Increase in the Incidence of Diseases in Farm Cattle Associated with Climate Change

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Abstract

Factors associated with climate change are compromising essential conditions for life, such as food security and human and animal health. Increased temperatures, humidity and wind speeds favors the spread of pathogens in food, water and air. In addition, vector-borne diseases are having a greater impact, due to the increase in population density, geographic distribution, changes in the bionomics of vectors, the development of greater resilience and the appearance of new variants and the diversification of hosts. Consequently, distribution patterns are changing due to the emergence and reemergence of diseases. For cattle farming, climate change has an impact on critical factors related to production, reproduction and health. Direct effects include damage to health due to heat waves, which generate thermal stress in animals, leading to metabolic disorders, oxidative stress, immune suppression and even death. Indirect effects include the influence of weather conditions on food production and the availability of water, which are essential for breeding, as well as the distribution of pathogens and the spread of vector-borne diseases.

Keywords: Climate change, Cattle, Disease, Incidence, Vectors, Transmission.

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Introduction

Climate change represents the largest environmental problem in the history of humanity. The repeated warnings, formulated since the 1980s, about the risks associated with global warming have been showing its adverse and progressive effects in a sustained manner. This warming, caused by the emission and accumulation of greenhouse gases (GHG) in the atmosphere, by changing the natural balance between the solar radiation received and the infrared radiation emitted, contributes to raising the temperature on the planet. Natural processes such as the carbon cycle, the decomposition of plants, the collision of tectonic plates, the magnetic field, volcanic eruptions, earthquakes or ocean currents, among others, generate GHG (IPCC, 2013; ICOS, 2017).

However, the magnitude of the current problem stems from emissions generated by human activities. The burning of fossil fuels (oil, coal and natural gas) for the development of industrial processes, the generation of electricity and the construction of cities are the main emitters. Likewise, all activities that alter the balance of nature, affecting the stability of ecosystems and causing loss of biodiversity. The most notable are the excessive felling of forests, the change in land use, the loss of wetlands, and mainly, agricultural and livestock activities (Yuan et al., 2023). In the long term, this increase in temperature is progressively altering natural cycles and climate patterns, making evident the consequences of anthropogenic climate change that affect life on the planet (Prasad et al., 2022).

The frequency and severity of meteorological phenomena associated with climate change represent serious risks and consequences. Beyond the direct effects caused in the daily life of populations, by floods, droughts, heat waves or food shortages, one of the most relevant aspects is the impact on human health and animal welfare (UN, 2020).

Impact of Climate Change on Animal Health

In the climate change scenario, the progressive environmental deterioration and the emission of greenhouse gases, as determining factors, are compromising the essential conditions for life; in particular, food security and the health of both humans and animals. The loss of biodiversity associated with the overexploitation of natural resources is increasing the proximity between wild and domestic animals. In addition, it favors the spread of pathogens, promotes the diversification of hosts, the expansion of the geographical distribution of vectors, as well as the development of greater resilience and the appearance of new variants of etiological agents. These conditions are modifying the distribution patterns of diseases and the animal species they affect. Likewise, it is increasingly common to detect that many that had been eradicated are reappearing or the emergence of others, as happened with the SARS-CoV2 β-coronavirus, the most important recent zoonosis (Ogden, 2017; García-Rubio et al., 2023; Hernández-Valdivia et al., 2023).

Collaterally, animal health and welfare face challenges due to the effects of climate change. Changes in temperature, relative humidity and wind speed give way to extreme weather events that affect the incidence rates of vector-borne diseases, contaminated food, water and air. In addition to generating heat waves, rising temperatures are changing storm patterns. Their intensity and frequency affect human and animal populations due to landslides caused by the loss of vegetation cover, flooding and the spread of pathogens that occurs under these conditions. Likewise, some vectors expand their geographic distribution with gusts of wind (López et al., 2018; Parums, 2024).

