Sedentaries with a fattening at short time (type I)	Semi transhumant fattening with lasted average (type II)	Transhumant and nomad with fattening at long life (type III)
Natural courses			
Fixed price by DA (dinar/ewe/month)	250	250	250
Utilization period (month)	9	12	9
Improved courses			
Fixed price by DA (dinar/ewe/month)	550		
Utilization period (month)	3		
Thatches			
Average costs to reach thatches (dinar/ewes/months) + standard deviation	200 ± 130	140 ± 86	190 ± 50
Utilization period	3	3	3
Annual load to reach the pasture (dinar/ewe)	1500	1800	1900

3.4 Perceptions of Breeders on the Constraints and the Future of their Farming

The inadequate availability and high cost of water, concentrate, and grazing land are some of

the common problems encountered by livestock breeders using different livestock breeding systems. However, the severity of the problems encountered by livestock breeders may differ depending on the system practiced. Inadequate access to water was indicated as the main

problem encountered by transhumant pastoralists. The shortage of grazing land was the key concern of individuals practicing the sedentary and semi-transhumant livestock breeding system. Furthermore, sedentary livestock breeders wanted to increase their activity whereas transhumant pastoralists were thinking of reducing their activity and eventually stopping completely.

The use of concentrate as a source of supplementary livestock feed is found in the steppes of Algeria Kanoun et al.,[17] and other regions throughout the Magreb Bourbouze, [3]. For instance, Ben Salem [18] estimates that rangelands represent only 10 to 15% of the diet of livestock in central Tunisia.

4. DISCUSSION

The findings of this research indicate that concentrate feed constitutes between 15% and 26% of the total dry matter ingested by ewes. The remaining percentage of the dry matter is from fodder (hay) and grazing on crop stubble or path vegetation; however, this research was unable to estimate the contribution of grazing on rangeland to the total dry matter content of ewes' diets. In contrast to ewes, concentrate feed constitutes a major proportion of the diet for fattening lambs.

This research has demonstrated some of the socio-economic and environmental challenges faced by the livestock breeders in the case study area; it also discusses the coping strategies adopted by these breeders.

The different socio-economic contexts of livestock breeders often influence the type of livestock breeding system they adopt. For example, drivers, retirees, technicians, and workers mostly practice the semi-transhumant breeding system. These breeders consider sheep as assets that can be used to meet expenses during special occasions such as marriages and school admission.

Transhumant livestock breeders, however, face numerous difficulties such as having limited access to drinking water, electricity, and other basic civic amenities. Younger generations are less interested in engaging in livestock rearing and often immigrate to urban towns to pursue higher education. Such out-migration of young people is observed throughout the Maghreb Amichi et al.,[19].

According to Benyounes et al. (2015), 77% of the lambing in Algerian steppe occurs in autumn, as in other steppe areas. In central Tunisia, livestock productivity is quite low: 1.2 to 1.3 lambs per ewe per year where 30–44% of ewes lamb twice a year in spring and autumn. Lassoued [20] argues that in areas with an annual rainfall of 400 mm to 500 mm, the ideal livestock productivity is between 1.1 and 1.2 weaned lambs per ewe per year.

Moraine et al. [21] indicate that the sustainable development of sedentary and semi-transhumant breeders is a major challenge for modern agriculture. They also note that it is difficult to take into account ecological issues when engaging in such activities on a large scale.

When there is a shortage of natural grazing resources, pastoralists often depend on subsidized agro-food industry products to provide supplementary feed for ewes, especially in dry seasons. Dichoefer et al. [22] argue that feeding livestock agro-food industry by-products is an important mechanism for ensuring viable livestock farming in fragile and semi-arid regions. These pastoralists also feed the ewes agricultural by-products, including stubble, to overcome shortages and help relieve pressures on natural resources.

Sedentary livestock breeders who specialize in fattening are especially vulnerable to fluctuations in cereal grain productions due to climate change.

5. CONCLUSION

This study highlights three livestock production systems (i.e., sedentary, semi-transhumant and transhumant/nomadic) and how they operate under changing and challenging conditions. Limited access to water, concentrate feed, and grazing areas were the three most common difficulties encountered by pastoralists in the El Bayadh region. Although livestock farmers involved in sedentary livestock farming are interested in expanding their operations to increase profitability and income, transhumant and nomadic livestock breeders are less interested in continuing to raise livestock due to the hardships involved and the lack of basic civic amenities. Hence, the existence and sustainability of transhumant livestock breeding are in question. Integrating livestock farming and crop production may be a viable option to enhance the productivity of livestock and, at the

same time, reduce pressure on natural rangelands. However, crop production is more vulnerable to climate change, which might pose other challenges and difficulties.

Our results also show that the sedentarization of livestock farming systems in the region and therefore the abandonment of transhumance. This kind of research is important to shed light on the current status of pastoral activities in the region and inform future decisions based on empirical evidence and scientific facts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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