


TECHNICAL-ECONOMIC IMPACT OF RISK MANAGEMENT ON THE SEMI-TRANSHUMANT LIVESTOCK SYSTEM, CASE OF AIN EL BELL REGION IN ALGERIA

Fatiha Rahouadja^A, Komi Apédo Atchemdi^B, Ahmed Houari^C



ARTICLE INFO	ABSTRACT
<p>Article history: Received: April, 08th 2024 Accepted: June, 28th 2024</p>	<p>Objective: This study aims to investigate the impact of risk management on the semi-transhumant livestock system, in order to suggest a better model for managing the sheep production cycle.</p>
<p>Keywords: Agricultural Policy; Agricultural Risk; Animal Production; Management; North Africa; Production Cycle.</p>	<p>Theoretical Framework: The semi-transhumant livestock system is facing an unprecedented set of risks occurring simultaneously. Therefore, studying the organization and management techniques of the semi-transhumant livestock system through a techno-economic approach, compares two situations (SWOR and SWR) based on using indisputable measures.</p>
	<p>Method: A field survey is conducted with 300 breeders during the period from 2019 to 2021. The collected data are processed using the statistical model SPSS.</p> <p>Results and Discussion: It is concluded that despite different situations, the same simplified production organization and marketing channels (social networks, informal contracts, etc.) are maintained. The SWR shows a decrease in herd size, adoption of 3 reproductive cycles, herd mobility and average profit, etc. However, there is an increase in production costs and acquisition of food products, etc. Ultimately, the results show that while unique risk situations impact semi-transhumant farming systems differently, their technical organizational and management measures render this impact insignificant based on non-parametric chi-square testing.</p> <p>Research Implications: This study provides insight into risk management offering implications for technically feasible practices that are reliable and bio-economically viable for sustaining semi-transhumant livestock system.</p> <p>Originality/Value: The value of this research is demonstrated by appropriate technical organizational and management measures impacting techno-economic farming results which will be useful to consider when other risks arise in future.</p> <p>Doi: https://doi.org/10.26668/businessreview/2024.v9i7.4841</p>

IMPACTO TÉCNICO-ECONÔMICO DO GERENCIAMENTO DE RISCOS NO SISTEMA DE PECUÁRIA SEMI-TRANSUMANTE, CASO DA REGIÃO DE AIN EL BELL NA ARGÉLIA

RESUMO

Objetivo: Este estudo tem como objetivo investigar o impacto do gerenciamento de riscos no sistema pecuário semitransumante, a fim de sugerir um modelo melhor para gerenciar o ciclo de produção de ovinos.

^A PhD Student of Resources and Rural Development. Department of Agricultural and Veterinary Sciences, Faculty of NLS, University of Djelfa. Algeria. E-mail: f.rahouadja@univ-djelfa.dz

Orcid: <https://orcid.org/0000-0002-8865-0459>

^B Doctor of Agricultural Sciences, Rural Economy. Department of Agricultural and Veterinary Sciences, Faculty of NLS, University of Djelfa. Algeria. E-mail: sankaridja@yahoo.fr

Orcid: <https://orcid.org/0009-0003-2085-5081>

^C PhD Student of Agricultural Sciences, Plant Production. Department of Agricultural Sciences, Faculty of NLS, University of Ferhat Abbas Sétif 1. Algeria. E-mail: kebbiryas2006@yahoo.fr

Orcid: <https://orcid.org/0000-0003-0367-9840>

Estrutura teórica: O sistema pecuário semitransumante está enfrentando um conjunto sem precedentes de riscos que ocorrem simultaneamente. Portanto, o estudo das técnicas de organização e gerenciamento do sistema pecuário semitransumante por meio de uma abordagem tecnoeconômica compara duas situações (SWOR e SWR) com base no uso de medidas indiscutíveis.

Método: Uma pesquisa de campo é realizada com 300 criadores durante o período de 2019 a 2021. Os dados coletados são processados usando o modelo estatístico SPSS.

Resultados e Discussão: Conclui-se que, apesar das diferentes situações, a mesma organização simplificada de produção e os mesmos canais de comercialização (redes sociais, contratos informais etc.) são mantidos. O SWR mostra uma diminuição no tamanho do rebanho, na adoção de três ciclos reprodutivos, na mobilidade do rebanho e no lucro médio, etc. Entretanto, há um aumento nos custos de produção e na aquisição de produtos alimentícios, etc. Em última análise, os resultados mostram que, embora situações de risco únicas tenham um impacto diferente sobre os sistemas agrícolas semitransumantes, suas medidas técnicas de organização e gerenciamento tornam esse impacto insignificante com base em testes não paramétricos de qui-quadrado.

Implicações da Pesquisa: Este estudo fornece uma visão sobre o gerenciamento de riscos, oferecendo implicações para práticas tecnicamente viáveis que sejam confiáveis e bioeconomicamente viáveis para sustentar o sistema de pecuária semitransumante.

Originalidade/Valor: O valor desta pesquisa é demonstrado pelas medidas técnicas organizacionais e de gestão adequadas que impactam os resultados técnico-econômicos da agricultura, que serão úteis para serem considerados quando surgirem outros riscos no futuro.

Palavras-chave: Política Agrícola, Risco Agrícola, Produção Animal, Gerenciamento, Norte da África, Ciclo de Produção.

IMPACTO TÉCNICO-ECONÓMICO DE LA GESTIÓN DE RIESGOS EN EL SISTEMA GANADERO SEMITRASHUMANTE, CASO DE LA REGIÓN DE AIN EL BELL EN ARGELIA

RESUMEN

Objetivo: Este estudio tiene como objetivo investigar el impacto de la gestión de riesgos en el sistema ganadero semitrashumante, con el fin de sugerir un mejor modelo de gestión del ciclo de producción ovina.

Marco Teórico: El sistema ganadero semitrashumante se enfrenta a un conjunto de riesgos sin precedentes que se producen simultáneamente. Por lo tanto, el estudio de las técnicas de organización y gestión del sistema ganadero semitrashumante a través de un enfoque tecnoeconómico, compara dos situaciones (SWOR y SWR) sobre la base de la utilización de medidas indiscutibles.

Método: Se realiza una encuesta de campo a 300 ganaderos durante el periodo comprendido entre 2019 y 2021. Los datos recogidos se procesan utilizando el modelo estadístico SPSS.

Resultados y Discusión: Se concluye que a pesar de las diferentes situaciones, se mantiene la misma organización simplificada de la producción y los canales de comercialización (redes sociales, contratos informales, etc.). Los ROE muestran una disminución del tamaño del rebaño, de la adopción de 3 ciclos reproductivos, de la movilidad del rebaño y del beneficio medio, etc. Sin embargo, se observa un aumento de los costes de producción y de adquisición de productos alimenticios, etc. En definitiva, los resultados muestran que, si bien las situaciones de riesgo singulares repercuten de manera diferente en los sistemas agropecuarios semitrashumantes, sus medidas técnicas de organización y gestión hacen que este impacto sea insignificante según las pruebas no paramétricas de chi-cuadrado.

Implicaciones de la Investigación: Este estudio proporciona una visión de la gestión de riesgos que ofrece implicaciones para las prácticas técnicamente factibles que son fiables y bioeconómicamente viables para sostener el sistema de ganadería semi-transhumante.

Originalidad/Valor: El valor de esta investigación queda demostrado por las medidas técnicas organizativas y de gestión apropiadas que repercuten en los resultados tecnoeconómicos de la ganadería y que serán útiles para tener en cuenta cuando surjan otros riesgos en el futuro.

Palabras clave: Política Agraria, Riesgo Agrario, Producción Animal, Gestión, Norte de África, Ciclo de Producción.

1 INTRODUCTION

In agricultural production, there are various animals involved in breeding systems, specifically pastoral systems in the case of extensive farming. These typically include nomadism, transhumance, and semi-transhumance (Belkhiri & Atchemdi, 2021; Grain de Sel, 2017). The animals are raised for their meat or by-products such as wool, milk, skin, and fat. Among them, small ruminants like sheep play a significant role in economic activities and human consumption in North Africa.

