



The Impact of Extreme Temperatures on the Incidence of Animal Diseases in Najaf Al-Ashraf Governorate

¹Muthanna Fadhel Ali Al-Wa'ili, ²Sayer Abbas Hassan

University of Kufa, College of Arts, Najaf, Iraq

(Received: 04 August 2023

Revised: 12 September

Accepted: 06 October)

KEYWORDS

Livestock,
Animal diseases,
Climate impact,
Geographical study

ABSTRACT:

Livestock is considered a complementary part of agricultural activity, making this research highly significant as it falls within the realm of geographical studies investigating the impact of a specific climate attribute on animal disease incidence. The research employs a descriptive approach to uncover the extent of the influence of extreme temperatures and their relationship with animal diseases in Najaf Al-Ashraf Governorate. It also aims to identify the reasons behind the increasing rates of these diseases.

Introduction

The livestock sector is another part of the agricultural sector and an important source of local and national income in the province of Najaf Al-Ashraf. Improving its health status is imperative to ensure an increase in productivity, as it contributes significantly to achieving food security for the population. This livestock sector is greatly affected by various climatic factors, including extreme temperatures, directly impacting it with many diseases.

1. Research Problem: The research problem can be summarized by the following question: What is the effect of extreme temperatures on the incidence of diseases in the livestock sector in the province of Najaf Al-Ashraf?

2. Research Hypothesis: The research hypothesis represents a preliminary guess at possible solutions to the problem and is formulated as follows: Extreme temperatures have a clear impact on the incidence of diseases in the livestock sector in the province of Najaf Al-Ashraf.

3. Research Objective: The aim of this research is to study the characteristics of extreme temperatures and their impact on the incidence of diseases in the livestock sector. This will enable planners and those involved in livestock farming to develop solutions to reduce the negative effects of extreme temperatures and promote comprehensive agricultural development.

4. Research Scope: Najaf Al-Ashraf is one of the provinces of central Iraq, located in the southwest part of the country, spanning between latitudes 29.50 to 32.21 degrees north and longitudes 42.47 to 44.44 degrees east. It has a rectangular shape and shares administrative borders with Babil and Karbala to the north, Qadisiyah and Muthanna to the east, Anbar to the west, and it has land borders with Saudi Arabia to the south and southwest. Its total area is 28,824 square kilometers, making up 6.6% of Iraq's total area of 435,052 square kilometers.

Administratively, there are 10 districts in Najaf Al-Ashraf, with varying sizes. The Najaf district, which includes the districts of Al-Haydariyah and Shabkha, serves as the provincial center and is the largest in terms of area, covering 27,761 square kilometers, which is 96.3% of the total area. The Kufa district, followed by the Al-Abbasiyah and Al-Hurriyah districts, covers an area of approximately 473 square kilometers, representing 1.51%. The Manathera district, followed by the Al-Hayrah district, occupies an area of 324 square kilometers, with a percentage of 1.1%. Lastly, the Mashkhab district, followed by the Al-Qadisiyah district, covers an area of 302 square kilometers, representing 1%. Please refer to Table 1 for administrative units.

Source: Republic of Iraq, General Authority for Survey, Administrative Map of Najaf Al-Ashraf Province, Baghdad, 2015, using ArcGIS 10.5 software.

**Table (1)** Area of Administrative Units in Najaf Al-Ashraf Province

Area ratio %	Area/km ²	Administrative unit	SC
3.93	1133	Najaf District Center	A1
4.26	1228	Haidariya district	A2
88.12	25400	Network hand	A3
0.44	129	Kufa District Center	A4
0.29	223	Abbasiya district	A5
0.77	85	Freedom district	A6
0.17	49	Manathira District Center	A7
0.95	275	The area of confusion	A8
0.42	123	Al-Mishkhab District Center	A9
0.62	179	Al-Qadisiyah district	A19
100	28824	Total province	

The average maximum temperatures vary seasonally, with the highest recorded during the hot summer season in Najaf station, reaching 43.7°C. This is due to the nearly vertical angle of sunlight during this season. The lowest seasonal averages were recorded during the cold winter season at 17.1°C in the Shabka Al-Mukhtar (2) station.

