

Animal Diseases Influenced by Climate Variation in Himachal Pradesh



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Introduction:

In Himachal Pradesh predominantly the rural population is dependent on agriculture based economy for livelihood. Animal husbandry is another important vocation for the people of the state. Almost every family rears livestock for their day to day requirement, for agricultural purposes and for cash income. The state has a cattle population matching that of human population. Rearing of livestock is an integral component of rural economy. In Himachal there is a dynamic relationship between common property resources (CPRs) such as forests, water and grazing land, livestock and crops. Livestock depend to a certain extent on fodder and grass grown on CPRs as well as on crops and residues. At the same time the animals return fodder, grass and crop residues to the CPRs and fields in the form of manure and provide much needed draught power.

Livestock thus is an important integral to the sustainability of economy of Himachal Pradesh. The contribution of major livestock products during the year 2012-13 was 11.39 lakh tonnes of milk, 1,650 tonnes of wool, 107.00 million eggs and 3,997 tonnes of meat which will likely to be of the order of 11.63 lakh tonnes of milk, 1,670 tonnes of wool, 110.00 million eggs and 4,000 tonnes of meat during 2013-14 (Economic Survey Of Himachal Pradesh 2013-14).

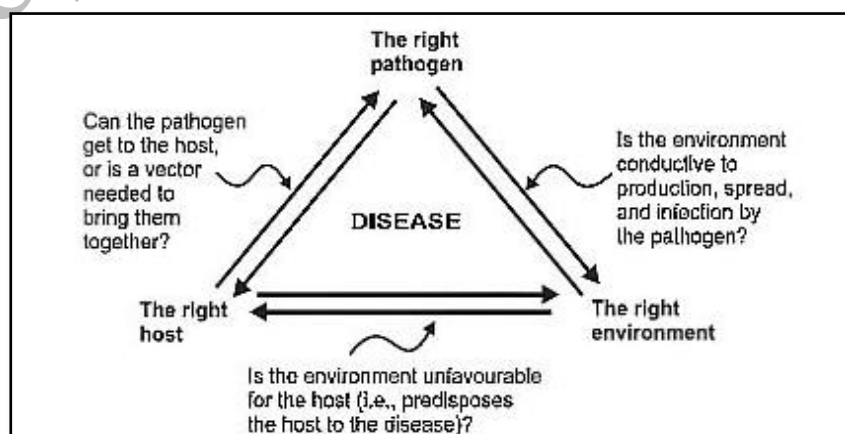
The success of livestock industry depends on the health of the livestock. Good health increases the productivity and any compromise on health ground shatter the hope of livestock sector. It also plays important role in the rural economy of a country as supplementing family incomes and generating gainful employment in the rural sector, particularly among the landless labourers, small and marginal farmers and women (Chaudhary, J. K. *et.al.*2013). The diseases results in loss of economy of the state, thus the knowledge of occurrence and pattern of animal diseases becomes vital in the management, as the main objective of the good management is to reduce the disease incidence and increase the productivities and reproduction.

Diseases, be they of humans, animals, or plants, play important roles in how all life on Earth evolves and develops. They have influenced the social and economic structure and indeed the very existence of past and present civilizations. Many diseases, and the organisms that cause them, are integral components of intricate natural ecosystems, involved in such varied processes as nutrient cycling in forests and the succession of different plant species on a landscape. The issue of climate change and disease has provoked intense debate over the past decade. The results of climate change (for example, an increase in temperature) may affect diseases in many ways; however, the complexity of the links between diseases and the

