Azarian Journal of Agriculture

Azarian J. Agric. VOL (7) ISSUE 6, 2020: 194-199

http://dx.doi.org/10.52547/azarinj.046

www.azarianjournals.ir

Azarian Journals

Research article **ISSN:2383-4420**

Contribution of the prophylactic campaigns of sheep flocks in preserving animal health in the Wilaya of Djelfa

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Article Info

Accepted:
29 Dec. 2020

Keywords:
Animal health, Beneficiary breeders, Djelfa, Precipitation, Sheep pox, Sheep

ABSTRACT

Sheep pox is the main infectious disease that worries sheep farmers in Algeria; because of its significant economic cost. Despite this, prophylactic campaigns through vaccination remain the only way to preserve animal health. In this study, the methodology consists of analyzing the data collected from reports of vaccination operations, which has very particular importance due to the massive adhesion of breeders to these campaigns. This analysis is directly related to the sheep vaccinated compared to the numbers of adhered breeders, which enabled us to highlight an upward trend. This leads to a conclusion that every year new breeders are taking the vaccination programs against sheep pox. The climatic factor, in particular the precipitation, of which the strong averages generate important grasses pushes in favor of regrouping herds, which increases the possibility of propagation of the sheep pox virus. This analysis has given a negative correlation between the ratio and the precipitation. The latter is weaker when the precipitation tends to increase, thus pushing breeders to seek veterinary services for the vaccination of their herds. From the above, it clearly emerges that the innovative study of the precipitation effect on the importance of the farmers' adhesion flow to vaccination programs is an essential element, which conditions the movements and regrouping of herds in Algeria.

INTRODUCTION

The majority of the sheep herds is found in large pastoral and agro-pastoral areas providing a wide range of products and services (Nottor 2012, Plowright et al. 2012, Abriham et al. 2018, Tolessa and Hika 2020). The Algerian steppe forms a ribbon of 1,000 km long over a width of 300 km to the West and to the center less than 150 km to the East. It covers more than 20 million hectares (Kanoun et al. 2007, Khaldi 2014, Khader et al. 2014). It is marked by a great landscape diversity in direct relation with the precipitation factor, which is the limiting factor for the steppe plant cover in these zones (Hirche et al. 2007, Nedjraoui and Bédrani 2008, Salamani et al. 2013, Guesmi et al. 2017). Geographically, it is located between two mountain ranges in this case, the Tellian Atlas in the North and the Saharan Atlas in the South. This is called «Bled el ghnem» (country of the sheep) because it is characterized by its main production: the sheep. It is located between isohyaetes 100 to 400 mm, with low and stunted vegetation, subject to very accentuated human exploitation (Nedjimi and Guit 2012). The steppes are mainly used for extensive sheep farming, supplemented by a random cereal crop. It is good to note that the sheep population in this area has grown significantly faster. The National Statistics Office confirms that the number of sheep in 2009 is 21 404584 (head) which is almost 4 times the number reported in the 1970s. It is in this geographical area that the transhumance of sheep flocks is practiced with the aim of the permanent search for pastures. In general, mobility and transhumance are the foundations of the pastoral economy in these regions (Kanoun et al. 2015). Today, this mobility is weakened by recurrent droughts, the obstacles to pastoral mobility, hence the need to develop pastoral areas, which generally

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raises the question of land, the saturation of which has not been without repercussion on the health status of the sheep population in Algeria, which has undergone changes This has led to greater contact between herds and thus greater contagiousness.

This aspect is not without influence on animal health, in particular the epidemiology of sheep pox (Bhanuprakash et al. 2006, Babiuk 2009, FAO 2013). The latter, is a highly contagious disease, is it a major animal health problem in Algeria because it is of economic importance in view of the losses it can cause to livestock (Kardjadj 2017, Kardjadj and Ben-Mahdi 2018). For this reason, the programmes of massive prophylaxis of the sheep are launched every year by the official veterinary services Algerian, in order to protect them against this pathology. If the pastures are spread over large areas this does not promote contact between animals, thus reducing the possibility of spreading the disease because the grouping of herds promotes the spread of the virus since this transit through the steppe promotes contact between herds with different immune status (Achour and Bouguedour 1999). The purpose of our work is to study the effect of the prophylactic campaigns of sheep flocks on the preservation of animal health in the wilaya of Djelfa through the study of the ratio of flocks vaccinated/ breeders benefiting from the prophylactic campaigns.