Sheep farming has always been the profession and source of income for herders across the northern part of the country with a high concentration in the steppe region. This area is situated between the Tellian Atlas to the north and Saharan Atlas to the south and is particularly well-suited for pastoral activities (Belkhiri & Atchemdi, 2021; Benchérif, 2011). In this space stands out Djelfa county including Ain El Bell region which is often considered as a major sheep reservoir of the steppe (Agricultural Services Directorate, ASD-Djelfa, 2023), housing one of the largest sheep production markets characterized by seasonal price instability linked to exogenous factors (Atchemdi, 2008). For this livestock breeding activity to be viable and evolve fundamentally, it depends on natural resources to be valorized and products to be sold on market for maximum profit (Abidi et al., 2013; Nettier et al., 2010). This may appear constraining because these living beings have their own biological characteristics with seasonal cycles that are subject to multiple risks requiring a combination of techniques and practices managed by producers (Dudouet et al., 2003; Moulin et al., 2006). In semi-transhumant breeding system, the production cycle involves constraints from start until its end affecting breeding animals as well as lambs for market preparation (Nettier et al., 2010; Boulanouar & Baquay, 2006; Meyer et al., 2004).

The most common constraints are seasonal hazards and unpredictable events (drought, pest of small ruminants (PSR)) (Meyer et al., 2004; Moulin et al., 2006), epidemics like foot-and-mouth disease, and notably, the unprecedented Covid-19 pandemic (Rahouadja et al., 2023; Hoffmann et al., 2020) causing losses affecting production factors, natural resources, and environment. The only way forward against these challenges would be to design appropriate mechanisms capable of leading minimal preservation of these absolutely necessary resources promoting sustainable development (Gaci, 2022; Abidi et al., 2013; Belloumi & Matoussi, 2007).

In ordinary circumstances, the seasonal cycle of sheep production requires interactions among stakeholders, decision-making regarding input supply, semi-transhumance, and the sale

of sheep products already constituting constraints for the breeder. These constraints are certainly amplified by the emergence of risks. The new context of uncertainty resulting from the complexity of natural, health-related, and socio-economic interactions raises concerns for semi-transhumant herders. It affects the availability and cost of production factors and impacts the environment and available natural resources (Ouali & Atchemdi, 2019; Benchérif, 2011; Dudouet, 2003).

As primary analysis, it appears that the unprecedented risks situation impacts semi-transhumant livestock farming. However, organizational measures and technical management practices make this impact non-significant. The economic stakes in particular are crucial in a semi-transhumant breeding system as they are essential for managers to control. Mobilizing all available resources based on appropriate knowledge and tools dispels concerns and promotes internal progress within agricultural companies which are often informal but still have a future. Starting from here, this study aims to compare the technical-economic results arising from organizational and management practices of semi-transhumant herders in a risk-free situation versus the one with risk. It is conducted based on similar technical-economic indicators to allow comparison between both situations in an original manner. The goal is to propose a better model for managing the production cycle to ensure the survival of the trilogy (natural or non-natural resources, animals, and semi transhumant), as well as biodiversity preservation and conservation of natural resources.

2 MATERIALS AND METHODS

Two important elements have been essential: a situation plan, and a collection and comparison plan. The first consists of creating a control situation with another experimental situation. This required the characterization of the study region and the explanation of specific terms contributing to the occurrence of both situations.

2.1 PRESENTATION OF THE STUDY REGION AND EXACT TERMS OF COMPARISON

The region of Ain El Bell (Ain El Bell, Moudjebara, Taadhmit, and Zeccar) is located in the center of Djelfa county, at a latitude of 34° 21' N and longitude of 03° 13' E. It is situated 35 km from the provincial capital and 335 km from the capital city, Algiers. The study region

covers an area of 231 367 ha representing 0.10% of the total land area of the country, with an agricultural surface area of 121 847 ha (Figure 1).

The soils are characterized by the presence of limestone accumulations, low organic matter content, and high susceptibility to erosion and degradation (Directorate of programming and budget monitoring, DPBM-Djelfa, 2018). The climate in the study region is continental with a semi-arid to arid bioclimatic stage characterized by a dry and very hot summer season with a less rainy and very cold winter season (National Meteorological Office, NMO-Djelfa, 2023). The average rainfall recorded for the year 2020 was equal to be 287.20 mm/year which is ecologically fundamental for terrestrial ecosystem functioning.

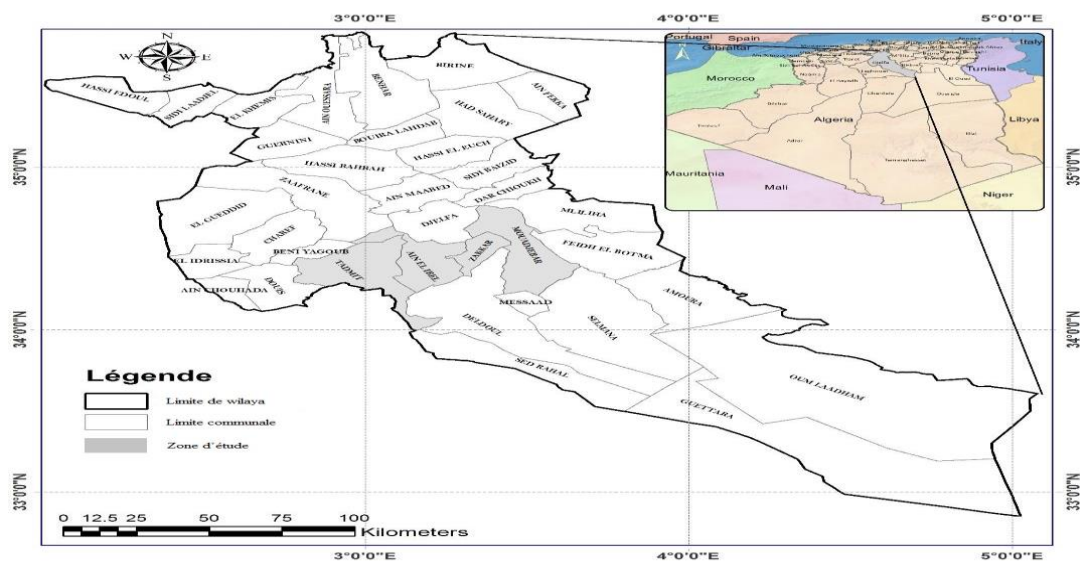
The land of the rangelands extends over an area of 85 277 ha, which is about 4% of the total area of the county and constitutes with the Alfa area 6% of the land in this agropastoral region (DPSB-Djelfa, 2018). The vegetation is dominated by various types of plant species. The Alfa plant, *Stipa tenacissima*, can reach a production rate of 10 tons DM/ha and has a low value in feeding units ranging from 0.3 to 0.5 UF/kg DM. The Armoise plant, *Artemisia herba alba* produces an average of 500 to 4 500 kg DM/ha with an average feeding value of approximately 0.65 UF/kg DM. The Sparte plant, *Lygeum spatum* has little pastoral interest with a feeding value ranging from 0.3 to 0.4 UF/kg DM. The Remt plant, *Arthrophytum scoparium*, with an annual average production ranging between 40 to 80 kg DM/ha, and its pastoral productivity is between 25 to 50 FU/ha/year (Nedjraoui, 2001).

In 2017, the study region had gathered 941 800 heads of sheep which represented 27.87% of the sheep stock of the county and 3.32% of the national stock. With these figures, it is the first at the national level in terms of the sheep stock. In parallel, goats and cattle have a significant place in live stock with 24.45 and 10.74% respectively (ASD-Djelfa, 2023).

Ain El Bell has long been ranked first in the production of red meats especially sheep meat. It has provided 14 261 tons of sheep meat representing 26.21% of the county's production with 23 944 000 liters of milk, 2 273 tons of wool (DPBM-Djelfa, 2018). It also has a large weekly market (Ain El Roumia), visited by people from all parts of the country, held every Sunday (Atchemdi, 2008).

Figure 1

Distribution of town halls in the study region (Ain El Bell, Djelfa county).



Source: Prepared by the authors (2023).

2.1.1 Livestock systems

According to Landais (1992), compared to a region, a livestock system is identified as a set of dynamically interacting elements organized by humans to develop natural and non-natural resources through livestock in order to obtain various productions (milk, meat, hides and skins, labor, manure, etc.) or to meet other objectives. One type of such system is semi-transhumant, which is characterized by significant movements of herds in an extensive grazing area that often includes neighboring counties and pre-Sahara pastures. In this type of system, feeding is ensured for a good part of the season through regular movements of either family members or livestock in search of grass and water (Grain de sel, 2017; Abidi et al., 2013; Atchemdi, 2008). However, since early 1980, it has also been using exogenous supplementation resources such as cereals due to seasonal price and climate variations (Gaci, 2022; Belkhiri & Atchemdi, 2021). This form is mainly found in cereal and legume-producing regions. Crop residues and fallow land play an important role in herd feeding. It is also found in irrigated areas where the reduction or abandonment of fallow land leads herders to graze their herds along roads based on their production cycle (Hadbaoui, 2021).