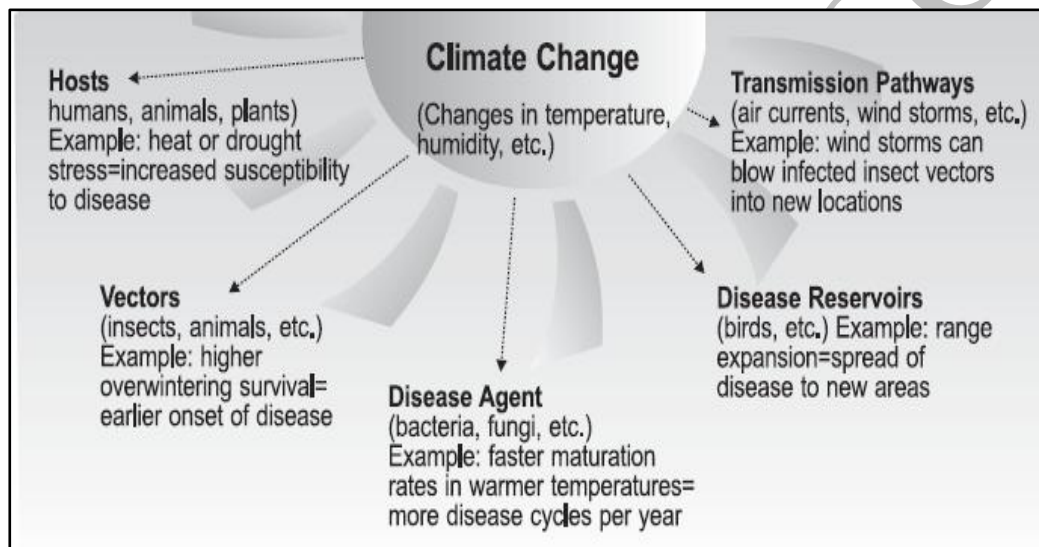
systems in which they exist makes it difficult to predict these changes. Climate (only one of the many determinants of health) interacts in complex and dynamic ways with the biophysical and social environment in shaping individual and population health (Greifenhagen, S. and T.L. Noland, 2003). Climate change is affecting the spread of infectious diseases worldwide, according to an international team of leading disease ecologists, with serious impacts on animals.

Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate change is real, that it will become worse, and that the poorest and most vulnerable people will be the worst affected. The International Fund for Agricultural Development (IFAD) acknowledges climate change as one of the factors affecting rural poverty and as one of the challenges it needs to address. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Agriculture and livestock keeping are amongst the most climate-sensitive economic sectors and rural poor communities are more exposed to the effects of climate change. The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8 and 4.0 °C. With global average temperature increases of only 1.5 – 2.5°C degrees, approximately 20-30 percent of plant and animal species are expected to be at risk of extinction (FAO, 2007). At the organism level, climate change can alter the physiology of both hosts and parasites. Some of the clearest examples are found in the Arctic, where temperatures are rising rapidly, resulting in faster developing parasites. A lungworm that affects muskoxen, for instance, can now be transmitted over a longer period each summer, making it a serious problem for the populations it infects.

The relationships between the disease-causing agents, the organism affected by the disease (termed a host), and the environments in which they function are often depicted as a “disease triangle”



Climate change factors can directly cause disease. These direct links between climate and disease are relatively easy to identify. Probably more important, however, are the complex *indirect* effects of climate change on diseases. These include effects on the organisms that cause disease, on the organisms that carry disease to the host (called *vectors*), on the animals or plants that “store” disease (called *disease reservoirs*), and on the host itself. These multiple effects can be difficult to identify and predict. (Greifenhagen, S. and T.L. Noland, 2003)



Direct Effects of Climate Change:

Diseases that can be directly affected by climate change are those that are associated with chemical and physical factors such as temperature or moisture extremes or air pollution. For example:

- More heat waves may lead to increased illness and death of animals.
- Milder winter temperatures could reduce the risk of hypothermia and hypoglycemia in newborn animals such as lambs.
- Increased ozone and other pollutants will affect respiratory diseases of animals.

Indirect Effects of Climate Change:

Organisms that cause disease include bacteria, fungi, viruses, nematodes, phytoplasmas, and parasitic plants. These disease agents are called *pathogens*. Bacteria and viruses are the main causes of infectious diseases in humans and other animals, whereas fungi cause the majority of plant diseases.

MODES OF DISEASE TRANSMISSION

Transmission mode	Examples	Possible effects of Climate Change
Vector	West Nile virus Lyme diseases	Lengthened transmission season, increased overwinter survival, range expansion, more frequent transmission
Food	Salmonella Mycotoxigenesis in pigs	Increased risk of food contamination, increased replication and survival of pathogens, higher incidence of pathogens in animal reservoirs
Water	E.coli O157:H7 Campylobacter	Increased risk of outbreaks because of extreme precipitation events
Direct	Rabies	Alterations in ranges and population dynamics of animal reservoirs

Diseases in animals are important for the animals that suffer from them and for the people who raise them, eat them, and/or share environmental spaces with them. Many of the bacteria, viruses and parasites that infect animals such as rabies, West Nile virus, *Escherichia coli* O157, and some intestinal parasites of dogs and cats can be transmitted to people. Others such as some fungi or environmental contaminants may show up in both people and animals because we share common environments. Still other agents may have sufficient impact on agricultural animals that then livelihoods of farmers and rural communities suffer, often severely. Whatever, their effects on the animals themselves, animal disease outbreaks may serve as sentinels or early warnings for ecosystem and human problems.