The second section: Diseases affecting livestock in Najaf Governorate

1- Foot-and-mouth disease:

It is a highly contagious viral disease that affects animals with cloven hooves, such as cows, buffalo, sheep, and goats. It is widespread throughout the world. It is characterized by its resistance to external environmental conditions, as it can cause infection for a long period in environmental conditions in which there is darkness, drought, and low temperatures, while its resistance weakens in a humid environment with high temperatures. This disease causes significant weight loss in the infected animal because the animal refrains from

eating its feed as a result of the pain and ulcers that appear in the animal's mouth, which are the beginning of the initial symptoms of the disease (4).

An increase in the animal's temperature to (42°C) is the first symptom of the disease, and the appearance of small bubbles and ulcers in the mouth, and thus this disease is known as (Abu al-Lusin), or ulcers between the hooves that cause the animal to become limp and unable to stand, and from here it is called (Abu Hatim). The ulcers affect the udder and it is called (Abu Dharai) (5).

The number of infections between cows and buffaloes with this disease varied spatially and temporally during the research period (2017-2021) in the Najaf Governorate. The highest number of infections was recorded in the Al-Mishkhab district, with (57 infections) and a percentage of (27.5%) of the total total infections. While the lowest number of infections was recorded in Al-Qadisiyah district, with (3) cases, at a rate of (1.4%).

Table (2)

Table (2) Number of cows and buffaloes infected with foot-and-mouth disease in Najaf Governorate for the period (2017-2021).

SC	Ratio	Total	autumn	Summer	الربيع	Winter
A1	5.3	11	3	0	1	7
A2	11	22	2	0	5	15
A3	6.2	13	0	0	2	11
A4	5.3	11	2	0	9	0
A5	26.5	55	16	0	0	39
A6	10.1	21	6	0	4	11
A7	6.7	14	0	0	5	9



A8	27.5	57	14	3	5	35
A9	1.4	3	0	0	0	3
A19	100	207	43	3	31	130

Source based on: Ministry of Agriculture, Veterinary Directorate, Veterinary Teaching Hospital in Najaf Al-Ashraf, Unpublished Data, Najaf Al-Ashraf, 2022.

As for the seasonal data, infections increase during the winter season, reaching 130 cases, while they are lower during the hot summer season, with only 3 cases. This variation is attributed to the virus's ability to spread in cold environmental conditions and the shorter duration of daylight in winter. Conversely, the higher temperatures and increased sunlight during the summer season contribute to the elimination of the virus causing this disease, as shown in Figure (3) [17].

2- Three Days Sickness (Bovine ephemeral fever) Disease:

It is a viral infectious disease transmitted by insects that feed on the blood of animals. This disease is called "Bovine fever" because it affects only cattle and buffalo. However, the infection rate in cattle is higher than that in buffalo due to the thickness of the buffalo's skin, which makes it difficult for insects to penetrate [18].

Symptoms of this disease, in addition to loss of appetite, include a sharp rise in body temperature, reaching 41-42°C, which usually decreases after three days. Other symptoms include muscle stiffness and rigidity, lameness in the limbs, increased and sometimes labored breathing, with nasal and ocular secretions, enlargement of lymph nodes. The majority of cases recover. The incidence of this disease increases during the hot season when temperatures rise [19].

Cattle and buffalo in Najaf Al-Ashraf province have been exposed to a number of cases of this disease during the research period (575 cases). Al-Hurriyah district had the highest number of cases (161 cases), accounting for 28% of the total number of affected animals. This is attributed to the environmental conditions conducive to the spread of this disease in the district, as the insects that transmit it multiply in the Ibn Najm Marsh, which is a permanent water marsh located largely within the boundaries of this district. The lowest number of cases was recorded in the Al-Kufa district, with 15 cases, accounting for 2.6% of the total cases. See Table (3) [20].

Table (3): Numbers of Cattle and Buffalo Affected by Three Days Sickness Disease in Najaf Al-Ashraf Province for the Period (2017-2021).