2.1.2 Production cycle of sheep

Cycles, which are periods between two troughs, are identified by looking for maximum deviations from the trend, positive for peaks and negative for troughs (Benjamin et al., 1999). The production cycle of sheep is divided into different phases: maintenance, mating, gestation, lactation (Dudouet, 2003; Rabehi et al., 2018). A production cycle corresponds to the completion of all phases. It begins with the mating phase, which is naturally followed by gestation. At the end of gestation, ewes give birth and lactation begins. At the end of lactation comes drying off and ewes return to the maintenance stage while lambs are weaned.

Different physiological stages correspond to different nutritional requirements, hence the need for semi-transhumant livestock in particular to adopt a combined strategy of feeding management and mobility that ensures adequacy between needs and food intake in order to maintain animals in a correct nutritional state (Rabehi et al., 2018; Atti, 2011). Requirements will also evolve depending on cycle periods and movements (Dirand, 2007; Moulin et al., 2006). They will probably vary depending on the age of the breeding animal. Economical and rational feeding of ewes relies on proper management of their body reserves throughout the production cycle as well as mobility planning. It is essential to estimate these reserves at the beginning of each characteristic phase (Boulanouar & Baquay, 2006; Gadoud, 2004; Dudouet, 2003).

2.1.3 Main risks

A risk is defined as the possibility of damage resulting from exposure to a hazard or dangerous phenomenon. In other words, risk is the combination of the probability of an anticipated event (incident or accident) occurring and the severity of its consequences on a given target (Rabehi et al., 2018; Zolla, 2017). Agriculture is exposed to a multitude of risks that can lead to variations in production and income, thus jeopardizing the sustainability of farms. These risks can be climate-related, sanitary, economic, regulatory, or environmental. This set of challenges involving both animals and the environment, not forgetting biological processes, are significant concerns for semi-transhumant systems (Ouali et al., 2022; Nettier et al., 2010).

2.1.3.1 Climate risks (case of drought)

Climate risks include drought. It is defined as a marked water deficit, mainly resulting from low precipitation over an extended period compared to the average observed inputs during that period (NMO-Djelfa, 2023; Itier and Seguin, 2007). This lack of rain directly affects living organisms. When drought affects cultivated vegetation, it is referred to as agricultural or edaphic drought (related to soil water reserves).

When the lack of rain reduces the supply to different compartments of the watershed (surface, soil, subsurface, etc.), it becomes hydrological drought due to a flow deficit in rivers and phreatic drought due to a deficit in groundwater. The severity of this lack of rain depends on both the extent of the deficit and the length of the deficit period (Itier and Seguin, 2007). Indeed, drought will be sensitive to surrounding climate factors such as humidity, precipitation, ambient temperature, wind, as well as soil and plants. Water deficiency (insufficient precipitation during winter and spring) and high temperatures (natural increase in evaporation and evapo-transpiration leading to soil drying out and erosion) are the main causes of drought (Nettier et al., 2010).

In the study region, peak precipitation occurs during September-May with maximum value in May while periods of dryness with low rainfall occur during June-August with July/August recording lowest values for SWOR/SWR respectively. The temperatures are characterized by their intensity and frequency which influence flow deficits estimation while playing a role in water condensation/evaporation processes (NMO-Djelfa, 2023).

In the SWOR, the annual cumulative rainfall amounts to 319.25mm, with a peak in May (42.80 mm), and monthly average temperatures are characteristic of the region (from 4.55°C in January to 26.45°C in December). On the other hand, during the SWR, the annual rainfall totals 208.81 mm with a peak in November (34.42mm), high average temperatures in summer at 27.39°C and spring at 20.12°C, and a dry spell during July and August. The SWR is characterized by a decrease compared to the SWOR with a difference of 110.44 mm/year in precipitation (about 9.20mm/month), a decrease of around 6.45%/month in humidity, and an increase of 1.52°C/month in temperature (Table 1).

During the SWR period, precipitation varies, temperatures rise, and extreme weather events multiply. All of this has an impact on agricultural production costs as well as selling prices, and affects the quality of forage plants and rangelands. In this area, forage production ranks first among agricultural productions affected by these extreme conditions causing drops

exceeding 50% in certain cases. SWR also significantly impacts available natural resources, the environment and animal health. But this climatic risk also indirectly affects the cycle of diseases, parasites and pests. According to Hadbaoui (2021) and Ramade (1984), temperature is an important factor influencing species distribution within living communities.

Table 1

Distribution of temperatures (°C), humidity (%) and average monthly precipitation (mm) in Djelfa county.

Situations	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Tot.	
SWOR	T° Avg. Mini.	0.97	1.54	4.70	7.35	14.60	16.15	24.45	18.65	15.30	8.90	4.50	1.55	118.66
	T° Avg. Max.	9.00	11.60	15.70	19.20	24.15	29.95	37.65	31.85	27.65	20.10	14.40	52.05	293.30
	Avg.	4.55	6.20	9.95	13.05	17.95	19.65	20.65	22.10	21.35	14.10	8.95	26.45	184.95
	H	75.00	68.00	61.00	52.00	51.50	38.00	25.00	40.00	46.50	51.50	65.00	74.50	648.00
	P	45.00	11.50	30.10	39.10	42.80	17.00	2.70	26.70	42.50	35.00	11.75	15.10	319.25
SWR	T° Avg. Mini.	1.13	0.80	4.47	8.10	12.23	17.90	20.97	20.93	16.47	9.30	5.43	3.23	120.97
	T° Avg. Max.	9.70	14.00	14.43	18.60	24.80	31.03	34.47	34.83	28.53	20.93	11.97	11.57	254.87
	Avg.	5.93	8.90	10.20	14.23	19.97	26.17	29.37	29.13	23.67	16.20	11.33	8.13	203.23
	H	65.53	51.77	52.73	52.93	39.40	28.67	24.83	28.13	41.00	49.53	69.03	67.00	570.57
	P	16.70	7.88	21.26	26.12	29.06	14.38	10.61	9.72	23.68	6.85	34.42	8.13	208.81
Gap	T° Avg. Mini.	0.16	-0.74	-0.23	0.75	-2.37	1.75	-3.48	2.28	1.17	0.40	0.93	1.68	2.31
	T° Avg. Max.	0.70	2.40	-1.27	-0.60	0.65	1.08	-3.18	2.98	0.88	0.83	-2.43	-40.48	-38.43
	Avg.	1.38	2.70	0.25	1.18	2.02	6.52	8.72	7.03	2.32	2.10	2.38	-18.32	18.28
	H	-9.47	-16.23	-8.27	0.93	-12.10	-9.33	-0.17	-11.87	-5.50	-1.97	4.03	-7.50	-77.43
	P	-28.30	-3.62	-8.84	-12.98	-13.74	-2.62	7.91	-16.98	-18.82	-28.15	22.67	-6.97	-110.44

Source: NMO-Djelfa, 2023.

H: Humidity (%); P: Precipitation; Avg.: Average; SWR: Situation with risks; SWOR: Situation without risks.

2.1.3.2 Health risk (case of pest of small ruminants)

Sheep diseases are numerous (Dirand, 2007; Meyer et al., 2004; Dudouet, 2003). Major classic infectious diseases, infestations by parasitic worms and external parasites, and multifactorial diseases such as respiratory conditions represent significant risks. Mortality can be high, especially among young animals. Sheep, like all domestic herbivorous species whose diet depends primarily on pastoral resources (Gaci, 2022; Hadbaoui, 2021; Abidi et al., 2013) (at least in extensive systems), are highly susceptible to metabolic and nutritional diseases. These can worsen an existing disease or constitute a separate condition. Finally, some diseases are related to livestock management practices (Meyer et al., 2004).

All the above mentioned diseases have a significant impact on the profitability of livestock farming. However, preventive measures and treatments are often possible. Good hygiene conditions in the stable, in watering, and in feeding practices limit the occurrence and effects of these diseases. Vaccinations and treatments against parasitic worms also play a

crucial role in disease prevention. Some diseases are widely known as contagious. Livestock farmers must be familiar with them to suspect their presence and seek assistance from competent services when necessary.

The main infectious diseases affecting steppe herds include: Sheep pox, Bluetongue, Foot-and-mouth disease, Pneumonia, Enterotoxemia, Internal and external parasites (Fluke worm, Tapeworm, Estrone) (Gaci, 2022; Hadbaoui, 2021). The PSR is highly contagious; this disease primarily affects goats but also sheep and sometimes buffaloes due to a virus belonging to the *Morbillivirus* genus. After two-day incubation period, the symptoms include: severe hyperthermia, anorexia, lethargy leading to mucopurulent discharge, coughing, dyspnea & profuse diarrhea, hypothermia, coma, and death within 5-6 days in the acute form. Regular abortions have been reported. PSR « more commonly » affects lambs under three months old (Meyer et al., 2004). Once introduced, the virus can infect up to 90% of a herd and the disease kills between 30 and 70% of affected animals.