Disease agents are transmitted in a variety of ways. Some diseases, such as rabies, brucellosis and tuberculosis, are transmitted among animals and from animals to people more or less directly. Other agents can be transmitted through insect vectors (Lyme disease, West Nile virus), through water (*E. Coli* O157:H7, *Campylobacter fetus*), through food such as meat (*Trichinella* spp. among animals), or through general environmental contamination (parasitic larvae from dogs and cats, Q fever). Some disease agents, such as fungi and the toxins they produce, live in the environment, from which they affect many species. Most of these diseases are in some way affected by weather patterns and, more generally, by climate. Changing rainfall patterns and milder temperatures affect the survival and amplification of insect vectors (ticks, mosquitoes) and allow diseases previously considered exotic or rare (West Nile, leishmaniasis) to invade and survive in given environment. Many diseases of

young livestock, such as pneumonia and diarrhea, as well as diseases in farmed fish, are more affected by rapid changes in temperature and moisture than by averages. Heavy rainfall or periods of drought followed by heavy rains flush resulting in a greater probability of outbreaks of diseases like toxoplasmosis.

Potential effects of climate change on the health of domestic animals are given below:

Climate Parameter	Potential direct effects	Potential indirect effects
Increased temperature	Morbidity and mortality associated with thermal stress	Alterations in habitat
		Altered phenology/ synchronicity of life cycle events.
		Alterations in incidence and distribution of vector-borne and parasitic diseases
		Alterations in quality/quantity of food supply
Altered amount and pattern of precipitation		Alterations in habitat
		Alterations in water quality
		Increased risk for waterborne diseases with flooding
		Alterations in incidence and distribution of vector-borne and parasitic diseases
Altered patterns of extreme weather events (storms, floods etc.)	• Direct mortality	Alterations in quality/quantity of food supply
		Increased risk of power outages and effects on housed livestock
		Increased risk for waterborne diseases with flooding
		Altered potential for airborne pathogen distribution
Stratospheric ozone depletion and increased ultraviolet radiation	Effects on immune function	Altered airborne vector dispersal patterns
		UV mediated effects on free- living waterborne parasite stages.

With the exception of catastrophic events such as ice storms and floods, most of the effects of climate on animal diseases are mediated through complex social and ecological interactions and feedback loops. Climate trends will change, but will be manifested in a variety of local weather patterns, which will have differing effects depending on local social

and ecological conditions (urbanization, agriculture, landscape structures). The specific diseases we are concerned will vary over time. Responses to possible threats will therefore need to take an adaptive approach and will require involvement from the general public; a diversity of government departments at local, provincial and national levels; and a wide variety of scientific scholarly disciplines.

The climate change poses formidable challenge to the development of livestock sector in India. The anticipated rise in temperature together with increased precipitation resulting from climate change is likely to aggravate the heat stress in dairy animals, adversely affecting their productivity and reproductive performance, and hence reducing the total area where high yielding dairy cattle can be economically reared. The predicted negative impact of climate change on Indian agriculture would also adversely affect livestock production by aggravating the feed and fodder shortage.

Climate affects animal production in four ways: (a) the impact of changes in livestock feed-grain availability and price; (b) impacts on livestock pastures and forage crop production and quality; (c) changes in the distribution of livestock diseases and pests; and (d) the direct effects of weather and extreme events on animal health, growth and reproduction. Alterations of temperature and precipitation regimes may result in a spread of disease and parasites into new regions or produce an increase in the incidence of disease, which, in turn, would reduce animal productivity and possibly increase animal mortality. Climate exerts both direct and indirect effects on the appearance and spread of human and animal infectious diseases. The impact of climate change on the transmission and geographical distribution of vector-borne diseases, including zoonoses (infections transmissible between vertebrate animals and humans), has been associated with changes in the replication rate and dissemination of pathogen, vector and animal host populations, which are sensitive to changing temperature and rainfall. Climate change is also increasing the threat of infections, such as bluetongue virus (BTV), in domesticated animals.