MATERIALS AND METHODS

Study area

The wilaya of Djelfa (Figure 1), the subject of our study, was chosen because it represents a large breeding region and a vast agro-pastoral territory very recognized nationally for its production of red sheep meat (Kanoun 2015). Also, the availability of data (livestock numbers, vaccination data and climate data) over a long period of time motivated us to choose this wilaya as a study area. The wilaya of Djelfa is located in the central region of the Ouled Nail Mountains of the Saharan atlas. The capital of the wilaya is 300 km south of Algiers. It is between 2° and 5°E longitude and between 33°and 35°N latitude. Its total area is 33,236 km² or 1.36% of the country's total area. It is characterized by a typical Mediterranean climate with a cold winter and a warm summer, giving it a semi-arid to arid bioclimatic stage with a continental shade (Djeddaoui et al. 2017, Guesmi et al. 2017). The wilaya vegetation cover belongs to the Mediterranean vegetation layer of semi-arid to arid areas characterized by precipitation between 150 mm and 300 mm per year (Khader 2014, Mouissa et al. 2018). Pastoralism is the main economic base of the region occupying a population representing 37.7% of the total population of the wilaya of Djelfa (Kanoun 2015).

Data

The data used (Table 1) for the study of the effect of the prophylactic campaigns of sheep flocks on the preservation of animal health are the statistics of the sheep flocks of the wilaya of Djelfa, as well as statistics on vaccination against sheep pox (number of vaccinated heads vs number of vaccinated breeders) collected from the official veterinary services of the wilaya of Djelfa. The annual average precipitation data were collected from the meteorological services of the wilaya of Djelfa since this is the only explanatory factor for

Table 1. Summary table of data used.

Year	Sheep (Heads)	Number of sheep vaccinated (Heads)	Number of beneficiary breeders	Precipitation (mm)
2005	2382000	1367397	10294	376.00
2006	2400000	1315013	8250	267.80
2007	2450000	1337875	6910	288.00
2008	2500000	1735641	9577	297.40
2009	2517000	1943356	9469	347.00
2010	2752000	1941950	8479	389.00
2011	2891800	1773642	7632	266.40
2012	2967300	2094252	8439	328.60
2013	3113500	2046388	8124	486.20
2014	3242760	2398038	9630	239.60
2015	3364460	2371540	8825	281.00
2016	3379000	2388473	9140	277.54
2017	3379500	1977569	7267	300.30
2018	3393000	2079460	7233	300.20

the increase in plant cover in the study area (Guesmi et al. 2017). The period covered by this study from 2005 to 2018 is a period of 14 years.

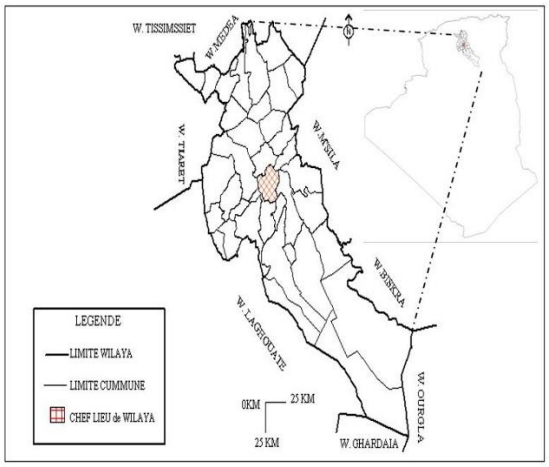

Figure 1. Location of the Wilaya of Djelfa (WGS 48, Zone 31N).

Statistical analyses

A descriptive statistical study was carried out under MS Excel for all the data in order to establish a good characterization of these data according to the duration set by the study. The first step was the collection of data (numbers of sheep, number of sheep vaccinated, number of farmers benefiting from vaccination, precipitation). Then, these data were gathered in a global database to see:

1) The evolution of vaccinated population in relation to livestock statistics; 2) the evolution of the ratio of the number of sheep vaccinated (Ov) by the breeders benefiting from the prophylactic campaigns of the sheep herd (B) and 3) the reading of the relationship which may exist between this ratio and the annual precipitation recorded after normalization of values by the application of the Min- Max method (Larose 2005). The used formula is:

$$Normalized\ x\ = {}^{x - x_{Min}}/_{x_{Max} - x_{Min}}$$

RESULTS AND DISCUSSION

Analysis of the data used

The descriptive analysis of the data used over a 14-year period (2005-2018) is shown in Table 2. This table summarizes the number of sheep, the number of sheep vaccinated, the number of breeders benefiting from the prophylactic campaigns of the sheep flocks and the average precipitation recorded during the period fixed by the study. It should be noted that the years associated with the Minimum and Maximum values are also represented in Table 2. For a better visibility of the evolution of vaccination against sheep pox during the period fixed by the study, the vaccination rates against sheep pox were calculated for each year (see Figure 2). The highest vaccination rate was 77.21% in 2009, while the lowest rate (54.61%) was recorded in 2007. The annual precipitation recorded at Djelfa from 2005 to 2018 is between 239.6 and 486.2 mm with an average of 317.49 mm.

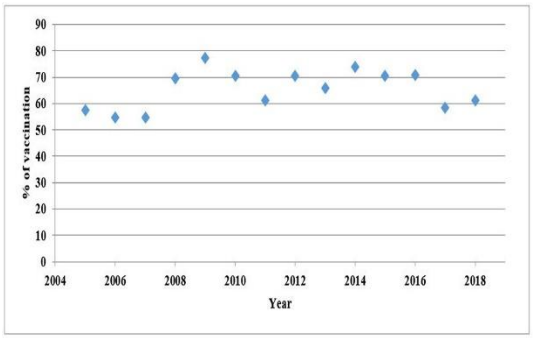

Figure 2. Variation in the percentage of vaccination against sheep pox from 2005 to 2018 in the Wilaya of Djelfa.

Evolution of the Ov / B ratio

The calculation of the ratio of the number of vaccinated sheep to the number of breeders benefiting from the prophylactic campaigns (Ov/B) showed its evolution during the period set by the study (Figure 3). This evolution follows a linear function (R^2 = 0.92) compared to the years. The lowest ratios (Ov/B) are 132.83 and 159.40 respectively for the years 2005 and 2006. The largest ratio (287.50) was recorded for 2018.

Relationship between Ov / B and precipitation

To make a good reading and to see the relation that exists between the Ov / B ratio and the precipitation, we proceed by normalizing the values of the latter using the Min-Max method to avoid assigning importance to a variable according to its values. (Larose 2005). It is clear from the graphical representation (see Figure 4 and Table 3) that these data are inversely linked; something which was confirmed by the correlation test where we obtained a correlation coefficient equal to - 0.07. In

Table 2. Descriptive statistics of the data used.

	Sheep (Heads)	Number of sheep vaccinated (Heads)	Number of beneficiary breeders (breeders)	Precipitation (mm)
Min	2382000 (2005)	1315013 (2006)	6910 (2005)	239.6 (2013)
Max	3393000 (2018)	2398038 (2014)	10294 (2007)	486.2 (2014)
Average	2909451.43	1912185.29	8519.21	317.49
Standard deviation	405155.52	371357.71	1027.30	64.42

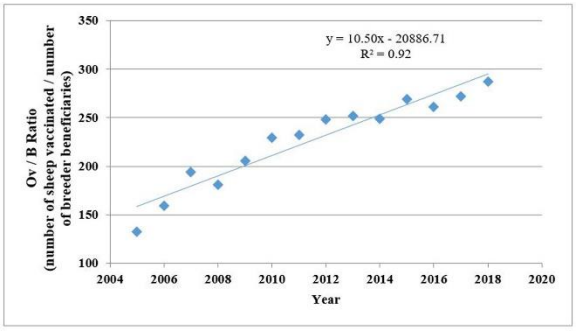

Figure 3. Variation of the Ov / B Ratio from 2005 to 2018 in the Wilaya of Djelfa.