The role of Vectors

Climate change is playing a fundamental role in the increase and spread of vector-borne diseases (VBDs). Climatic variations, mainly temperature and rainfall, in addition to promoting an increase in the population density of vectors, are changing their bionomics, periods of activity and geographical distribution. Vectors remain active for longer throughout the year, and have managed to move to new altitudes and latitudes across the planet, increasing the spread of VBDs. Mosquitoes, sandflies and ticks represent a serious threat to animal health (Fouque & Reeder, 2019; Touray et al., 2023).

Among the vectors, ticks play an important role in VBDs. Climate change, in addition to modifying their habitats and increasing their abundance, is having effects on their vector competence, increasing their capacities to acquire, maintain and transmit pathogens. Their high survival and reproductive capacity makes them efficient vectors of a wide range of pathogens (bacteria, viruses, protozoa). In addition to the diversity of hosts they can affect, they cause significant damage to health, particularly through horizontal transmission in which the pathogen moves from the tick to an uninfected host. The colonization of new habitats by ticks contributes to the spread of pathogens from wild to domestic species. Rodents, bats and migratory birds play a decisive role in expanding the geographical distribution of these vectors (El-Sayed & Kamel, 2020; Perumalsamy et al., 2024).

Climate Change and the Health of Domestic Cattle

Even though changes in environmental conditions affect all animals, the importance of cattle in food security and human health highlights various interrelations. In principle, the important contributions of cattle breeding in the generation of GHG. At a global level, the supply chain of this livestock activity generates 7.1 GT CO_2, equivalent to 14.5% of global emissions. Cattle farming contributes about 2/3 of this total. It includes the GHG generated by changes in land use for the expansion of breeding areas. The largest contributions (measured in CO_2 equivalents) come from the emission of methane (CH_4) produced during ruminal digestion (37%), nitrous oxide (N_2O) from manure and 64% of ammonia (NH_3) emissions (FAO, 2017; García-Rubio et al., 2022). These gases contribute significantly to global warming and environmental impact. Despite the low atmospheric concentrations of N_2O, its heat retention capacity is 265 times greater than that of CO_2. For its part, NH_3, rather than influencing climate change, produces other environmental impacts such as acid rain due to its high volatility, eutrophication of aquatic ecosystems and acidification of terrestrial ecosystems, damaging biocenoses (Hernández-Tapia et al., 2019).

In contrast, climate change has direct and indirect impacts on critical factors in cattle farming related to production, reproduction and health. They result from changes in environmental temperature and humidity, rainfall and the frequency and intensity of extreme weather events. Direct effects include damage to health due to the rise in temperature and the frequency and magnitude of heat waves. Under these conditions, livestock suffer from thermal stress, which leads to metabolic disorders, oxidative stress, a progressive reduction in the immune response and even death (Grossi et al., 2019; Sánchez et al., 2020).

Among the metabolic disorders, respiratory alkalosis stands out, caused by the increase in the respiratory rate and the rapid loss of CO_2. Acidosis, due to the reduction in food intake during hot hours and an increase in lower temperature hours, is the main cause of laminitis, which generates difficulties in the movement and mobility of animals. The energy imbalance between food consumption and the regulation of body temperature, in addition to weight loss, causes ketosis due to the mobilization of adipose tissue. In addition, heat stress can cause immune suppression, which compromises the animal's well-being by increasing the susceptibility to developing infections, which depending on their severity can cause death. Indirect effects of climate change refer to the influence of meteorological phenomena on the production of fodder and feed and the availability of water used for breeding. Likewise, with the distribution of pathogens and the spread of vector-borne diseases (El-Sayed & Kamel, 2020; Prasad et al., 2022).

Approach to the Incidence of Diseases in Cattle

Recent data on disease incidence allow us to generate an approximation to identify the most affected regions of the world and those that are endemic. Likewise, the emergence of new diseases, the registration of pre-existing diseases in new localities and the re-emergence of previously eradicated diseases. This «approximation» is due to the limitations of the *World Animal Health Information System* (WAHIS) of the *World Organization for Animal Health* (WOAH). The sporadic lack of information from authorized users in member countries, deficiencies in the timely evaluation of the evolution of diseases, or the lack of systematicity and rigor to consistently report on animal health alerts, introduce biases in the information (WAHIS, 2024).