Influence of climate variation on diseases occurrence:

Temperature sensitivity

Extreme temperatures often are lethal to the survival of disease-causing pathogens but incremental changes in temperature may exert varying effects. Where a vector lives in an environment where the mean temperature approaches the limit of physiological tolerance for the pathogen, a small increase in temperature may be lethal to the pathogen. Alternatively, where a vector lives in an environment of low mean temperature, a small increase in temperature may result in increased development, incubation and replication of the pathogen.

Temperature may modify the growth of disease carrying vectors by altering their biting rates, as well as affect vector population dynamics and alter the rate at which they come into contact with humans. Finally, a shift in temperature regime can alter the length of the transmission season. Disease carrying vectors may adapt to changes in temperature by changing geographical distribution. Another possibility is that vectors undergo an evolutionary response to adapt to increasing temperatures.

Precipitation sensitivity

Variability in precipitation may have direct consequences on infectious disease outbreaks. Increased precipitation may increase the presence of disease vectors by expanding the size of existent larval habitat and creating new breeding grounds. In addition, increased precipitation may support a growth in food supplies which in turn support a greater population of vertebrate reservoirs. Unseasonable heavy rainfalls may cause flooding and decrease vector populations by eliminating larval habitats and creating unsuitable environments for vertebrate reservoirs. Alternatively, flooding may force insect or rodent vectors to seek refuge in houses and increase the likelihood of vector-human contact. Unseasonable drought can cause rivers to slow, creating more stagnant pools that are ideal vector breeding habitats.

In Himachal Pradesh there are number of diseases occurred past ten years. Among these diseases there are some diseases which are worsened by climate change. These are influenza, cholera, babesiosis, verminous pneumonia, tuberculosis, rabies, bronchopneumonia etc.

In Himachal Pradesh animal treated during the year 2011-12 were given below

District	Animal Treated
Bilaspur	197
Chamba	386
Hamirpur	162
Kangra	477
Kinnaur	51
Kullu	166
Lahaul & Spiti	79
Mandi	341
Shimla	327
Sirmaur	281
Solan	221
Una	172
Total treated	2860

(Directorate of Animal Husbandry, H.P)

Diseases occurred in Himachal Pradesh during the year 2003-2012

(According to latest Disease surveillance report Himachal Pradesh)

1. FOOT AND MOUTH DISEASE (FMD)

Causative agent: *Aphthovirus*.

Symptoms/lesions: Rise of temperature, particularly marked in young animals. Vesicles on the tongue, lips, cheeks, gums dental pad and on the skin of inter-digital space, bulbs of heel, coronary band, teats and udder. Stingy salivation with difficulty in chewing and lameness. In pig, sheep and goat, the salivation may be absent. Pregnant animals may abort.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	114	7478	206
2004-05	5	126	2
2005-06	12	350	17
2006-07	2	50	0
2009-10	1	8	NIL
2010-11	1	10	NIL
2011-12	3	116	4

2. HAEMORRHAGIC SEPTICAEMIA (HS)

Causative agent: *Pasteurella multocida*

Symptoms/lesions: High fever (105°-110°F), difficult respiration, oedema of the throat region, loss of appetite, coughing, sudden death may occur.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	2	3	-
2004-05	6	170	109
2005-06	7	86	48
2007-08	1	14	14
2008-09	2	6	3
2009-10	2	3	2
2011-12	2	10	3

3. PESTE DES PETITS RUMINANTS (PPR)

Causative agent: *Morbillivirus*

Symptoms/lesions: Emaciation, conjunctivitis, erosive stomatitis involving the inside of the lower lips and adjacent gum near the commissures and the free portion of the tongue. Lesions on the hard palate, pharynx and upper third of the oesophagus in severe cases.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	102	11018	967
2004-05	13	2885	875
2005-06	5	131	54
2006-07	10	3291	509
2007-08	7	4280	777
2010-11	4	968	167
2011-12	7	1461	738

4. PNEUMONIC PASTEURELLOSIS

Causative agent: *Pasteurella haemolytica*

Symptoms/lesions: Elevated temperature, anorexia, severe prostration, and accelerated pulse and respiratory rates