SC	نسبة الإصابات من إجمالي الأعداد	المجموع	الخريف	الصيف	الربيع	الشتاء
A1	4.7	27	0	26	1	0
A2	4.3	25	2	23	0	0
A3	2.6	15	0	14	1	0
A4	24	138	3	129	6	0
A5	28	161	6	153	2	0
A6	14.6	84	1	82	1	0
A7	11.9	68	0	67	1	0
A8	4.5	26	0	25	1	0
A9	5.4	31	1	28	2	0
A19	100	575	13	547	15	0

Source based on: Ministry of Agriculture, Veterinary Directorate, Veterinary Teaching Hospital in Najaf Al-Ashraf, Unpublished Data, Najaf, 2022.



As for the seasonal data, the highest number of infections were recorded during the hot summer season, reaching 547 cases during the research period (2017-2021). This is due to the proliferation of insects (mosquitoes) that transmit the infection significantly during this season. The lowest number of infections was 13 cases in the autumn season, and no cases were recorded during the cold winter season due to the reduced activity of the disease-carrying insects [21][22].

- ****Pest of Small Ruminants (Peste des Petits Ruminants):****

It is a highly contagious viral disease that affects sheep. It first appeared in Ivory Coast in 1942 and subsequently spread to many countries. This disease is transmitted through direct contact, contaminated air carrying the virus, as well as through contaminated water and feed. This disease tends to spread after rainfall, but it is affected and weakened by high temperatures and ultraviolet sunlight [23].

Symptoms of this disease include high fever, diarrhea, pneumonia, coughing, and the discharge of clear mucous from the nose and eyes, which later turns purulent after a few days. Animals may experience sudden weakness, loss of appetite, and acute respiratory distress due to nasal mucous. The virus incubation period is between 3-6 days, and it can lead to miscarriages in pregnant animals. The disease can result in the death of the animal within 5-10 days of the appearance of symptoms.

Cases of this disease have been recorded among sheep and goats, with approximately 287 cases. Najaf district in the province had the highest number of cases, with 88 cases, accounting for 30.7% of the total affected animals. This increase in cases is directly related to the number of animals in this district. On the other hand, Al-Hurriyah district had the lowest number of cases, with only 10 cases, accounting for 3.4% of the total cases. See Table (4).

Table (4): Numbers of Sheep and Goats Affected by Peste des Petits Ruminants in Najaf Al-Ashraf Province for the Period (2017-2021).

SC	نسبة الإصابات من إجمالي الأعداد	المجموع	الخريف	الصيف	الربيع	الشتاء
A1	30.7	88	21	0	22	45
A2	14.6	42	3	0	15	24
A3	5.9	17	2	0	4	11
A4	17	49	6	0	14	29
A5	3.4	10	5	0	0	5
A6	4.5	13	6	0	0	7
A7	9.8	28	2	0	8	18
A8	8.4	24	3	0	12	9
A9	5.6	16	4	0	0	12
A19	100	287	52	0	75	160

Source: Based on the Ministry of Agriculture, Veterinary Directorate, Veterinary Teaching Hospital in Najaf Al-Ashraf, Unpublished Data, Najaf, 2022.

The infections of this disease were concentrated among sheep and goats in Najaf province during the cold and wet winter season, with the highest number of cases reaching 160 infections. This numerical dominance in infections during this season is due to the favorable climatic conditions, including low temperatures and rain, which create a suitable environment for the spread of the virus. Conversely, during the summer season, no cases were recorded due to the high temperatures. The lowest

number of cases was recorded in the autumn season, with 52 cases. See Figure (5).

- ****Mastitis (التهاب الضرع):****

The term "Mastitis" refers to the inflammation of the mammary gland in animals, involving pathological chemical, physical, and bacterial changes in the mammary tissue. There are approximately 50 types of bacteria that can cause this disease, with some being controllable and others more difficult to control and



limit. This disease affects all female animals, particularly dairy cows.

Infection in animals occurs when pathogenic bacteria enter the animal's body through the teats or through cracks and wounds on the udder, especially during the nursing season or when the udder becomes cold due to low temperatures and increased humidity in winter. Increased humidity, poor ventilation, or high temperatures are factors that can lead to a fermentative condition in the bedding of the barns, creating a suitable environment for the growth of various bacteria, including those causing this disease.

