

# Analysis of Cattle Diseases from Hazard Perspective

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## Abstract

*This paper presents the analysis of specific cattle diseases, infections and infestations for 244 countries between 2007 and 2017. The author proposed five indicators to analyse the cattle diseases, i.e. the animals' disease impact indicator (ADII), the prophylaxis indicator (PI), the animal-to-animal transmission indicator (AATI), the animal-to-human transmission indicator (AHTI), and the morbidity and mortality indicator (MMI). The ADII is computed based on other three indicators: the total animals dead (TAD), the total animals slaughtered (TAS), and the total animals destroyed (TADT). Due to the homogeneity of the indicators, an algorithm was elaborated to ensure the objectivity of the analysis. It was developed a classification of specific cattle diseases, infections and infestations according to the hazard for human health.*

**Keywords:** *cattle; diseases; infections; infestations; hazard; indicators; algorithm*

**JEL Classification:** *C29; D18; I29*

## Introduction

Cattle have an important role in the world mythology and culture. In Ancient Greece, the cattle symbolized “the strength and service of the man to the community” and in the Ancient Greek mythology, Zeus transformed into a white bull to seduce and abduct Europa (McInerney, 2010, p.121). In Hindu religion, all life forms are considered sacred, but the cow (named divine cow or Kamadhenu) is the most sacred of all, symbolizing the wealth, even if before Vedic period the cattle were slaughtered for food as the archaeological discoveries stated (Agoramoorthy and Hsu, 2012; Jha, 2009; McCormick, 2012).

The main cattle genotypes are *Bos indicus* and *Bos taurus*. There are differences between the two genotypes with respect to the behaviour in the milking process, to the temperament (cattle' reaction to fearful stimulus), to the grazing time, to the calf's suckling, to the time needed to reach puberty, etc. (Phillips, 2002).

It is thought that the humans start to raise cattle approximately 7500 years ago (Hiemstra *et al.*, 2010) and since then the cattle are used for provision of traction, food and skin. Nowadays, the importance of the cattle' traction capacity has decreased significantly due to development of transport and mechanization of agriculture. The main uses of cattle are: (i) the food industry where the meat and the milk are use in raw state or they are ingredients in different food products; (ii) the footwear and clothing industry by processing the skin.

The importance of cattle in the global economy is determined also by the fact that cattle are being traded in the commodity exchanges such as Chicago Mercantile Exchange and Australian Securities Exchange (Matei *et al.*, 2008).

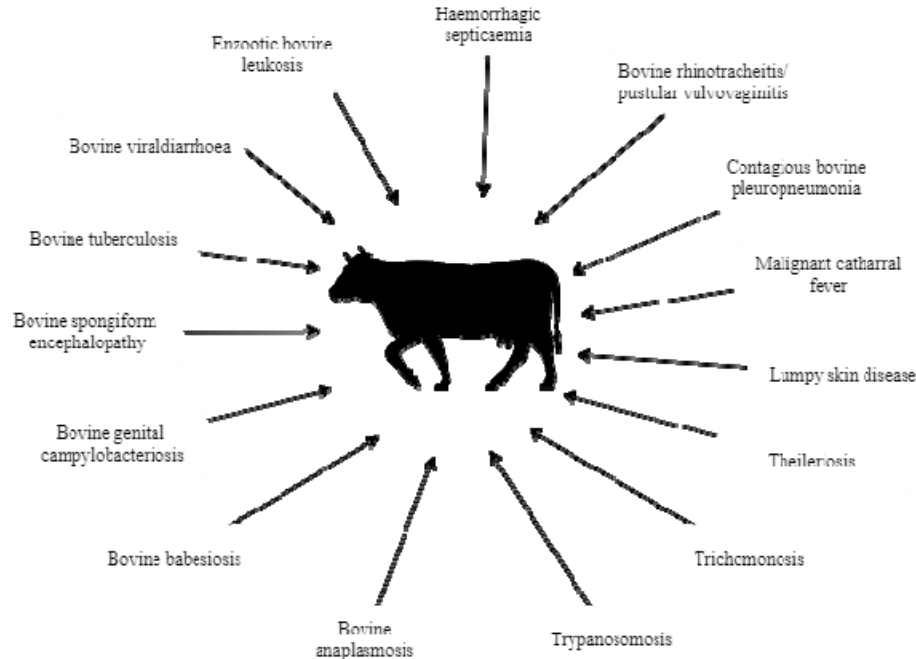
Animal farms affect agri-environmental indicators, contributing to different types of pollution, therefore choosing green and more sustainable farming practices could improve the food supplies quality and in the same time minimize the environmental impact (Ene *et al.*, 2017).