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	5	385	83
2005-06	2	92	82
2008-09	2	29	8
2009-10	1	25	10
2010-11	2	26	11
2011-12	1	10	1

5. COLISEPTICEMIA

Causative agent: *Escherichia coli*

Symptoms/lesions: Respiratory signs, coughing, sneezing, reduced appetite and poor growth

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	2	117	57
2007-08	1	20	8
2009-10	1	10	10
2010-11	1	150	57
2011-12	1	10	3

6. VERMINOUS PNEUMONIA

Causative agent: *Dictyocaulus viviparus*

Symptoms/lesions: Cough, which becomes more and more frequent. Breathing is faster and more forceful. Often a loud grunt follows each breath. The sick animal may stand away from the herd with head lowered and extended.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2007-08	1	250	50
2008-09	2	66	17
2009-10	2	387	55
2010-11	2	275	60
2011-12	3	169	55

7. SHEEP POX

Causative agent: *Capripox spp.*

Symptoms/lesions: Rise in temperature, swelling of eyelids, pustules that gradually develop into scabs on the skin of entire body, excessive salivation.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	1	430	236
2009-10	1	449	222
2010-11	1	166	13
2011-12	3	143	17

8. COCCIDIOSIS

Causative agent: *Eimeria* spp.

Symptoms/lesions: Blood stained diarrhoea, anaemia and weakness. Death may also occur in untreated cases.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	20	5
2005-06	2	74	10
2011-12	3	30	9

9. CONTAGIOUS CAPRINE PLEUROPNEUMONIA (CCPP)

Causative agent: *Mycoplasma capricolum* subsp. *capripneumoniae*

Symptoms/lesions: Weakness, copious nasal discharge, loss of appetite, cough, respiratory signs, and abortion may occur.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	2	1502	88
2006-07	1	45	19
2010-11	1	120	35

10. OMPHALITIS

Causative agent: *Staphylococcus*, *Streptococcus*, *Proteus* spp

Symptoms/lesions: little interest in food or drink. Abdominal muscles may be bluish and there may be putrid yolk material present, diarrhoea and death may occur.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2007-08	1	20	6
2008-09	8	471	151
2011-12	1	200	200

11. RABIES

Causative agent: *Lyssavirus*

Symptoms/lesions: Affected animal become restless, excited and aggressive, there is grinding of teeth, increased salivation and choking. Paralysis of hind quarter followed by death.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	2	16	6
2005-06	2	11	1
2010-11	1	4	4

12. BRONCHOPNEUMONIA

Causative agent: *Dictyocaulus filaria*, *Muellerius capillaris*, or *Protostrongylus rufescens*

Symptoms/lesions: Fever, high pulse and respiratory rates, bronchial breathing, cough with purulent bloody sputum, severe chest pain and abdominal distension.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2010-11	3	83	17
2011-12	1	50	40

13. ANAPLASMOSIS

Causative agent: *Anaplasma marginale*

Symptoms/lesions: Rise in temp., dyspnoea, increased pulse & respiration rate, suspended rumination, anaemia, constipation followed by diarrhoea, mucous membranes become pale, pregnant animal may abort, and animal may die.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	2	3	-
2005-06	1	1	1

14. BABESIOSIS

Causative agent: *Babesia bigemina*

Symptoms/lesions: Fever, coffee coloured urine, anaemia, jaundice.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	7	8	1
2005-06	1	4	-

15. BLACK QUATER (BQ):

Causative agent: Clostridium chauvoei

Symptoms/lesions: High fever (104°-105°), stiff gait, lameness of fore or hind legs, crepitating swellings over the shoulder, back and other places. Sudden death may occur.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	1	17	17
2004-05	1	1	-

16. COLLIBACILOSIS

Causative agent: Escherichia coli

Symptoms/lesions: Fever, diarrhoea or dysentery, loss of appetite, dry skin coat, sunken eyeballs and temperature becomes subnormal.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	1	90	38
2010-11	3	43	29

17. CONTAGIOUS ECTHYMA

Causative agent: Parapoxvirus

Symptoms/lesions: Erythema which develops into scabs on lips, muzzle & nose. Restricted suckling & grazing. Sometimes gastroenteritis and broncho-pneumonia.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	1	30	30
2009-10	1	25	3