In the case of domestic cattle, the *Terrestrial Animal Health Code* (WOAH, 2024a), in Article 1.3.1, includes 25 diseases common to several species, 20 (80%) affect cattle, 8 with incidences greater than 50%. For its part, Article 1.3.4 includes 13 bovine diseases, identifying other affected domestic species. Table 1 shows the accumulated total for the different affected species, segregating the incidence in cattle, as well as the regions that report the highest and lowest number of cases for the diseases that affect domestic cattle (WAHIS, 2024; WOAH, 2024a).

From 2014 to 2023, the 33 most common diseases affecting cattle reported 16.6 million cases (Mc). Of this total, 6.20Mc correspond to Asia with 26 diseases, Americas 5.54 Mc with 20, Africa 3.3 Mc with 29, Europe 1.52 Mc with 24 and Oceania 0.01 Mc with 10 different diseases. In general, these figures reflect the proportions by region; in particular, the incidences by disease allow us to measure the true impact, by correlating the figures with the severity of the disease. In this case, in Asia only two diseases, foot and mouth disease (1.3 Mc) and nodular dermatosis (4.09 Mc), reach the number of cases reported for the Americas. However, the most serious diseases such as anthrax and haemorrhagic septicaemia have the highest incidence in Africa (14.8 Mc and 77.9 Mc, respectively) and Q fever in Europe with 11.6 Mc. Table 2 integrates the data by region (WAHIS, 2024).

Table 1: Cumulative incidence of diseases affecting cattle and other domestic species (2014-2023)