Symptoms of the disease include high fever, the animal's refusal to eat, swelling and redness of the udder, and a change in the color of milk to yellow or it may become clotted and have a foul odor.

Al-Abbasiyah district in the province had the highest number of cases, with 178 cases, accounting for 19% of the total cases of affected animals, which amounted to 934 cases. These high numbers of infections result from the proliferation of bacteria causing the disease in the barn floors, where soil moisture levels increase due to lack of daily cleaning by breeders. On the other hand, the lowest number of cases was recorded in the Al-Munathara district, with 59 cases, accounting for 6.3% of the total cases. See Table (5).

Table (5): Numbers of Cattle and Buffalo Affected by Mastitis Disease in Najaf Al-Ashraf Province for the Period (2017-2021).

SC	نسبة الإصابات من إجمالي الأعداد	المجموع	الخرف	الصيف	الربيع	الشتاء
A1	15.4	144	38	8	84	14
A2	7.3	68	20	2	34	12
A3	8	75	8	20	36	11
A4	19	178	41	11	104	22
A5	10.7	100	19	6	51	24
A6	6.3	59	14	3	16	26
A7	11.4	106	16	6	48	36
A8	9.2	86	19	4	41	22
A9	12.7	118	22	5	67	24
A19	100	934	197	65	481	191

****Source:**** Based on the Ministry of Agriculture, Veterinary Directorate, Veterinary Teaching Hospital in Najaf Al-Ashraf, Unpublished Data, Najaf, 2022.

The number of cattle and buffalo affected by mastitis disease varies seasonally in Najaf province. The highest number of infections, reaching 481 cases, was recorded in the spring season due to the significant proliferation of the bacteria causing this disease. On the other hand, the lowest number of infections, 65 cases, was recorded during the hot summer season due to the decrease in humidity levels and the increase in temperatures.

****Source:**** Based on the Ministry of Agriculture, Veterinary Directorate, Veterinary Teaching Hospital in Najaf Al-Ashraf, Unpublished Data, Najaf, 2022.

Brucellosis, also known as "Malta fever," is a contagious bacterial disease that affects sheep, goats, and cattle. The infection is transmitted when healthy animals come into

direct contact with infected animals or through mucous secretions from the nose and eyes. The disease was first discovered by the English doctor Bruce in 1978. It is characterized by inflammation of the reproductive organs and fetal mucous membranes, leading to abortion in pregnant females. In males, the infection is characterized by swelling of the reproductive system, leading to infertility in both sexes.

This disease becomes more active during periods of drought or high temperatures. Infected animals typically do not show any external symptoms except for occasional abortion once or twice, but they continue to carry the infection. The bacteria responsible for the



disease can survive in pastures for more than 100 days in winter and 30 days in summer.

In Najaf Al-Ashraf, both sheep and goats have been affected by Brucellosis, with a total of 419 cases. The highest number of infections, 156 cases, was recorded in the Al-Haidariyah district during the research period (2017-2021), accounting for 37.2% of the total infected

animals. These animals are grazed in desert areas belonging to this district, which are characterized by dryness and high temperatures, especially during the hot season, creating suitable conditions for the pathogens of this disease. Meanwhile, the lowest number of infections was recorded in the Al-Kufa district, with only 2 cases, accounting for 0.5% of the total infected animals.

Table (6): Numbers of sheep and goats infected with Brucellosis (Contagious Abortion) in Najaf Al-Ashraf Governorate for the period (2017-2021).

SC	نسبة الإصابات من إجمالي الأعداد	المجموع	الخريف	الصيف	الربيع	الشتاء
A1	33.2	139	5	122	9	3
A2	37.2	156	28	117	10	1
A3	0.5	2	0	1	1	0
A4	6.2	26	10	15	1	0
A5	1.4	6	1	5	0	0
A6	1.7	7	0	7	0	0
A7	12	50	11	37	1	1
A8	3.6	15	1	11	3	0
A9	4.2	18	3	15	0	0
A19	100	419	59	330	25	5

The source relies on: the Ministry of Agriculture, the Veterinary Directorate, the Educational Veterinary Hospital in Najaf Al-Ashraf, unpublished data, Najaf, 2022.