In 2017, the world population of cattle was 1,491,687,240 head (FAOSTAT, 2018) with an increase of +0.18% against 2016 and a rise of +1.6% against 2015. Regarding the world beef and veal meat consumption, it reached 69,107,910 tons in 2017 (OECD, 2018) with +1.62% more than the consumption in 2016 and with +3.42% more than the level in 2015. Because the consumption growth rate is higher than the cattle population growth, it can generate a pressure on farmers to increase the cattle production. Therefore, the cattle diseases, infections and infestations should not be neglected.

Tackling food safety issues and disease prevention should be a priority for all actors involved (Ene, 2013, p. 104), and management tools including tracking food or ingredients along the food chain can facilitate control and surveillance in this area.

### Analysis of the Cattle Diseases, Infections and Infestations

According to World Organization for Animal Health (OIE), the animal diseases, infections and infestations are grouped into categories using the type of animal as criterion (OIE, 2018a). Each animal has its specific diseases, infections and infestations but is susceptible to be diseased with other viruses, infections and infestations which are connected with multiple species. Thus, Figure 1 shows the specific cattle diseases, infections and infestations.



**Fig. 1.** The diseases, infections and infestations specific to cattle

Source: Made by author based on the OIE, 2018a; OIE, 2018d; Pixabay. 2018

The analysis of specific cattle diseases infections and infestations is based on the following 5 indicators proposed by the author:

- The animals' disease impact indicator (ADII);
- The prophylaxis indicator (PI);
- The animal-to-animal transmission indicator (AATI);
- The animal-to-human transmission indicator (AHTI);
- The morbidity and mortality indicator (MMI).

The ADII is developed by the author based on of the following 3 indicators of animals' disease:

- The total animals dead (TAD);
- The total animals slaughtered (TAS);
- The total animals destroyed (TADT).

The ADII is computed as a weighted average with formula (1). The weight was set considering that the TAD is more important (40% weight) than TAS and TADT (with 30% weight each).

$$ADII = TAD \cdot 0.4 + TAS \cdot 0.3 + TADT \cdot 0.3 \quad (1)$$

Each value of TAD, TAS and TADT is obtained by summing data of 244 countries between January 2007 and December 2017 (Table 1).

**Table 1.** The TAD, TAS, TADT, and ADII of specific cattle diseases for 244 countries between 2007 and 2017

Diseases, infections and infestations which are specific to cattle	TAD	TAS	TADT	ADII	Rank
Bovine anaplasmosis	0	781	1	234.6	5
Bovine babesiosis	13	441	2	184.9	6
Bovine genital campylobacteriosis	0	2	0	0.6	11
Bovine spongiform encephalopathy	3	6	164	63.0	8
Bovine tuberculosis	3	158	2	60.0	9
Bovine viral diarrhoea	n/a	n/a	n/a	n/a	-
Contagious bovine pleuropneumonia	491	579	1147	2,481.8	3
Enzootic bovine leukosis	1	4	4	6.4	10
Haemorrhagic septicaemia	134722	626	0	539,075.8	1
Infectious bovine rhinotracheitis/ infectious pustular vulvovaginitis	0	37	268	91.5	7
Lumpy skin disease	3312	2331	24356	21,254.1	2
Malignant catharral fever	n/a	n/a	n/a	n/a	-
Theileriosis	n/a	n/a	n/a	n/a	-
Trichomonosis	n/a	n/a	n/a	n/a	-
Trypanosomiase	142	0	1	568.3	4