From 2019 to 2022, in the SWR, PSR and foot-and-mouth disease have attacked the livestock in 25 counties of the country, resulting in the loss of tens of animals and harm to breeders. It was the first time that Algeria had faced PSR and foot-and-mouth disease in sheep; this put veterinarians and breeders in an unprecedented situation and a difficult task. The intervention of public authorities and veterinary services has reported the death of a number of sheep. Only one diagnostic technique and one vaccine are useful for controlling PSR, regardless of the type of disease manifestation.

According to ASD-Djelfa (2023), the epidemic of PSR that occurred in Djelfa county led to the appearance of 30 disease outbreaks, with 200 cases and decimated 130 heads of livestock including 100 sheep heads and 30 goat heads, causing great concern among breeders who suffered heavy losses. It was countered by vaccination campaigns; however, compensation was difficult due to non-statement or non-insurance subscription by most breeders. The sheep farming sector is informal and unorganized as a whole (ASD-Djelfa, 2023; Belkhiri et al., 2021; Abidi et al., 2013). The average annual number vaccinated against PSR has been consistently around 2 174 295 sheep annually with an average number SWR affected breeders at 5852 (Table 2).

Table 2

The total number vaccinated with anti-pestin Djelfa county.

Situations	Campaigns	Vaccinated total (heads)	Affected breeders
SWOR	2017/2018	//	//
SWR	2019	1 610 399	883
	2020	2 729 403	9 309
	2021	2 183 084	7 364
	Total	6 522 886	17 556
	Average annual	2 174 295	5 852

Source: ASD-Djelfa, 2023.

SWR: Situation with risks; SWOR: Situation without risks.

2.1.3.3 Socioeconomic risks (Case of Covid-19 Pandemic)

The biophysical risks (health, safety, environment, etc.) are compared to socioeconomic risks (quality, social, financial) on scales. These risks extend, on the one hand, over time going from the immediate to beyond a human life and, on the other hand, over space going from immediate proximity to the entire planet in affecting the availability of resources such as the impact of human activities on the ecosystem. Thus, «Corona virus Disease 2019» or Covid-19 is an infectious disease caused by a virus of the Coronaviridae family, the SARS-CoV-2. It is a respiratory disease that can be transmitted through close contact with infected individuals but also by asymptomatic people. Since December 2019, Covid-19 has become an epidemic threat (Rahouadja et al., 2023; Hoffmann et al., 2020). Covid-19 is considered an unpredictable and difficult-to-control event, whose socioeconomic effects are challenging to envision in the medium and long term (Kaci, 2020).

In SWR, according to Rahouadja et al. (2023), as of April 30th, 2023, there have been 271 712 cases of coronavirus in Algeria, and a total number of recoveries at 182 956 cases, while the number of deaths remains 6 881 cases. In Djelfa, there have been 5 281 confirmed cases including 649 cumulative deaths since the onset of Covid-19 pandemic (Public Health Directorate, PHD-Djelfa, 2023). Moreover, it seems that domesticated animal species are not susceptible to SARS-CoV2 (Hoffman et al., 2020), which has vulnerability and damage to semi-transhumant livestock system in study region. This was probably also true for all countries affected by pandemic where large livestock species and small ruminants were not threatened.

The government authorities have implemented emergency plans to treat the pandemic while simultaneously dealing with economic and social repercussions. For example, the enactment of regulations helped implement measures for prevention and control against the spread of Covid-19, such as confining measures (partial or total depending on circumstances),

restrictions on movement, supervision of commercial activities, and provisions of citizens' supplies, distancing rules (Executive decrees n°20-69 dated March 21st, n°20-70 dated March 24th, 2020). It also involves decisions by local authorities to close all weekly livestock markets in Djelfa county (Decisions n° 1176 of July 2nd, 2020 and n°1521 of July 20th, 2020).

2.2 CHOSEN METHODOLOGY

2.2.1 Two comparison situations

To sum up, the study of management and organization techniques of the semi-transhumant livestock system compares – based on unquestionable measures – the two established situations:

- **SWOR**: Situation without risks: SWOR where there is an absence of previously described combined risks including organizational and decision-making practices, a control situation;
- **SWR**: Situation with risks: SWR where the combined risks, as explained, occur leading to organizational techniques and decision-making, an experimental situation.

It is a moment of particularism in every sense of the term that has occurred in this environment, since all identified risks occur simultaneously and for the first time. It is both a local and original particularism due to the characteristics of the environment and its semi-transhumant livestock system. They have affected the entire most widely practiced economic activity. The risks (drought, PSR disease, epidemics, and Covid-19 pandemic) have led to a new situation (SWR) that is not similar to previous situations (SWOR), due to its likely consequences. Either way, the rationality of management favored by economic agents, including their interactions, changes to act on the elements of vulnerability of semi-transhumant livestock breeding in order to achieve their economic objective.

2.2.2 Collection of comparison materials

The means used to carry out this work first relied on exhaustive documentation. Then, for its informal activities and lack of accounting (Belkhiri and Atchemdi, 2021, Ouali and Atchemdi, 2019), the second tool was a field survey conducted among 300 semi-transhumant breeders from a target population during the period from 2019 to 2021. The survey provided

materials of a technical-economic nature. The breeders are distributed across the town halls in Ain El Bell region. Ain El Bell was chosen for reasons explained earlier.

The selection of semi-transhumant herders was dictated by several practical and scientific considerations, with a sufficient number of individuals for statistically adequate sampling. Random sampling was used (individuals belonging to the semi-transhumant system had an equal probability of being chosen to be part of the sample). Additionally, the survey questionnaire provided information on buying livestock, acquiring feed and veterinary products, marketing sheep, and semi-transhumance operations under different conditions in both situations. This resulted in identifying inputs used, lambing periodicities, numbers with their characteristics, as well as reaction capacity applicable at different mobility scales. The result also provides information on risk levels considering mortality rates and externalities associated with events; equally addressing economic costs related to damages along with economic outcomes achieved.

2.2.3 Statistical analysis comparing the two situations

The calculated comparison indicators are mainly related to technical-economic aspects in order to identify the impact of risks on sheep production. The interpretation of the obtained results was made possible through statistical analysis, which involved comparing the data obtained in both situations.

Finally, descriptive statistics and the non-parametric chi-square test were performed using "SPSS 26." software. To further refine the comparative demonstration, measurements of technical aspects were first considered, allowing semi-transhumant respondents to take action, followed by market economic measures of semi-transhumant management efficiency.

3 STUDY RESULTS

Field investigations allowed for the identification and comparison of the impact of risks on sheep production in both SWR and SWOR situations. Measurements were taken on 10 technical and economic indicators resulting from management practices. In the primary analysis of data of Figures 2 and 3, as well as Tables 3 and 4, it appeared that vulnerability caused by risks led to dissimilarity in the semi-transhumant livestock system in Ain El Bell, with non-similar technical-economic results compared to the previous situation, but not significant overall.

3.1 BEHAVIOR OF SEMI-TRANSHUMANT FACED TO RISKS

In both SWOR and SWR situations, actors involved in the semi-transhumant livestock system in the study region are divided into two groups. The first group fulfills functions related to production, transaction, transformation, fattening, livestock trading, and butchery. The second actor is the State which performs agricultural policy functions through public transfers, offering public goods and services, and regulation activities. The State implemented it through its supervisory and service delivery structures, including the Algerian Interprofessional Cereals Office (AICO), which provides subsidized livestock feed. Both groups of actors experienced both situations and acted according to their rationality. Regarding the overall organizational framework of farms involved in this study, management structure was simple since they were family-owned farms employing few external workers; there was no modification during SWR period. As for commercialization circuit organization technique, behavior of semi-transhumant remained rigid (Figure 2). However, other technical indicators show that the organizational and decision-making practices of management and interactions between stakeholders in the semi-transhumant system are not the same in the control and experimental situations. Except for forages products acquisition indicator which was not significant, along with partial sale of sheep indicator showing (positive significance), all other technical parameters showed negative significance (Table 3).