The number of cases of brucellosis infection in sheep and goats varied seasonally, with the highest recorded during the hot summer season at 330 cases. This is due to the favorable conditions for the spread of the bacteria causing the disease during this season. On the other hand, the lowest number of cases was recorded in the winter season, with only 5 cases.

****Third Section - The Impact of Maximum Temperature on Livestock Diseases in Najaf Al-Ashraf Governorate:****

Temperature is one form of energy that directly affects various biological activities, whether in humans, animals, or plants. This effect is determined by the physiological functions of animals, as warm-blooded animals (homeothermic) have body temperatures ranging from 38-39°C in cattle and buffalo, and from 39-40°C in sheep and goats. Camels, on the other hand, have body temperatures ranging from 34-41°C. The temperature at which an animal does not have to expend

energy to regulate its body temperature or dissipate excess heat is referred to as the optimal temperature for the animal (18).

Any change in an animal's temperature by approximately 4.4°C from the normal reference point, whether an increase or decrease, will lead to physiological changes in the animal's body functions. It can affect the growth and reproduction of the animal due to its impact on the pituitary gland, which is responsible for these processes. High maximum temperatures have been shown to impact the incidence of various diseases in livestock in Najaf Al-Ashraf Governorate. The magnitude of this impact varies by administrative units. The strongest statistically significant positive correlation for three-day fever in cattle and buffalo was recorded in the Al-Kufa district, with correlation coefficient (0.75), regression (2.92), and interpretation coefficient (0.56). This means that the incidence of this disease increases as maximum temperatures rise. On the other hand, the strongest inverse correlation was recorded for rinderpest in cattle and buffalo in the Najaf district, with a correlation coefficient (-0.79), regression (-0.28), and interpretation coefficient (0.63), indicating that the number of cases of



this disease decreases as maximum temperatures increase.

The weakest statistically significant relationships were recorded for brucellosis in sheep and goats in the Najaf district with a positive correlation (0.30), regression

(1.85), and interpretation coefficient (0.09). The weakest inverse correlation was recorded for mastitis in the Al-Mashkhab district with a correlation coefficient (-0.32), regression (-0.64), and interpretation coefficient (0.10). (Table 7)

****Table 7:** The Impact of Maximum Temperatures on the Incidence of Livestock Diseases in Najaf Al-Ashraf Governorate for the Period (2017-2021).**

البروسيل للأغنام والماعز	التهاب الضرع للأبقار والجاموس	طاعون المجترات الصغيرة أغنام وماعز	حمى ثلاث أيام أبقار وجاموس	قلاعية أبقار وجاموس	المرض العلاقة	District
0.30	-0.36	-0.56	0.73	-0.79	Relation	Najaf
1.85	-0.92	-1.04	0.47	-0.28	Deviation	
0.09	0.13	0.31	0.54	0.63	تفسير	
طردية ضعيفة	عكسية ضعيفة	عكسية متوسطة	طردية قوية	عكسية قوية	Correlation	
0.37	-0.43	-0.60	0.75	-0.58	Relation	Kufa
0.21	-1.52	-0.71	2.92	-0.63	Deviation	
0.13	0.19	0.36	0.56	0.33	تفسير	
طردية ضعيفة	عكسية ضعيفة	عكسية متوسطة	طردية قوية	عكسية متوسطة	Correlation	
0.37	-0.53	-0.53	0.68	-0.61	Relation	Almanathe ra
0.21	-0.83	-0.42	1.56	-0.30	Deviation	
0.13	0.28	0.28	0.46	0.37	تفسير	
طردية ضعيفة	عكسية متوسطة	عكسية متوسطة	طردية متوسطة	عكسية متوسطة	Correlation	
0.53	-0.32	-0.53	0.65	-0.75	Relation	Almshkhab
0.28	-0.64	-0.34	0.56	-0.59	Deviation	
0.28	0.10	0.28	0.42	0.56	تفسير	
طردية متوسطة	عكسية ضعيفة	عكسية متوسطة	طردية متوسطة	عكسية قوية	Correlation	