18. ENTEROTOXEMIA

Causative agent: *Clostridium perfringens*

Symptoms/lesions: Sudden death. Otherwise excitement, excessive salivation, champing of jaws, frothing, head pushing, convulsion, glycosuria at terminal stage (Hyperglycaemia). Soft pulpy kidney after 3-4 hours of death.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2009-10	1	2	1
2010-11	1	27	27

19. GLANDERS

Causative agent: *Burkholderia mallei*

Symptoms/lesions: Acute-high temperature, coughing, nasal discharge, ulceration of nasal mucosa. Chronic cough, epistaxis, laboured, respiration, nodules on nasal septum and turbinate produce serous to mucopurulent discharge, enlargement of submaxillary lymph node, s/c nodules discharge honey like pus.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2007-08	1	11	2
2010-11	1	4	4

20. NECROTIC ENTERITIS

Causative agent: *Clostridium perfringens*

Symptoms/lesions: Birds may become acutely depressed and die within hours.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2010-11	1	5	5
2011-12	1	1	1

21. TOXOSCARIASIS

Causative agent: *Toxocara canis*

Symptoms/lesions: Constipation or diarrhoea. Diarrhoea may be bloody or purulent. Cramping abdominal pain may be predominant feature.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	1	-
2005-06	1	2	-

22. DICROCOELIASIS

Causative agent: *Dicrocoelium dendriticum*

Symptoms/lesions: Biliary colic and general digestive disturbances, including bloating and diarrhoea

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	2	92	-
2011-12	1	10	3

23. HYDATIDOSIS

Causative agent: *Echinococcus granulosus*

Symptoms/lesions: Stomach upset, diarrhoea, unexplained weight loss, swollen abdomen, anaemia, weakness and fatigue.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2009-10	1	40	36
2011-12	1	10	1

24. VISCERAL GOUT

Causative agent: High levels of uric acid in the blood

Symptoms/lesions: Pain, tenderness, redness, warmth, and swelling of the joint

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2007-08	1	25	15
2008-09	3	39	7

25. INFECTIOUS SINUSITIS

Causative agent: *Mycoplasma gallisepticum*

Symptoms/lesions: Affected birds become droopy, feed consumption decreases and there is a rapid loss of body weight.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2010-11	1	10	1
2011-12	1	5	1

26. CONTAGIOUS AGALACTIA

Causative agent: *Mycoplasma agalactiae*

Symptoms/lesions: Transient fever, anorexia, depression. Udder gradually atrophies and milk yield decreases. Abortion in pregnant animal. Swelling in joints, pain, arthritis & lameness.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	1	10	-
2004-05	3	70	-

27. ACUTE FIBRINOUS PNEUMONIA

Causative agent: *Streptococcus pneumoniae*

Symptoms/lesions: High fever, chills, pain in the chest, difficulty in breathing, cough, and sputum that is pinkish at first and becomes rust-coloured as the infection progresses. The skin may turn bluish because the lungs are not sufficiently oxygenating the blood.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2003-04	5	2550	239

28. FOWL TYPHOID

Causative agent: *Salmonella gallinarum*

Symptoms/lesions: Fever, loss of appetite, increased thirst, and usually a yellowish-orange diarrhoea. Paleness of the head and shrivelling of the comb are usual.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	25	5

29. LYMPHOID LEUKOSIS

Causative agent: Alpharetrovirus spp.

Symptoms/lesions: Reduced feed intake, weakness, diarrhoea, dehydration, weight loss, depression and reduced egg production. Palpation often reveals an enlarged bursa of Fabricius and sometimes an enlarged liver.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	15	5

30. PARATUBERCULOSIS

Causative agent: Mycobacterium paratuberculosis

Symptoms/lesions: Diarrhoea of long duration, not responding to any treatment, loss of body weight, emaciation etc.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	1	-

31. THEILERIOSIS

Causative agent: Theileria annulata

Symptoms/lesions: High fever, enlargement of the superficial lymph glands, difficult respiration, jaundice and anaemia.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2004-05	1	1	-

32. BROODER'S PNEUMONIA

Causative agent: *Aspergillus fumigatus*

Symptoms/lesions: Dyspnoea, diarrhoea, listlessness, pyrexia, loss of appetite and loss of condition. Seizures and torticollis may occasionally occur if infection disseminates to the brain.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	1	130	50