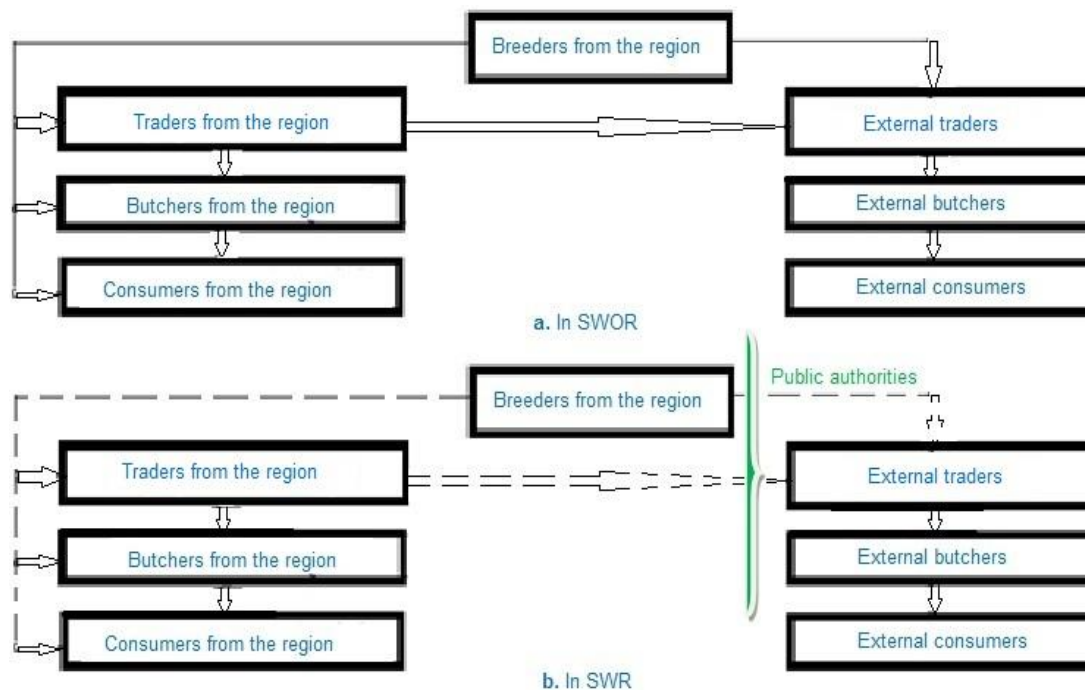
It appeared that the seasonal reproduction cycle was based on the choices made by the breeders, taking into account various options available to them in relation to the constraints of production and consumption cycles, in order to decide. The production cycle was aligned as closely as possible with the grazing season (grass growth in semi-transhumant areas). Similarly, feed deficits during years marked by risks led breeders to purchase concentrates and expand grazing areas for their animals. However, limited access to grazing land forced semi-transhumant to use nearby pastures, even if they had limited availability. The results also showed that risks significantly impacted the movement of semi-transhumant, sheep marketing, and interactions with other related activities.

Faced to uncertainties surrounding sheep production, exacerbated by drought, PSR disease, and Covid-19 pandemic in Ain El Bell and throughout the steppe region, stakeholders in the industry strengthened certain elements of their economic rationality through informal means that escaped State monitoring and control. This mainly involved social networks and informal contracts to cope with disruptions in sheep marketing circuits (such as livestock

markets' operations or transportation logistics involving traders from the region, butchers from the region, consumers from the region and external traders).

Figure 2

Technique for organizing sheep marketing circuits.



Source: Prepared by the authors (2023).

Table 3

Comparison of technical indicators of the impact of risks on the semi-transhumant livestock system in Ain El Bell.

Technical indicators (Number of breeders)		Avg. ± S.D., Range (Max-Min), C.V. (%)		Rate of variation (%)	X ²	sig.
		SWOR (n = 300) (2017/2018)	SWR (n = 300) (2019, 2020, 2021)			
Partial purchase of sheep	Pps	253 ± 0.36 0.14	206 ± 0.46 0.23	-18.58	20.48	***
Partial sale of sheep	Pss	236 ± 0.41 0.17	300 ± 0.00 0.00	+27.12	71.64	***
Production cycle (3 reproductive cycles)	Pc	61 ± 0.40 0.66	14 ± 0.21 1.51	-77.05	33.66	***
Acquisition of forages products	Afp	237 ± 0.41 0.17	260 ± 0.34 0.13	+9.70	6.2	**
Mobility of herds	Mh	274 ± 0.28 0.10	220 ± 0.44 0.20	-19.71	33.41	***
Acquisition of veterinary products	Avp	257 ± 0.35 0.14	231 ± 0.42 0.18	-10.12	7.42	***

Source: constructed and calculated based on data from our survey, 2023.

C.V.: Coefficient of variation (%); S.D.: Standard deviation; Range: Max-Min; Avg.: Average; SWR: situation with risks; SWOR: situation without risks; sig: significance; * indicates degree of significance (***: p < .001, **: p < .01); differences are tested using the non-parametric chi-square test).

3.2 VARIABILITY OF ECONOMIC INDICATORS DEPENDING ON THE SITUATIONS

Our results indicated that various costs increased during the SWR, resulting in higher average production costs compared to the normal situation, leading to financial variability between the two situations (Figure 3).

For the entire sample, 23% of breeders reported a decrease in revenue due to drought, lack of movement, low productivity of grazing areas, PSR disease, and Covid-19 pandemic. However, the average selling price for all age categories (rams, ewes, yearling rams, yearling ewes, lambs and ewe lambs) and average profit increased compared to SWR.

Similarly, there was a difference in cost structure between the two situations. The predominant costs were animal purchases (48.32% vs 40.94%), followed by feed expenses (35.27% vs 41.74%) and miscellaneous expenses. Production costs increased with an additional expenditure of approximately 4.53% on average. It was found that breeding practices involving higher production costs during SWR included land rental at 46.84%, concentrated feed (barley, bran) at 26.31% and 3.92%, labor at 25.77%, and marketing expenses at 80%. However, total breeding costs decreased following a decrease in livestock numbers.

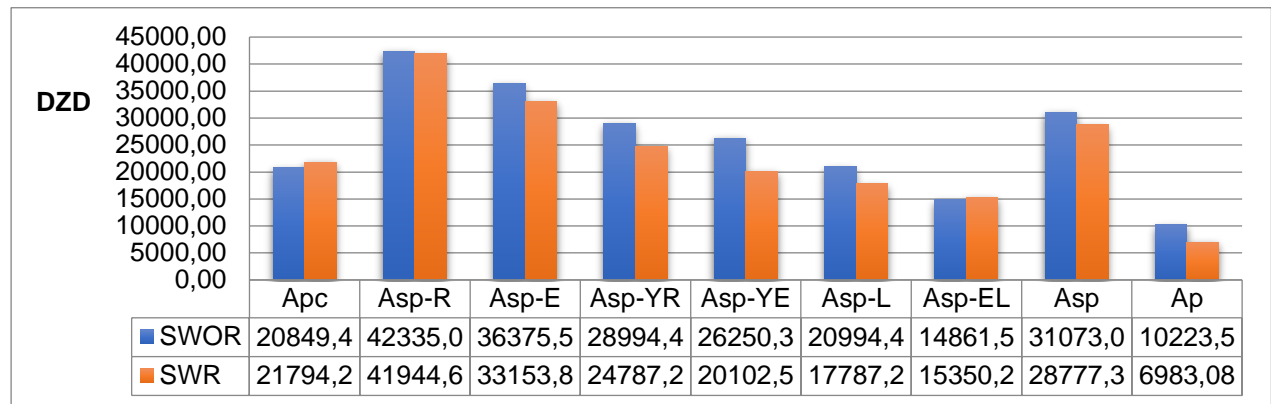
The economic analysis revealed either negative or positive differences in most economic indicators between SWOR and SWR, with average variation rates ranging from -77.05% to +27.12%. However, positive results were observed in both situations, particularly with negligible differences between SWOR and SWR based on chi-square non-parametric test (600.00).

Risks disrupted production cycles (availability and cost of production factors) and relatively reduced economic agents' profitability, leading to repercussions on biodiversity within the study region (number of animals and pressure on plant cover).

This forced stakeholders to modify their rationality and interactions in order to maintain their economic activities while achieving ultimate goal of maximizing profit. Ultimately, comparing SWR with SWOR using technical and economic indicators along with chi-square test demonstrated the degree of impact risks had on semi-transhumant livestock system as well as effectiveness of decisions made. It also led to establishing a better model for managing production cycles in order to ensure survival of the trilogy (natural or non-natural resources), animal, and semi-transhumant), adding to preservation of biodiversity and natural resources (Figure 3, Table 4).

Figure 3

Comparison of economic indicators of the impact of risks on the semi-transhumant livestock system in Ain El Bell.



Source: constructed and calculated based on data from our survey, 2023.