Disease	Total de cases		Incidence (Region)		Domestic Species Affected											
	Diferent species	Bovine	Major	Minor	Birds	Bovine	Buffaloes	Camelids	Goats	Cervids	Rabbits	Equines	Cats	Sheep	Dogs	Suids
ARTICLE 1.3.1 DISEASES, INFECTIONS AND INFESTATIONS COMMON TO SEVERAL SPECIES																
Anthrax	82,552	26,208	AF-14,891	OC-226		*	*	*	*	*		*	*	*	*	*
Hydrocarditis	97,277	47,324	AF- 47,324			*		*	*					*	*	
Japanese encephalitis	4,446	0										*				*
Equine encephalomyelitis	1,580	0			*							*				
West nilo fever	5,661	0			*			*				*		*	*	
Crimean-congo Hemorrhagic fever	244	38	AF/As=19			*	*	*	*					*		
Q-fever	37,648	12,076	EU-11,606	AF-8		*		*	*	*	*			*	*	*
Hydatidosis	8,342,720	5,525,681	AM-4,404,503	AS-667		*	*	*	*	*		*		*	*	*
Alveolar Equinococcusis	2,459	3	EU-2	AS-1		*				*		*	*	*	*	*
Bovine Tuberculosis	1,728,466	1,633,595	EU-844,873	OC-7,175		*	*	*	*	*				*		*
Aujeszky's disease	73,738	22	AM-22			*									*	*
Epizootic haemorrhagic	3,507	3,507	EU-2520	AF-383		*	*		*	*				*		
Foot and mouth disease	2,803,157	1,984,223	AS-1,300,234	AM-1,344		*	*	*	*	*				*		*
Rift valley fever	20,317	9,126	AF-9126			*	*	*	*					*		
Bluetongue	627,643	63,738	AS-40,913	OC-10		*	*	*	*	*				*		*
Rinderpest	88,818	87,844	AS-31,186	OC-1		*	*		*							
Rage	139,922	41,487	AM-17,799	EU-3504		*	*	*	*	*	*	*	*	*	*	*
Trichinosis	4,596	24	AM-24			*						*			*	*
Trypanosomiasis (*t. Simiae*)	145,181	143,227	AF-142,468	AM-149		*	*	*				*			*	*
Surra (*t. Evansi*)	10,869	1,109	AS-756	AM-79		*	*	*	*			*			*	
Leishmaniasis	17,142	0			*							*	*		*	
Myasis (*Chrysomya bezzania*)	9,725	4,429	AF-3,016	AS-1,413	*	*	*	*	*			*	*	*	*	*
Myasis (*Cochliomyia. hominivorax*)	38,698	25,588	AM-24,718	AF-870	*	*	*	*	*			*	*	*	*	*
Paratuberculosis	50,596	40,197	EU-26,358	OC-16		*	*	*	*	*		*		*	*	
Tularemia	117	17	EU-17			*					*			*	*	
ARTICLE 1.3.4 BOVINE DISEASES AND INFECTIONS																
Anaplasmosis	185,651	175,258	AF-109,593	OC-100		*	*		*			*		*	*	
Babesiosis	325,529	265,115	AF-154,217	EU-1,192	*	*	*	*	*	*		*		*	*	*
Brucellosis (*B.abortus*)	991,571	827,013	AM-422,977	OC-207		*	*	*	*	*		*		*	*	*
Bovine genital campillobacteriosis	921	920	AM-535	OC-1		*	*									
Bovine spongiform encephalopathy	57	57	EU-47	AM-10		*	*									
Nodular dermatosis	4,451,458	4,437,451	AS-4,096,345	EU-20,781		*	*		*					*		
Contagious bovine perineumonia	138,227	135,610	AF-135,600	AS-10		*	*							*		
Bovine viral diarrhea	79,078	76,444	AS-29,061	AF-16		*	*		*							
Enzootic bovine leucosis	346,813	345,393	EU-263,907	AF-1,564		*	*							*		*
Infectious rhinotracheitis	143,196	138,248	EU-91,230	AF-9		*	*		*	*				*		
Haemorrhagic septicaemia	252,817	198,077	AS-120,148	OC-2	*	*	*	*	*			*		*		*
Theileriosis	476,599	362,510	AF-278,931	EU-815	*	*	*	*	*	*		*		*	*	
Trichomonosis	1,366	1,083	AS-524	AM-35		*						*				*

REGIONS: AF=AFRICA; AM=AMERICAS; AS=ASIA; EU=EUROPE; OC=OCEANIA

SOURCE: Prepared by the authors, based on the processing of quantitative data from WAHIS (2024) and (WOAH, 2024a)

Table 2: Incidence of diseases in cattle by region (2014-2023)

Disease	Africa	Americas	Asia	Europe	Oceania	Total
Antrax	14,891	27	8,998	451	226	26,208
Hydrocarditis	47,324					47,324
Crimean-congo hemorrhagic fever	19		19			38
Q-fever	8	64	398	11,606		12,076
Hydatidosis	1,085,835	4,404,503	667	34,676		5,525,681
Alveolar equinococcusis			1	2		3
Bovine tuberculosis	197,520	408,072	175,955	844,873	7,175	1,633,595
Aujeszky's disease		22				22
Epizootic hemorrhagic disease	383		604	2,520		3,507
Foot and mouth disease	681,203	1,344	1,300,234	1,442		1,984,223
Rift valley fever	9,126					9,126
Blue tongue	603	2,100	40,913	20,112	10	63,738
Rinderpest	16	25,624	31,186	31,017	1	87,844
Rage	6,424	17,799	13,760	3,504		41,487
Trichinosis		24				24
Trypanosomiasis (*T. Simiae*)	142,468	149	610			143,227
Surra (*T. Evansi*)	274	79	756			1,109
Myasis (*Chrysomya bezzania*)	3,016		1,413			4,429
Myasis (*Cochliomyia hominivorax*)	870	24,718				25,588
Paratuberculosis	23	2,042	11,758	26,358	16	40,197
Tularemia				17		17
Bovine anaplasmosis	109,593	36,725	24,304	4,536	100	175,258
Bovine babesiosis	154,217	20,228	89,478	1,192		265,115
Brucellosis (*B. Abortus*)	64,415	422,977	204,084	135,330	207	827,013
Bovine genital campillobacteriosis	301	535	6	77	1	920
Bovine spongiform encephalopathy		10		47		57
Nodular dermatosis	320,325		4,096,345	20,781		4,437,451
Contagious bovine perineumonia	135,600		10			135,610
Bovine viral diarrhea	16	20,296	29,061	27,070	1	76,444
Enzootic bovine leucosis	1,564	39,175	40,747	263,907		345,393
Infectious rhinotracheitis	9	35,152	11,857	91,230		138,248
Haemorrhagic septicaemia	77,917	10	120,148	2		198,077
Theileriosis	278,931	82,764		815		362,510
Trichomonosis	408	35	524	116		1,083
Total	3,333,299	5,544,474	6,203,836	1,521,681	7,737	16,612,642