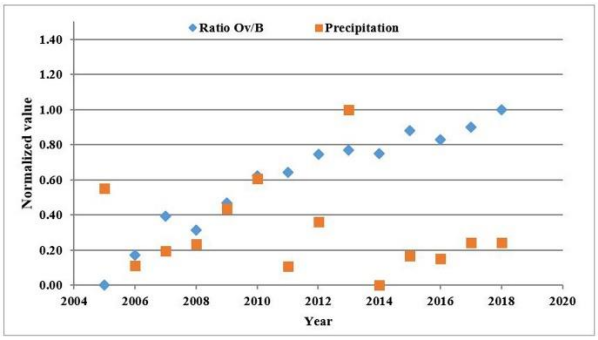

Figure 4. Relationship between the Ov / B Ratio and precipitation during the study period.

semi-arid steppe environments, precipitation is the limiting factor that controls the spatial distribution of vegetation (Verstraete et al. 2008, Amghar et al. 2016, Mouissa et al. 2018) and involved in the formation and evolution of soils (Boutelli 2012).

Steppe courses in the wilaya of Djelfa make up 70% of its total area. It is the most important wilayate steppiques in terms of size and number of sheep (Yabrir et al. 2015). In this region, the breeders exploit sheep breeds (Rumbi and Ouled Djallel) most adapted to the climatic conditions (Kanoun 2015). It should be noted that flock aggregation promotes the spread of the sheep pox virus (Achour and Bouguedour 1999). It is clear from this that: When the precipitation increases the Ov / B ratios decrease with the example of the year 2005. When the precipitation decreases the Ov / B ratios increase.

The correlation test (-0.07), comforts our advanced thesis and which is it-even taken from the reality of the field and which says that in the years with heavy precipitation there is a very strong adherence of the breeders to the program of vaccination in order to avoid any contagion of the herds which are more and more close to each other in the pastures of the steppe. Because the breeders have acquired over time the reflex to vaccinate their flock against the sheep pox even before the departure of the transhumance since the experience of the years with good precipitation showed them that the sheep herds will be more in contact with each other than in the years they will therefore be more exposed to contagion by the sheep pox if they are not previously vaccinated.

This rule they understood so much that during the years when the grass is abundant they all want to vaccinate at the same time their flocks, which is clearly visible on the values of the ratio analyzed. For example, in Algeria from 2007 to 2016, the study carried out by Kali et al. (2019) to show that the outbreaks of sheep pox occurred each year with an average of 44.9 outbreaks per year, these outbreaks are also correlated with the climatic precipitation factor. It also appears that the correlation between precipitation and the number of vaccinations are very highly significant (Achour and Bouguedour 1999, Kali et al. 2019).

Finally, data mining and the application of simple statistical methods (descriptive statistics,

Table 3. Summary of normalized data for the Ov / B Ratio and precipitation during the study period.

Year	Normalized ratio (OV / B)	Normalized Precipitation
2005	0.00	0.55
2006	0.17	0.11
2007	0.39	0.20
2008	0.31	0.23
2009	0.47	0.44
2010	0.62	0.61
2011	0.64	0.11
2012	0.75	0.36
2013	0.77	1.00
2014	0.75	0.00
2015	0.88	0.17
2016	0.83	0.15
2017	0.90	0.24
2018	1.00	0.24

ordinary regression, correlation test) made it possible to identify the relationship between the Ov/B ratio and precipitation, at regional and even national level. Very interesting improvements can be made if detailed vaccination data is available by season and by bioclimatic stage which is the combination of the two precipitation factors and temperature. The availability of these detailed data calls for the application of advanced methods and treatments. For example, the analysis in main components (ACP) makes it possible to see the links between the variables and to observe as objectively as possible the correlations existing between the different variables (Achour et Bouguedour 1999; Abdi and Williams 2010). Therefore, vaccination should cover the entire Algerian sheep herd to improve animal welfare and reduce economic losses associated with epidemic episodes (Kali et al. 2019). On the other hand, a good program to fight against sheep pox must be adapted to the agro-pastoral and bioclimatic conditions of the country according to the factors responsible for the persistence of sheep pox, in particular precipitation (Achour and Bouguedour 1999).

CONCLUSIONS

The climatic parameter was chosen with care to point out the relation between observation and experience in the field. Analysis of the results confirms the existence of the link between the precipitation and the risk of spreading sheep pox. This is visible in the years which have a strong rainfall and whose correlation is negative with the ratio of vaccinated sheep and beneficiary breeders. This means that the precipitation factor inversely influences the importance of the flow of breeders to the vaccination program. The breeders fear much more the contagion of their herds over the years with a strong promiscuity among the herds, which gather in the common pasturage following the heavy vegetation cover after the heavy rains.

ACKNOWLEDGMENTS

We warmly thank the editors for their professional expertise.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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