Apc: Average production cost; DZD: Algerian Dinars; Ap: Average profit; Asp: Average selling price; R: Rams; E: Ewes; YR: Yearling rams; YE: Yearling ewes; L: Lambs; EL: Ewe lambs; SWR: situation with risks; SWOR: situation without risks. Average exchange rate (2014-2023): 1 DZD = 0.00744 USD

Table 4

Comparison of economic indicators of the impact of risks on the semi-transhumant livestock system in Ain El Bell.

Economic indicators		Avg. ± S.D., Range (Max-Min), C.V. (%)		Rate of variation (%)	X ²	sig.
		SWOR (n = 300) (2017/2018)	SWR (n = 300) (2019, 2020, 2021)			
Herd size (heads/breeder)	Hs	287 ± 25 (330-245), 8.78	260 ± 21 (298-215), 8.13	-9.60	269.10	***
Average production cost (DZD/head)	Apc	20849.44 ± 289.69 (21537.00-20255.00), 1.39	21794.23 ± 406.97 (24919.00-20819.00), 1.87	+4.53	578.33	*
Average selling price by age category (DZD/head)	Asp-Rams	42335.05 ± 237.54 (43273.00-41779.00), 0.56	41944.61 ± 120.21 (42159.00-41678.00), 0.29	-0.92	528.33	***
	Asp-Ewes	36375.50 ± 637.14 (37500.00-35250.00), 1.75	33153.80 ± 476.85 (33751.50-31048.50), 1.44	-8.86	600.00	*
	Asp-Yearling rams	28994.40 ± 2018.99 (32400.00-25600.00), 6.96	24787.20 ± 1690.60 (27840.00-21200.00), 6.82	-14.51	417.66	***
	Asp-Yearling ewes	26250.33 ± 424.76 (27000.00-25500.00), 1.62	20102.53 ± 317.90 (20501.00-18699.00), 1.58	-23.42	600.00	*
	Asp-Lambs	20994.40 ± 2018.99 (24400.00-17600.00), 9.62	17787.20 ± 1690.60 (20840.00-14200.00), 9.50	-15.28	600.00	***
	Asp-Ewe lambs	14861.54 ± 190.68 (15099.00-14023.00), 1.28	15350.20 ± 254.86 (15800.00-14900.00), 1.66	+3.29	518.87	**
Average selling price (DZD/head)	Asp	31073.04 ± 496.06 (32203.75-29863.60), 1.60	28777.31 ± 398.09 (29425.69-27089.31), 1.38	-7.39	600.00	ns
Average profit (DZD/head)	Ap	10223.59 ± 572.99 (11575.59-8640.88), 5.60	6983.08 ± 578.52 (8284.02-4154.61), 8.28	-31.70	600.00	ns

Source: constructed and calculated based on data from our survey, 2023.

C.V.: Coefficient of variation (%); S.D.: Standard deviation; Range: Max-Min; Avg.: Average; SWR: situation with risks; SWOR: situation without risks; sig: significance; * indicates the degree of significance (***: p < .001, **: p < .01, *: p < .05, ns (non-significant): p > .05); differences are tested by the non-parametric chi-2 test. DZD: Algerian Dinar; Average exchange rate (2017-2021): 1 DZD = .0072 USD.

4 DISCUSSION

4.1 MAINTENANCE AND REINFORCEMENT FOR OPTIMIZING GAINS

The processes of production decision-making, the sale of inputs and sheep products are not simple and require regular monitoring and self-assessment; this seems difficult in complete informality and the absence of reliable records (Belkhiri & Atchemdi, 2021). Ouali and Atchemdi (2019) confirm that there is an almost perfect similarity in the identified management principle that serves as the basis for mobile systems. Typically, the organizational framework as conceptualized in academic institutions or even businesses does not formally exist. In other words, it appears informal and highly simplified since their digital human capital needs are minimal (managerial leader, family help, and 1 to 4 agricultural workers). However, it is because certain elements of technical and economic rationality often escape State monitoring and control that actors in semi-mobile livestock systems have been able to maintain them and strengthen them solely for their own profit optimization interests.

Within the same framework, Belkhiri & Atchemdi (2021) and Abidi et al., (2013) have shown how forms of informal networks based on social capital have been used by sheep farmers to identify potential sources of competitiveness. Moreover, this politically sensitive issue lies at the heart of debates on the management of support systems for semi-transhumant livestock farming, extending to livestock farming as a whole in the country. Perhaps transforming livestock farming towards formalized management structures based on competition would be less affected by any situation involving risks or vulnerability. The formalization of all activities related to sheep production could limit disease propagation, thus reducing losses and damages. Under these circumstances, improving domestic-level quality management systems becomes crucial alongside monitoring, funding, and public transfers.

4.2 TECHNICAL ADJUSTMENT OF THE CYCLE ACCORDING TO THE SITUATION

Regarding the partial purchase and sale of sheep, the raw products sold or purchased are not the same when comparing SWOR and SWR. The number of breeders engaging in herd renewal practices (partial sale: 236 vs 300 breeders) and herd renewal (partial purchase: 253 vs 206 breeders), with a difference of 64 and 47 in sales and purchases respectively, was not the same. In

SWOR, sales are low compared to SWR. Conversely, purchases are significantly higher in relation to experience, with a negative significant difference between the two situations ($\chi^2=20.48$).

As for the production cycle, in SWOR, the most common time for reproduction is autumn (October-November) with ewes being reproductive every 16 to 17 days. Gestation lasts approximately 150 days (Dirand, 2007; Meyer et al., 2004). The seasonal reproduction cycle in semi-transhumant breeding systems is divided into three distinct categories based on periods, semi-transhumance locations, and reproduction inputs. This result is similarly confirmed by research on mobile sheep farming systems in the region by Rabehi et al. (2018). The focus is on the decisions made by breeders regarding different choices available to them in relation to production and consumption cycles constraints. Thus, semi-transhumant breeders consider differentiating cyclic lambing phenomenon according to issues favouring viability and evolution of their herds.

A single annual reproductive cycle plan is simplest and easiest to manage for operators. These elements were disrupted during SWR; therefore, technically possible, breeders resorted less frequently to three reproductive cycles (during two years or within 24 months having 3 reproductive cycles), following ($\chi^2=33.66$), which is significantly negative. The lambing cycles (1st and 2nd cycles) are similar between SWOR and SWR. The category of two annual reproductive cycles opposes that of an annual cycle in terms of time and simplicity; however, it's less profitable according to Rabehi et al. (2018). It finally implies considerable human investment under very difficult living conditions in complementary regions and during their reproduction process.

The sale of animals during periods of sustained drought strengthened by PSR and Covid-19 pandemic, rarity of pasture, and lack of finance among semi-transhumant is an unanimously declared decision by all breeders. In fact, the SWR affects sheep prices especially with the preventive closure of large livestock markets and a ban on livestock transportation with $\chi^2=600.00$, that is insignificantly negative. Sales revenues are used to support remaining herd needs in terms of feed purchases as also highlighted by Gaci (2022). Semi-transhumant prefer to sell sheep even with sales difficulties. In fact, breeders resorting most to the sale of animals due to the fragility of their production system based more on traditional range grazing. Sale of animals is more common, especially during sustained droughts. It's worth noting that animal sales during crises generally follow logical priorities. Older animals (ewes, rams) are sold first, followed by lambs, and finally ewe lambs. The sale of yearling rams and yearling ewe lambs remains always the last resort; they are sold only if situation worsens.

Many other studies reach the same conclusion (Ouali et al., 2022; Rabehi et al., 2018; Benchérif, 2011; Atchemdi, 2008).

In contrast to animal sales, another rationality is buying animals during prolonged risks periods. Indeed, the supply of animals significantly increases in animal markets leading to declining sale prices. Animals purchased typically aim at renewing and reinforcing the herd size. Moreover, following the purchase of animals at low prices, some semi-mobile producers seize this opportunity during risks for massive investments. In addition to the funding source (for all breeders: 300, it is their own funding), these events lead to the difference in the herd size (287 vs 260 heads/breeder), implying financial variability when comparing SWOR and SWR.

4.3 ARBITRAGE IN TERMS OF FORAGE AND VETERINARY PRODUCTS

Forage shortage in the steppe region, especially in Djelfa region is already a real issue and farmers are trying to address it in different ways, as authors have noted (Gaci, 2022; Rabehi et al., 2018; Benchérif, 2011). More harmful, forage deficits during years marked by risks, led farmers to resort to purchasing concentrates and expanding grazing areas for their animals. However, the difficult access to SWR pastures (travel restrictions, confinement measures, etc.) forces breeders to use nearby pastures even if they offer limited resources. Gaci (2022) also mentioned that during drought periods, less privileged steppe farmers who cannot undertake long or medium movements make do with grasses from their immediate vicinity.