SOURCE: Prepared by the authors, based on the processing of quantitative data from WAHIS (2024) and (WOAH, 2024a)

The incidence of cases included in official reports has varied worldwide over the last 10 years. Figure 1 shows these variations in six of the diseases with the highest incidence (WAHIS, 2024).

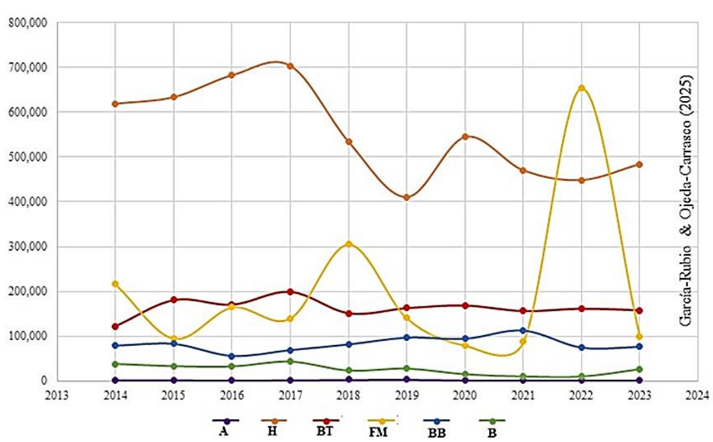

Fig. 1: Annual variations in the incidence of diseases affecting cattle
A: Anthrax; **H**: Hydatidosis; **BT**: Bovine tuberculosis; **FM**: Foot and mouth disease; **BB**: Bovine brucellosis; **B**: Babesiosis. **Source:** Prepared by the authors

Table 3 shows the behavior of some diseases in terms of reported incidences. The numbers in red correspond to the maximum incidences. The period 2014-2018 includes 14 (42.4%) of these maximum incidences and for 2019-2023, 19 (57.6%). Based on the average values prior to the maximum reported incidence, the following stand out: epizootic hemorrhagic disease, $\bar{x}$=129 (2015-2022) reached 2,477 cases in 2023. Foot and mouth disease, x̄=153,758 (2014-2021) registered 653,873 in 2022. Bluetongue, x̄=2,538 (2014-2021) with 40,643 in 2022. Meanwhile, nodular dermatosis, x̄=66,453 (2014-2021) reached 3'219,110 cases in 2022. The averages for the periods 2014-2018 and 2019-2023, increased the incidence of diseases reported in cattle of 6,638,380 to 9,860,210, respectively (WAHIS, 2024).