**As for the seasonal variation, there was a variation in the impact of maximum temperatures on the incidence of livestock diseases in Najaf Al-Ashraf Governorate. The strongest statistical relationship was recorded in the winter season for Peste des Petits Ruminants (PPR) in sheep and goats, with a perfect inverse correlation (-1), regression (-30.70), and interpretation coefficient (9.99). This means that the incidence of this disease decreases as maximum temperatures rise. On the other hand, the strongest positive correlation was recorded in the autumn season for mastitis in cattle and buffalo, with a correlation coefficient of (0.97), regression (4.75), and

interpretation coefficient (0.94). This indicates that the number of cases of this disease increases as maximum temperatures rise.

The weakest statistical relationships were recorded for three-day fever in cattle and buffalo in the summer season, with a positive correlation (0.18), regression (12.57), and interpretation coefficient (0.04). There were no significant relationships recorded for three-day fever in sheep and goats in the winter season and Peste des Petits Ruminants (PPR) in sheep and goats in the summer season, meaning that these diseases are not affected by maximum temperatures. (Table 13).



****Table 13:** Seasonal Impact of Maximum Temperatures on the Incidence of Livestock Diseases in Najaf Al-Ashraf Governorate for the Period (2017-2021).**

القضاء	المرض / العلاقة	قلاعية ابقار وجاموس	حمى ثلاث أيام ابقار وجاموس	طاعون المجترات الصغيرة أغنام وماعز	إلتهاب الضرع للأبقار والجاموس	البروسيلة للأغنام والماعز
الشتاء	ارتباط	0.23	0.00	-1.00	0.75	-0.86
	إنحدار	4.62	0.00	-30.70	16.68	-2.27
	تفسير	0.05	0.00	0.99	0.56	0.74
	العلاقة	طردية ضعيفة جداً	لا يوجد ارتباط	رتباط عكسي تام	عكسية قوية	عكسية قوية
الربيع	ارتباط	-0.44	-0.47	-0.71	-0.76	-0.48
	إنحدار	-0.54	-0.75	-4.06	-17.77	-1.84
	تفسير	0.20	0.22	0.50	0.57	0.23
	العلاقة	عكسية متوسطة	عكسية ضعيفة	عكسية قوية	عكسية قوية	عكسية ضعيفة
الصيف	ارتباط	-0.61	0.18	0.00	0.44	0.68
	إنحدار	-0.55	12.57	0.00	3.52	43.40
	تفسير	0.37	0.04	0.00	0.19	0.47
	العلاقة	عكسية متوسطة	طردية ضعيفة جداً	لا يوجد ارتباط	طردية ضعيفة	طردية متوسطة
الخريف	ارتباط	0.27	0.19	0.73	0.97	0.55
	إنحدار	0.49	13.57	1.64	4.75	2.02
	تفسير	0.07	0.04	0.53	0.94	0.31
	العلاقة	طردية ضعيفة جداً	طردية ضعيفة جداً	طردية قوية	طردية قوية جداً	طردية متوسطة

Results:

1. The research showed that temperature has a strong direct and inverse impact on the incidence of livestock diseases in Najaf Al-Ashraf Governorate.
2. The strongest monthly statistical relationships for three-day fever in cattle and buffalo were recorded in Al-Kufa district with a positive correlation coefficient (0.75), regression (2.92), and interpretation coefficient (0.56).
3. The research revealed that most diseases are affected seasonally by maximum temperatures. In the winter season, there was a perfect inverse correlation (-1), regression (-30.70), and interpretation coefficient (9.99) for Peste des Petits Ruminants (PPR) in sheep and goats. This means that the incidence of this disease decreases as maximum temperatures rise.

References

1. Haddid, Ahmed Saeed, and Ibrahim Shareef. "Climatology." Ministry of Higher Education and

Scientific Research, College of Education, University of Baghdad, Baghdad, 1979, p. 33.