The purchase of forages can be divided into two types: buying to replenish safety stocks, generally in summer; and buying to meet immediate animal needs during lean periods in winter, and sometimes at the beginning of spring or end of autumn. Safety stocks primarily concern concentrates due to near-total market dependence. Most semi-mobile operators purchase concentrates according to their needs, and if they plan to store them, it does not exceed one month or one season; it all depends on the cash flow of the breeder and their contract with the AICO (Algerian Interprofessional Cereals Office) and the prices practiced by informal resellers, reported by authors (Ouali et al., 2022; Rabehi et al., 2018; Abidi et al., 2013).

Semi-transhumant breeders are aware of government intervention in disease treatment through vaccination and subsidizing certain medications. They maintain constant contact with veterinarians during travel bans and quarantine restrictions. Normally, larger semi-transhumant breeders more readily avail themselves of veterinary services than their less affluent counterparts, which can sometimes hinder veterinarian consultations. In all circumstances, the

most common diseases are fever, diarrhea, and emaciation disease, accompanied by others (dystocia, coughing, scabies, and constipation). Furthermore, the main diseases that worsened during SWR and increased production cycle costs are: Smallpox which appeared in 16% of breeders due to the scarcity of medications. It has also been observed the spread of foot-and-mouth disease in 19% of semi-transhumant farms and internal parasites in 26% of breeders. It was also noted that there are certain breeders (12%) whose sheep have been infected with parasites (ticklice, etc.). The emergence and spread of certain diseases during SWR is attributed to severe shortages of numerous medications and lack of adequate forage. However, certain infectious diseases did not appear during SWR due to market closures and movement bans preventing transmission of certain infectious diseases.

4.4 COST OF PRODUCTION AND PRODUCT RESULT

Research results show that the average production cost items (purchase of animals, land and grazing rental, concentrated feed (barley, bran, etc.), veterinary care, watering supply, livestock transportation during semi-transhumance and for the market, sales, and labor) (20 849.44 vs 21 794.23 DZD/head) are not similar. They involve financial variability when comparing SWOR and SWR but a chi-square = 578.33 show it to be insignificant.

The average cost of feeding sheep on pasture is estimated at 3 044.45 and 3 935.07 DZD/head in SWOR and SWR respectively. SWR has recorded an increase in pasture rental prices (grazing land, barley in green: gsill), leading farmers to reduce the rented areas. Semi-transhumant continue to migrate northward (Tell) to avoid heat and dried-out grazing areas in the steppe pastures. In addition to its economic aspect, there is a technical aspect as well, namely the search for forage on stubble at the end of harvests. Furthermore, they move southward to reach the Sahara. The juxtaposition of animal needs with natural forage supply from pastures reveals periods of forage insufficiency occurring at the end of summer and winter seasons. Similar trends have been reported by Boulanouar and Baquay, (2006), concluding that the benefit/cost ratio turns out to be high when the production system involves cost optimization by using grazing with low consumption of stored forage and concentrates.

Increased spending during SWR mainly comes from rising concentrate prices (barley, bran). Speculation in the food market during SWR has contributed to the rise in prices of barley (5 500 DZD/q) and bran (4 200 DZD/q) compared to 3 000 DZD/q and 2 000 DZD/q respectively in SWOR with a significant chi-square test result of 6.20. Under the effect of risks,

food expenses have accounted for 41.74% of total production costs. Concentrated feeding was an important recourse in SWR and was one of the main factors conditioning animal production, affecting both quantity and quality of animal products.

However, the irregularity and insufficiency of rainfall (drought) in both space and time necessitate this complementation during SWR. In addition, the pandemic affected the manufacturing process and the supply chains, also led to a negative impact on raw materials affecting mass food market growth.

Daily work cannot be delayed since it is linked to the biological and seasonal nature of animals and certain resources. It corresponds to the daily care given to animals (feeding, disease control, mating, birthing, vaccination, etc.). Since livestock farming is mainly a family activity, farmers often rely on the services of their family members but sometimes also hire employees for sheep-related work. Semi-transhumant employers are increasingly facing difficulties in recruitment due to the harshness of this job (intensity of work, social isolation, exposure to weather conditions, lack of social protection), as evidenced by Benchérif (2011).

The work being evaluated in hours, it represents an average of 14 hours/head/year in SWOR and 16 hours/head in SWR, equivalent to 105.50 DZD/month and 132.68 DZD/month respectively. In SWR, the increase in production costs also came from increased demand for services by shepherds; since travel conditions are specific, forage and animal transporters have similarly increased their rates. Moreover, it is known that the success of any economic activity, especially livestock farming, hinges on controlling production costs. Similarly, Gaci (2022), asserts that the monthly remuneration for a shepherd was 40 000 DZD in 2021, and is on the rise.

Total livestock costs during SWR are relatively controlled due to a decrease in herd size. Farmers have partially sold animals to be able to bear additional expenses when food prices on the market increase. In addition, some farmers with a financially strong position take advantage of risks by buying animals at low prices, to increase capital and improve their turnover.

This overall insignificant difference between the two situations can be justified by risks (drought reinforced by PSR and Covid-19) that endanger herds as they threaten the productivity of the herds. All this affects the cost of factors of production and availability of natural resources. Seasonal rainfall deficit associated with water scarcity and increasing temperatures decreases soil moisture hampers plant growth, reduces crop and rangeland yields and indirectly affects the cycle of diseases, pests and the distribution of all living beings (Gaci, 2022; Itier and Seguin, 2007; Meyer et al., 2004; Dudouet, 2003).

Furthermore, the pandemic and the tightening of containment measures have caused a strong disruption in the “survival” rationality of consumers and producers. Consumption and production habits are simultaneously destabilized because of the climate of uncertainty which characterizes the socio-economic situation of the country and the fluctuation of prices (Hoffmann et al., 2020; Kaci, 2020). This has at times caused a seeming balance between supply and demand on the market to limit the fall in prices of categories of sheep attested by chi-2. Moreover, the functioning of activities is relatively disrupted, and therefore, the semi-transhumant breeding system in Djelfa region. Semi-transhumant pastoralists have systematically mobilized available resources to promote their internal progress through the reasonable technical organization and management of animals and natural resources.

The determination of the results took into account sales and purchases of animals, the sale of wool, and self-consumption. The economic analysis revealed positive results of the sheep production activity in both situations, this leads to the conclusion that the risks have relatively disrupted the production cycle (availability and cost of production factors) and reduced the profitability of economic agents. Nevertheless, the difference being insignificant between the two situations (Table 4), seems reassured that the organization and management techniques of semi-transhumant farms have been effective. Despite the unprecedented situation, they have managed to preserve the best margins which are obtained with good numerical productivity, the good sale price and productivity of lambs at favorable periods, and above all, the balance between market fundamentals. In this worst situation, the semi-transhumant were able to maintain the quality of the sheep products. The results show that in the face of unprecedented adversity, effective behavior does not induce any dissimilarity in the semi-transhumant livestock system with technico-economic results not similar to the previous situation, but minimal.

5 CONCLUSION

The organization and management techniques of the semi-transhumant system in a unique major risk situation make it possible to put preconceived ideas to the test of the facts in a technico-economic approach. Compared to those placing sheep products on the market, the study concludes that the same circuit is maintained whatever the situations are. Social networks and informal contracts manage to resist the disruption of this technique of organizing exchanges. The partial sale of the sheep followed by less renewal of the herd was a common

and justified management decision, for falling sales prices and increased costs for SWR denoting the impact of the risks, but effectively countered by the management so that the influence is hardly significant overall. The adjustment between sales and the size of the herd making it possible to feed the preserved livestock, and the fall in household demand in the context of unprecedented risk are at the origin of the quasi-balance between the fundamental market forces avoiding a collapse in livestock prices.

The same risks, especially PSR, Covid-19 and confinement have considerably reduced the mobility of herds; which seemed reasonable, but informality and escaping State control allowed actors in the semi-mobile livestock system to maintain certain forms in place and to strengthen them for their interests. In addition to the ban on contact between actors and animals, the renunciation of three reproductive cycles may have suited the impossibility of undertaking semi-transhumance in perfect conditions that could reduce production costs; this seems indicated at the same time as the low demand for subsidized food and veterinary products.