Table 3: Annual incidence of diseases in domestic cattle

Disease	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Antrax	2,693	2,781	1,954	2,815	3,282	3,922	2,381	2,194	2,302	1,884
Hydrocarditis	3,354	6,003	6,834	4,405	5,867	5,832	1,859	1,887	5,090	6,193
Hydatidosis	618,630	633,503	682,400	703,303	533,117	409,649	544,247	469,357	447,961	483,514
Tuberculosis	122,282	181,199	170,834	199,971	151,315	162,989	168,897	156,310	161,719	158,079
Foot and mouth disease	216,182	95,176	164,897	140,365	305,556	140,522	79,953	87,414	653,873	100,285
Bluetongue	4,497	2,004	5,522	3,658	1,336	612	826	1,848	40,643	2,792
Rage	5,394	4,882	4,526	4,822	5,633	4,567	3,011	3,028	3,021	2,603
Myasis (*c. Hominivorax*)	3,442	4,832	1,817	1,671	4,154	2,681	149	442	1,144	5,256
Paratuberculosis	4,246	4,218	3,782	3,732	3,447	4,745	3,938	5,024	2,985	4,080
Anaplasmosis	20,508	19,001	17,079	23,321	15,044	17,827	9,129	16,525	6,163	30,661
Babesiosis	38,348	33,551	32,872	43,362	23,873	28,277	15,805	11,107	10,905	27,015
Brucellosis (*b.* Abortus)	79,269	83,189	56,055	69,297	82,069	97,460	94,952	113,450	74,760	76,512
Nodular dermatosis	43,242	33,095	69,886	44,755	46,353	37,634	50,134	206,523	3,219,110	686,719
Contagious perineumonía	4,127	11,254	20,754	10,328	7,335	15,703	9,369	20,954	16,754	19,032
Viral diarrhea	6,113	8,112	8,281	6,142	6,451	5,886	7,493	7,473	7,936	12,557
Enzootic leucosis	45,892	45,503	43,261	47,055	35,868	32,897	29,996	26,131	23,691	15,099
Infectious rhinotracheitis	12,516	13,893	16,705	11,926	14,791	13,798	13,685	16,499	12,542	11,893
Haemorrhagic septicaemia	23,246	16,923	13,679	51,504	14,832	14,690	17,250	18,715	22,886	4,352
Theileriosis	21,611	44,338	63,729	51,991	47,948	31,953	20,479	27,938	17,128	35,395

SOURCE: Prepared by the authors, based on the processing of quantitative data from WAHIS (2024) and (WOAH, 2024a)

Variations in disease incidence are multifactorial in nature. In addition to the breeding conditions, physical and immunological state of the animals, exposure to a variety of pathogens and vectors increases the susceptibility to developing diseases. The distribution, incidence and prevalence depend on the interrelations established between pathogens, hosts and the ecological conditions of the ecosystems, determined by climate, temperature, humidity and other factors associated with climate change (Rojas et al., 2021). The impacts on livestock health and production depend on the pathogens involved, the forms of contagion and the climatic conditions of the breeding locations. In cattle, the etiological agents include viruses, bacteria, protozoa and insects (larvae). Vector-borne diseases are of particular relevance. Table 4 compiles information on some diseases in cattle, highlighting the influential climate change events (WOAH, 2024b).

The interaction between pathogen-host and ecological conditions has been a determining factor in the emergence and re-emergence of diseases. Based on the zoosanitary events reported to WOAH from 2005-2024 by countries in different regions, on diseases affecting cattle, 70.7% correspond to the category «Recurrence of an eradicated disease» (Reemerging disease). Of the remaining categories in the information system, 10.2% report the appearance of a new strain in an area, due to the mutation of pathogens as an adaptive measure to climate change. The first appearance of a disease in the country (5.4%), in a new area (4.8%), a new strain in the country (3.4%), translated into the expansion of the distribution of diseases. 2.9% report an unexpected change or increase in cases (increase in incidence), 1.43% the recurrence of an eradicated strain and 1.2% an emerging disease (WAHIS, 2024).

These data reflect, *in part*, the current situation in which in each region of the world there are different vulnerabilities due to the convergence of social, economic and, mainly, environmental factors. Changes in the incidence of diseases are not only due to alterations in the pathogenic balance due to exogenous stress associated with increased temperature. The expansion in the distribution and density of vector populations, changes in the pathogen/vector interaction, the exchange of pathogens between wild and domestic species, among other aspects, have important implications throughout the world (Sánchez et al., 2020).