33. FOOT ROT

Causative agent: *Fusobacterium necrophorum*

Symptoms/lesions: Swelling and lameness in one or more feet.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	2	1307	0

34. PULLORUM

Causative agent: *Salmonella pullorum*

Symptoms/lesions: Anorexia, diarrhoea, dehydration, weakness and high mortality

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2005-06	1	2	2

35. GASTROINTESTINAL NEMATODIASIS

Causative agent: *Ostertagia ostertagi*

Symptoms/lesions: Anaemia, weakness, loss of body weight, decreased meat and milk production, diarrhoea, hypoproteinaemia and finally death.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2006-07	1	30	5

36. LUNG WORM INFECTION

Causative agent: *Dictyocaulus* spp.

Symptoms/lesions: Coughing, wheezing and weight loss. These symptoms are caused by larvae that reside in the lungs where immunity develops and the accumulation of mucus cause blockage of the airway into the lungs.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2006-07	3	860	31

37. PARASITIC HEPATITIS

Causative agent: *Hepevirus* spp.

Symptoms/lesions: Fever, jaundice, and diarrhoea.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2006-07	1	33	5

38. AFLATOXICOSIS

Causative agent: *Aspergillus flavus* and *A. parasiticus*.

Symptoms/lesions: Depression, jaundice, lethargy and death occur in acute cases.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2007-08	1	25	15

39. AEROMONAS SEPTICEMIA

Causative agent: *Aeromonas hydrophila*

Symptoms/lesions: Acute septicemia, with lethargy and convulsions, associated with lung and epicardial haemorrhages and hemorrhagic enteritis, severe pneumonia, sometimes highly contagious within colonies of animals, with high mortality. Ulcerative stomatitis, with presence of foamy exudate in the mouth and impairment of food ingestion.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	1	150	70

40. CRYPTOSPORIDIOSIS

Causative agent: *Cryptosporidium parvum*

Symptoms/lesions: Watery diarrhea, vomiting, stomach cramps, loss of appetite, weight loss and slight fever.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	1	110	24

41. EQUINE INFLUENZA

Causative agent: *Orthomyxovirus*

Symptoms/lesions: High temperature of 39-41° C (103-106° F), lasting for one to five days, dry, harsh-sounding cough that may linger for several weeks. Clear nasal discharge that may turn green or yellow as secondary infections developed. Swollen lymph nodes under the jaw, clear eye discharge, depression, lethargy, and loss of appetite. There may be swelling in the lower limbs and a horse may be stiff and reluctant to move.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	2	21	-

42. STRANGLES

Causative agent: *Streptococcus equi*

Symptoms/lesions: Fever, heavy nasal discharge, and swollen or enlarged lymph nodes in the neck and throatlatch. Affected animals may also stop eating and have a dull aspect.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2008-09	1	1	-

43. INFLAMMATORY BOWEL DISEASE (IBD)

Causative agent: *Mycobacterium* spp.

Symptoms/lesions: Vomiting, weight loss, diarrhoea, lethargy and variable appetite.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2009-10	1	20	6

44. PULMONARY HYPERTENSION SYNDROME

Causative agent: *Enterococcus faecalis*

Symptoms/lesions: Drowsy, cough, short of breath, and can faint. Gums become bluish.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2010-11	1	10	4

45. HOG CHOLERA

Causative agent: *Pestivirus spp.*

Symptoms/lesions: Young pigs are more susceptible. The disease starts with sudden death of an animal followed by illness of other pigs. There is high rise of temperature (105°-107°F), dullness, weakness in hind quarters, constipation followed by diarrhoea. Red patches appear on the skin of the abdomen, ears and mouth. There may be coughing.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2010-11	1	2	2

46. ALVEOLAR EMPHYSEMA & ATELECTASIS

Causative agent: Blockage of one of the tubes (bronchi) that branch off from the trachea (windpipe) and lead to the lung tissue. The blockage may be caused by something inside the bronchus, such as a plug of mucus, a tumour, or an inhaled foreign object.

Symptoms/lesions: Shortness of breath. The heart rate and breathing rate may increase and chest pain.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2011-12	1	10	1

47. MANGE

Causative agent: *Sarcoptes scabiei*, *Psoroptes ovis*, *Demodex canis*

Symptoms/lesions: Severe itching, falling of hair, scabs and crusts on affected skin, occasionally pustules.