The unprecedented complex danger situation has impacted semi-transhumant livestock farming, but the organizational and management techniques adopted by semi-transhumant herders and public authorities make this impact insignificant. The anti-risk measures were then effective, since the semi-mobile farm remains profitable despite everything and the variability of profitability is controlled. Research shows that defining the solution to anticipate and combat risks is beneficial for both pastoralists and consumers. All public and private stakeholders must jointly define this technically feasible, reliable and bio-economically viable solution for the continuation of semi-transhumant livestock farming, or even the formalization of its management in the region. It is also in this sense that this study could find a useful extension.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to all the semi-transhumant breeders who participated in the survey, as well as the agricultural subdivision officer of Ain El Bell and the veterinarians who contributed directly or indirectly to the success of this research.

REFERENCES

Abidi, F., Kharroubi, H., & Atchemdi, K. A. (2013, décembre). Efficacité des institutions locales organisatrices des marchés locaux de la ressource fourragère biologique. *Algerian Journal of Arid Environment*, 3(2), 73-59.

- Atchemdi, K. A. (2008). Impact des variations climatiques sur le prix des moutons sur le marché de gros de Djelfa (Algérie). *Cahiers Agricultures*, 17(1), <https://doi.org/10.1684/agr.2008.0156>
- Atti, N. (2011). *Système optimum de conduite des ovins : cas des conditions alimentaires améliorées du sud de la Méditerranée*. Opt Méd : Série A. Séminaires Méditerranéens, 97p
- Belkhir, F., & Atchemdi, K. A. (2021). Formes de réseau de relations des exploitations agricoles familiales dans trois communes de Djelfa (Algérie) et les effets bénéfiques. *Revue Études Économiques – ASJP*, 15(01), 283-308. <https://www.asjp.cerist.dz/en/downArticle/417/15/1/148562>
- Belloumi, M., & Matoussi, M. S. (2007). Impacts de la salinité sur l'efficacité technique de l'agriculture irriguée : application au cas des Oasis de Nefzaoua en Tunisie. *Économie et prévision*, 77-89. <https://doi.org/10.3917/ecop.177.0077>
- Bencherif, S. (2011). *L'élevage et la céréaliculture dans la steppe algérienne. Évolution et possibilités de développement*. Thèse de doctorat. Agro Paris Tech, Paris, France, 269p. <http://tel.archives-ouvertes.fr>
- Benjamin, C., Fraysse, J., & Herrard, N. (1999). *Identification des cycles des abattages bovins et des prix en France*. INRA – Economie et Sociologie Rurales, France
- Boulanouar, B., & Baquay, R. (2006). *L'élevage du mouton et ses systèmes de production au Maroc*. INRA, Maroc, 348p
- Dirand, A. (2007). *L'élevage du mouton*. Educagri éditions France, 241p
- Direction de la programmation et du suivi budgétaire de la wilaya de Djelfa, DPBM-Djelfa (2018). Monographie de la wilaya de Djelfa. Direction de la programmation et du suivi budgétaire. Edition 2018, wilaya de Djelfa, Algérie
- Direction de la santé publique de la wilaya de Djelfa, DSP–Djelfa (2023). Bilan statistique, document interne DSP – Djelfa, Direction de Sante et de la Population de la wilaya de Djelfa, Algérie
- Direction des services agricoles de la wilaya de Djelfa, DSA–Djelfa (2023). Rapport des statistiques agricoles. Bilan des réalisations du DSA, document interne DSA – Djelfa, Direction des services agricoles de la wilaya de Djelfa, Algérie
- Dudouet, C. (2003). *La production du mouton* (2e éd.). Editions France Agricole, France.
- Gaci, D. (2022). *Etude des mobilités pastorales dans les parcours steppiques algériens : cas des éleveurs de la wilaya ovin de la wilaya de Djelfa (Algérie)*. Thèse de doctorat en sciences agronomiques, École Nationale Supérieure Agronomique El Harrach, Algérie, 170p
- Gadoud, R. (2004). *Nutrition et alimentation des animaux d'élevage* (Vol. 2.). Educagri éditions France, 312p
- Grain de sel, (2017). Le pastoralisme a-t-il encore un avenir en Afrique de l'Ouest ? Pour une vision régionale du pastoralisme. Un mode de vie en crise ? Conflits : foncier, insécurité et instrumentalisation. *Grain de sel*, (73-74), 1-43.

- Hadbaoui, I. (2021). *Evaluation de la durabilité des systèmes d'élevage ovin en zone steppique algérienne. Cas de la région de M'sila*. Thèse de doctorat en sciences agronomiques. Université Kasdi Merbah – Ouargla, Algérie, 283p
- Hoffmann, M., Kleine-Weber, H., Krüger, N., Mueller, M., Drosten, C., & Pöhlmann, S. (2020). *The novel corona virus 2019 (2019-nCoV) uses the SARS corona virus receptor ACE2 and the cellular protease TMPRSS2 for entry into target cells*. BioRxiv.
- Itier, B., & Seguin, B. (2007). Sécheresse : caractérisation et occurrence. *Journées AFPP – Productions fourragères et adaptations à la sécheresse*, 27 et 28 mars 2007, France.
- Kaci, S. (2020). L'effet de la pandémie de Covid-19 sur l'activité économique en Algérie. *Les cahiers du CREAD*, 36(3), 107-130, Algérie.
- Landais, E. (1992). Principes et modélisation des systèmes d'élevages. *Approches graphiques. Cah, Rech, Dev*, 32(2), 25-82.
- Meyer, C., Faye, B., Karembe, H., & Poivey, J. P. (2004). *Guide de l'élevage du mouton méditerranéen et tropical*. Libourne : CEVA Santé animale-CIRAD-EMVT, 166p
- Moulin, C. (2006). *Une méthode pour comprendre les pratiques d'alimentation des herbivores domestiques: analyse du fonctionnement des systèmes d'alimentation par enquêtes en élevage*. Guide méthodologique, 89p. www.inst-elevage.asso.fr
- Nedjraoui, D. (2001). *Country pasture/forage resource profiles Algeria*. FAO. <http://www.fao.org/ag/AGP/AGPC/Counpoof/Algérie.htm>
- Nettier, B., Dobremez, L., Coussy, J. L., & Romagny, T. (2010). Attitudes des éleveurs et sensibilité des systèmes d'élevage face aux sécheresses dans les Alpes françaises. *Revue de Géographie Alpine /Journal of Alpine Research*, 98(4), 13. hal-02594477
- Office national de météorologie de la wilaya de Djelfa, ONM-Djelfa (2023). *Bulletin d'information climatique et agronomique*. Ed. off. Nat. Météo. Cent.Clim. Nat. Djelfa, Algérie
- Ouali, M., & Atchemdi, K. A. (2019). Système de management de l'environnement par le pasteur local : Une grille d'évaluation de durabilité spécifique. *Journal of Animal & Plant Sciences (J. Anim. Plant Sci.)*, 40(2), 6603-6618 Publication date 31/05/2019, <http://www.m.elewa.org/JAPS>; ISSN 2071-7024, https://m.elewa.org/Journals/wp-content/uploads/2019/05/2.Ouali_.pdf
- Ouali, M., Belkhiri, F., Medouni, Y., & Atchemdi, K. A. (2022). The Efficiency of Struggle Against Sheep Price Volatility in Djelfa Region of Algeria. *Les Cahiers du Cread- Vol. 38 -n° 01*; p105-138. <https://www.asjp.cerist.dz/en/PresentationRevue/>
- Rabehi, N., Boukoufalla, M., Atchemdi, K. A., Ouali, M., Medouni, Y., & Omrani, R. (2018). Analyse du cycle de production dans le système d'élevage transhumant sous des contraintes saisonnières. In *Session 5 : Investissements, structures de production et de commercialisation (Projets, systèmes de production, structures de production et d'encadrement, commercialisation, approches participatives*. VI meeting International :

Agriculture Oasienne et Développement Durable (OASuD2018), Djerba (Tunisie), le 19-21 décembre 2018. www.ira.agrinet.tn

Rahouadja, F., Atchemdi, K. A., & Houari, A. (2023). Effet de la pandémie Covid-19 sur la production du mouton fondée sur le système d'élevage semi-transhumant dans la région d'Ain El Bell, Djelfa-Algérie. In *3e Webinaire International – Sécurité Alimentaire et Santé Animale WISASA « Enjeux et perspectives de la mise en œuvre de l'approche One Health en Algérie »*, 09 juillet, École Nationale Supérieure Vétérinaire d'Alger, Algérie, <https://sites.google.com/ensv.dz/wisasa-2023/accueil>

Ramade, F. (1984). *Éléments d'écologie, Écologie fondamentale*. Paris: McGraw-Hill.

Zolla, E. (2017). *La gestion des risques dans les établissements et services sociaux et médico-sociaux* (2^{ème} ed., pp. 21-68). Dunod.