The analysis only includes cases of cattle, of the 12 domestic species recorded. To dimension the problem, it is necessary to include wild species. Anthrax and rabies are good references to exemplify this situation. From 2014-2023, anthrax reported 82,552 cases in domestic animals (see Table 1). The highest incidence for sheep with 32,361 (39.2%), followed by cattle (31.7%). Wild animals account for 1,851 cases in 40 species. In the case of rabies, of the 139,922 cases in domestic species, 50.8% are associated with dogs and 26.7% with cattle. Wild species record 15,722 and 147 affected species, with the highest incidences for the mongoose and the red fox (WAHIS, 2024).

The small number of wild animals affected contrasts with the number of species, despite the fact that these are incidental records, which do not have the same monitoring as for domestic animals. The implications of the displacement of these wild species, together with their pathogens, towards other habitats due to climate change, tend to increase the risks for domestic animals and humans. The recorded figures offer only an approximation based on official reports. As an example, for wild species, anthrax was recorded in 2016, 194 cases (59.7% in Africa for the black wildebeest). Europe only reports three cases in elk in Sweden (WAHIS, 2024). In that year, news reports reported an outbreak that claimed the lives of reindeer and humans in Siberia (BBC News, 2016). Scientific publications associate this outbreak with the increase in temperature that gradually melted the permafrost, as well as with the decrease in precipitation (10% below the average of the last 30 years). The very dry summer favored the release and activation of the pathogen's spores, 70 years after the last reported incident in the area. The outbreak affected 2,650 reindeer with a high fatality rate (88.7%), also causing the infection and death of some people (Ezhova et al., 2021; Liskova et al., 2021). The data presented outline the complexity of the current problem.

Table 4: Characterization of diseases affecting domestic cattle and climatic determinants

	ETIOLOGICAL AGENT	FORMS OF CONTAGION	CHARACTERIZATIO	ASSOCIATED CLIMATE CHANGE EVENTS	REFERENCE
ANTHRAX	BACTERIA: *Bacillus anthracis*	Fomites Inhalation of spores Contaminated fodder Contaminated natural water sources Mechanical transmission (insect bites, spread by dogs or scavengers)	A serious, hyperacute infectious disease that causes sudden death in cattle. The bacteria forms spores that are highly resistant to severe environmental conditions. It is a zoonosis.	High temperatures Heat waves Heavy rainfall Drought Thawing of permafrost Floods Wind gusts (dispersal of spores)	(Bressuire-Isoard et al., 2018; Alam et al, 2022)
TUBERCULOSIS	BACTERIA: *Mycobacterium bovis*	By direct route (contact with contaminated biological fluids) and indirect route (consumption of contaminated feed, contaminated milk)	Chronic infectious disease, with cattle as primary hosts. Serious global zoonosis. Lesions in the digestive tract are more frequent in temperate climates, which promote the dissemination and survival of the bacteria. Lesions in the respiratory tract are more common in arid climates, due to aerosols.	Temperate climates: Rising temperatures Decreased precipitation Deep storms Dry climates: Heat waves Rising temperatures	(Borham et al., 2022; Byrne et al., 2022)
H. SEPTICAEMIA	BACTERIA: *Pasteurella multocida* (serotypes 6:b and 6:e)	Horizontal transmission (asymptomatic carriers), contact with sick animals	Severe hyperacute infection with high morbidity and mortality rates. Zoonosis. Bovines and water buffalos are the main reservoirs.	Increased rainfall Rising temperatures Sudden changes in weather conditions	(Dabo et al., 2008; CFSPH, 2019)
BRUCELLOSIS	BACTERIA: *Brucella abortus*	Vertical transmission (intrauterine) Horizontal transmission: Contact with infectious discharges (fetuses, placenta, body fluids), contaminated fodder.	Infectious disease specific to cattle, which secondarily affects other animals. The most frequent zoonosis. In cattle, losses are associated with abortions, retained placenta, premature births, weak neonates, mastitis, sterility and infertility.	Survival of bacteria in the environment: Low temperatures and reduced humidity	(Lozano-López et al., 2022; Demissie et al., 2024; Khairullah et al., 2024)
MYASIS	INSECT (Larvae) *Cochliomyia hominivorax*	Infestation by oviposition of the fly in wounds or mucous membranes of body orifices (nasal cavities, eye sockets, mouth, external ear, vagina).	Parasitic disease caused by the larval stage of the fly *C. hominivorax* (screwworm), an obligate tissue parasite. Endemic to the Americas.	High temperatures and environmental humidity reduce the duration of the life cycle, increasing fly populations.	(Rodríguez et al., 2016; WOAH, 2024c)
FOOT AND MOUTH DISEASE	VIRUS: *Aphtovirus* (Picornaviridae)	Contact with sick animals, excretions, contaminated food, fomites, or in the form of aerosols	Highly transmissible infectious disease with high morbidity. Low mortality in adults and high in young animals. It does not affect humans. It causes vesicular lesions in mucous membranes and epithelia. Viral disease of major economic importance.	Low temperatures promote the stability of the virus Increased ambient humidity Increased wind gusts (aerogenic route)	(Ruiz-Sáenz et al., 2009; Belsham et al., 2021)
BLUETONGUE	VIRUS: *Orbivirus* (Reoviridae)	VECTORS (*Culicoides* spp, Insect: Diptera)	Non-contagious viral infectious disease. With high rates of infection in cattle, most with subclinical manifestations. Clinical manifestations end with the death of the animal. It is not a zoonosis. A disease is more widespread through transmission by arthropods.	Changes in precipitation, temperature and humidity increase the density, periods of activity and geographic distribution of vectors.	(Saminathan et al., 2020; De la Torre et al., 2021)
ANAPLASMOSIS	BACTERIA: *Anaplasma marginale*	VECTORS Ticks (mainly): *Rhipicephalus* spp.	Infectious disease, with acute to chronic symptoms. It causes anemia, jaundice and fever.		(Perveen et al., 2021)