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2011-12	1	2	2

48. HYDROPERICARDIUM ASCITES SYNDROME

Causative agent: *Aviadenovirus*

Symptoms/lesions: The livers of affected birds show necrotic foci and basophilic intranuclear inclusion bodies in the hepatocytes. The disease can be diagnosed from its gross and microscopic changes in the liver

	NUMBER OF OUTBREAKS	AFFECTED	DIED
2011-12	1	1	1

Diseases worsened by climatic variations:

Among all these diseases the few ones are worsened by climate variations. These are as follows:

Diseases	Reference
Influenza	Black, P. and Nunn, M. 2009; Chan, P.K. 2002. ; Geraci, J.R. <i>et.al.</i> 1982; Halvorson, D.A. <i>et.al.</i> 1985; Karasin, A.I. <i>et.al.</i> 2000a ; Karasin, A.I., . <i>et.al.</i> 2000b; Webster, R.G. <i>et.al.</i> 1981; Van Campen, H. and Early, G. 2001.
Cholera	Lippe,K. <i>et.al.</i> 2002; Colwell, R.R. 1996; Shah, S. 2011.
Babesiosis	Thornton, P. and Cramer, L. 2012.
Verminous pneumonia	Radostits, O.M, <i>et.al.</i> 2000
Tuberculosis	Black, P. and Nunn, M. 2009; Acha, P.N. and Szyfres, B. 2001; Clifton-Hadley, R.S., <i>et.al.</i> 2001; Radostits, O.M., <i>et.al.</i> 2000.
Rabies	Black, P. and Nunn, M. 2009; MacInnes, C.D. <i>et.al.</i> 2001; Mitchell, M.A <i>et.al.</i> 1999; Christensen, L.S.

	<i>et.al.</i> 1993; Rupprecht, C.E <i>et.al.</i> 2001.
Foot and mouth disease	FAO corporate document repository; Ramarao 1988; Morgan <i>et al</i> 2007; Van den Bossche,P. 2008.
Haemorrhagic disease	Zang, Y. <i>et.al.</i> 2008; Patz, J. A. and Reisen, W.K. 2001; Kovats, R.S. <i>et.al.</i> 2001; Reiter, P. 2001.
Tick-borne diseases	Sutherst 1995; Ralph 1987; Singh <i>et al.</i> 2000; Basu and Bandhyopadhyay 2004; Kumar <i>et al.</i> 2004
Parasitic diseases (excluding tick-borne)	Black, P. and Nunn, M. 2009.
Pneumonia Pasteurellosis	Black, P. and Nunn, M. 2009; Morgan <i>et al</i> 2007; Van den Bossche,P. 2008.
Blackleg	Black, P. and Nunn, M.,2009.; Van den Bossche, P. 2008
Contagious pleuropneumonia	Morgan <i>et al</i> 2007

As global temperatures increase, the effects will be quite complex and vary from region to region. Though the extent of these effects is uncertain, it is known that those communities and regions with the least resources, such as rural agricultural areas, will be the most vulnerable to climate variation.

Warmer and wetter weather (particularly warmer winters) will increase the risk and occurrence of animal diseases, as certain species who serve as disease vectors, such as biting flies and ticks, are more likely to survive year-round. Certain existing parasitic diseases may also become more prevalent, or their geographical range may spread, if rainfall increases. This may contribute to an increase in disease spread, including zoonotic diseases. Transportation of animals for personal, entertainment, or agricultural purposes also increases the possibility for the introduction and subsequent presence of diseases and pests, including ticks and parasites, previously considered exotic. The viral infection Bluetongue Disease, for example, was once only a threat in Africa, now affects cattle and sheep in the whole of Europe.

Any changes in rainfall and temperature patterns could, therefore, affect the occurrence of these diseases. Climate variability affects the population dynamics of wild animals, and these dynamics affect the transmission of diseases. Keeping track of the changing global disease situation is very important, as climate change increases the risk of zoonoses by expanding the host, reservoir, and vector base. Public health infrastructure for disease surveillance, food and water safety, control of vectors and disease reservoirs, and public health outbreak response needs to be strengthened. The provision of safe food and

water and the control of zoonoses and associated outbreaks are important challenges to be faced. Multinational and collaborative scientific efforts to minimise the effects of climate variation on zoonotic diseases must be given renewed impetus if the spread of these diseases is to be controlled.

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