2. Rameed, Tahseen Hadi. "The Reality of Cattle and Buffalo Farming and Ways to Develop it in Diyala Province for the Year 2013." Master's thesis, College of Humanities Sciences, Diyala University, 2014, p. 95.
3. Al-Mayali, Sayir Abbas Hassan. "The Impact of Climatic Characteristics on the Incidence of Diseases in Livestock in Najaf Al-Ashraf Governorate." Master's thesis, College of Arts, University of Kufa, 2023, p. 77.
4. Al-Wawi, Awad Aboud Matar. "Spatial Analysis of Raising Cattle in Najaf Al-Ashraf Governorate." Doctoral dissertation, College of Arts, University of Kufa, 2017, p. 165.
5. Al-Ani, Falah Khaleel. "Infectious Diseases in Cattle and Buffalo." Higher Education Printing and Publishing House, University of Mosul, 1989, p. 140.



6. Abdulkareem, Fuad Abdul Latif. "Meat Animal Production." College of Agriculture, University of Basrah, 1988, p. 154.
7. Jubbar, Kazim Saad, and Musdaq Salim Abdul Razzaq. "Iraqi Buffalo: Breeding, Nutrition, and Management." Guidance Bulletin.
8. Fleyfil, Kamel Hamza. "Climatic Characteristics in Iraq and Their Spatial Relationship in Cattle Rearing and Productivity." Master's thesis, College of Arts, University of Kufa, 2008, p. 89.
9. Said, Luay Abdul Majeed. "Animal and Poultry Diseases." Arab Knowledge Printing and Publishing House, University of Mosul, 1987, p. 63.
10. Bouquet, M. "Principles of Farm Animal Care." Technical Institutes Foundation, 2nd ed., Technical Institutes Foundation Printing House, Baghdad, 1985, p. 108.
11. Shalash, Muhammad Rafat. "Animal Wealth in Egypt." Arab Book House for Printing and Publishing, 1st ed., Cairo, 1968, p. 49.
12. Abdulhadi, Muhammad Salem. "Animal Wealth in Gaza Governorate (An Economic Geography Study)." Master's thesis, College of Graduate Studies, Islamic University of Gaza, 2013, p. 68.
13. Hassan, Mansour Fares. "Breeder's Guide for Sheep Production and Breeding." Institute of Animal Production Research, Arab Thought Publishing House, 2nd ed., Cairo, 2008, p. 237.
14. Republic of Iraq, Ministry of Planning, Central Statistical Organization, Statistical Yearbook for 2015.
15. "Peste des Petits Ruminants." Article published on the Wikipedia website.
16. Hareman, Jules J. "The Farmers Veterinary Handbook." Prentice-Hall, INC, New York, 1953, p. 153.
17. Mall, Pawan Kumar, et al. "Rank Based Two Stage Semi-Supervised Deep Learning Model for X-Ray Images Classification: AN APPROACH TOWARD TAGGING UNLABELED MEDICAL DATASET." Journal of Scientific & Industrial Research (JSIR) 82.08 (2023): 818-830.
18. Narayan, Vipul, et al. "A Comprehensive Review of Various Approach for Medical Image Segmentation and Disease Prediction.
19. Mall, Pawan Kumar, et al. "A comprehensive review of deep neural networks for medical image processing: Recent developments and future opportunities." Healthcare Analytics (2023): 100216.
20. Narayan, Vipul, et al. "Severity of Lumpy Disease detection based on Deep Learning Technique." 2023 International Conference on Disruptive Technologies (ICDT). IEEE, 2023.
21. Saxena, Aditya, et al. "Comparative Analysis Of AI Regression And Classification Models For Predicting House Damages In Nepal: Proposed Architectures And Techniques." Journal of Pharmaceutical Negative Results (2022): 6203-6215.
22. Kumar, Vaibhav, et al. "A Machine Learning Approach For Predicting Onset And Progression""Towards Early Detection Of Chronic Diseases ""." Journal of Pharmaceutical Negative Results (2022): 6195-6202.
23. Chaturvedi, Pooja, A. K. Daniel, and Vipul Narayan. "A Novel Heuristic for Maximizing Lifetime of Target Coverage in Wireless Sensor Networks." Advanced Wireless Communication and Sensor Networks. Chapman and Hall/CRC 227-242.