	A. centrale	Mechanical transmission: *Tabanus, Stomyx, Culicoides* (Insect: Diptera)		
BABESIOSIS	PROTOZOAN: *Babesia* spp; mainly *B. bigemina* y *B. bovis*	VECTORS (Ticks: *Rhipicephalus* spp, mainly *R. microplus* y *R. annulatus*)	Hematopoietic parasitosis caused by piroplasmatic protozoa, in which cattle are intermediate hosts. *B. bovis* is the most pathogenic species. The most important disease transmitted by arthropods at a global level.	(Morel et al., 2019; MacGregor et al., 2021)
HYDROCARDITIS	RICKETTSIA: *Ehrlichia ruminantius*	VECTORS (Ticks: *Amblyomma* spp)	One of the most common bacterial diseases in Africa. The moderate, subacute and acute forms of the disease affect animal welfare and productivity, the hyperacute form is fatal. Mortality of 60% of affected cattle.	(Gammada & Jara, 2020; WOAH, 2024a)

SOURCE: Prepared by the authors based on the references cited

Conclusions

Due to climate change, countries around the world are facing serious problems due to the increase in the incidence of diseases. The sudden increase in some of these diseases exceeds the capacities of zoosanitary surveillance, prevention and control, generating significant losses, especially in species of importance for global food security. In the case of domestic cattle, the range of diseases that they can develop, accounts for the current magnitude of this problem. From heat waves to infections by pathogens, they are undermining the productive and reproductive competence of animals, with serious effects on livestock production. In addition to the fact that food availability is continually threatened, the increase in zoonotic diseases is even more worrying. Although the search for alternatives to mitigate the effects of climate change and the incidence of diseases has been incessant, unfortunately recent disease outbreaks show that reality is becoming increasingly complex, so it is essential to continue generating knowledge to strengthen control, prevention and care capacities, since the future of humanity depends on it.

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