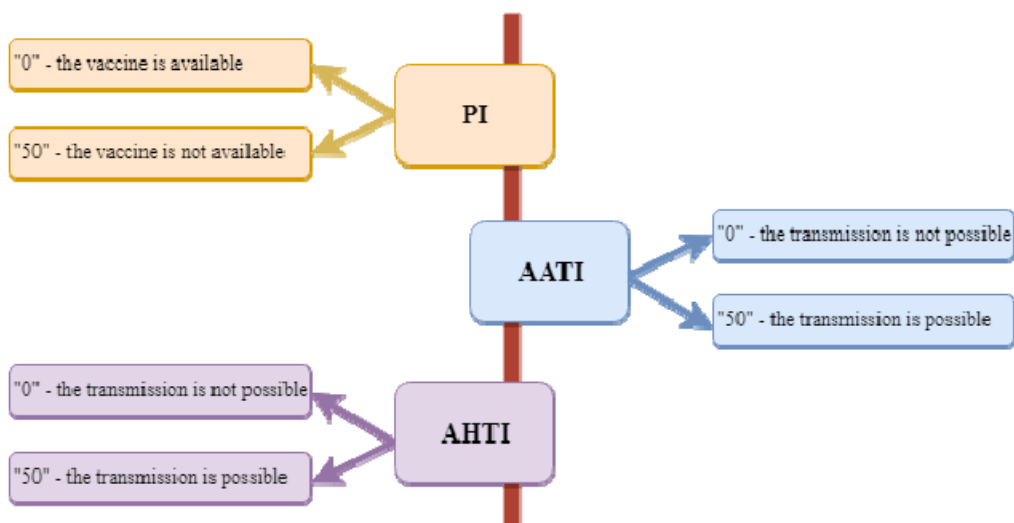
Source: Made by author based on the OIE, 2018b

Data in Table 1 emphasize that the highest values of ADII are for the haemorrhagic septicaemia (ADII = 539075.8), the lumpy skin disease (ADII = 21254.1), and the contagious bovine pleuropneumonia (ADII = 2481.8), being the most dangerous diseases according to AIIC criterion. Contrariwise, the bovine genital campylobacteriosis (ADII = 0.6), the enzootic bovine leukosis (ADII = 6.4), and the bovine tuberculosis (AIIC = 60) are less dangerous.

In the case of the bovine viral diarrhoea, the theileriosis, the trichomonosis, and the malignant catharral fever there were not data available in the World Animal Health Information Database and the rank cannot be assigned.

The prophylaxis indicator, the animal-to-animal transmission indicator, and the animal-to-human transmission indicator are dichotomic. The prophylaxis indicator refers to the availability or unavailability of a vaccine which can improve the animal health for limited or full recovery. The animal-to-animal transmission indicator and the animal-to-human transmission indicator state that the disease, infection or infestation can spread between animal and it can transcend or not the animal-human boundary. The morbidity and mortality indicator describe the number of death human at 100,000 population.

The values of PI, AATI, and AHTI, and their meaning are described in Figure 2. Thus, zero indicates that it is a vaccine available and it is not an animal-to-animal or animal-to-human transmission for the corresponding disease, infection or infestation. The number “50” specifies that the vaccine is not available, and it is an animal-to-animal or animal-to-human transmission for the corresponding disease, infection or infestation. The number “50” was chosen in correlation with the highest value of MMI in table 2 (i.e. 52.9) in order to ensure a homogeneity among the values of the PI, AATI, AHTI, and MMI, to counterbrace the absence of values for PI, AATI, and AHTI, and to generate results that can be compared.



**Fig. 2.** The meanings of the values for PI, AATI, and AHTI

Source: Made by author

Table 2 presents the values of PI, AATI, AHTI and MMI for specific cattle diseases, infections and infestations. The values were obtained by analysing the technical factsheet of each specific cattle disease, infection and infestation and considering the correlation illustrated in Figure 2.

**Table 2.** The values of PI, AATI, AHTI and MMI for specific cattle diseases, infections and infestations

Diseases, infections and infestations which are specific to cattle	PI	AATI	AHTI	MMI	PI+AATI+AHTI+MMI	Rank
Bovine anaplasmosis	0	50	0	0	50	7
Bovine babesiosis	0	50	50	6	106	5
Bovine genital campylobacteriosis	0	50	50	52.9	152.9	3
Bovine spongiform encephalopathy	50	50	50	30	180	1
Bovine tuberculosis	50	50	50	13.5	163.5	2
Bovine viral diarrhoea	50	50	0	0	100	6
Contagious bovine pleuropneumonia	0	50	0	0	50	7
Enzootic bovine leukosis	50	50	0	0	100	6
Haemorrhagic septicaemia	0	50	50	0	100	6
Infectious bovine rhinotracheitis/infectious pustular vulvovaginitis	0	50	0	0	50	7
Lumpy skin disease	0	50	0	0	50	7
Malignant catharral fever	50	50	0	0	100	6
Theileriosis	0	50	0	0	50	7
Trichomonosis	0	50	50	0	100	6
Trypanosomiase	50	50	50	0	150	4

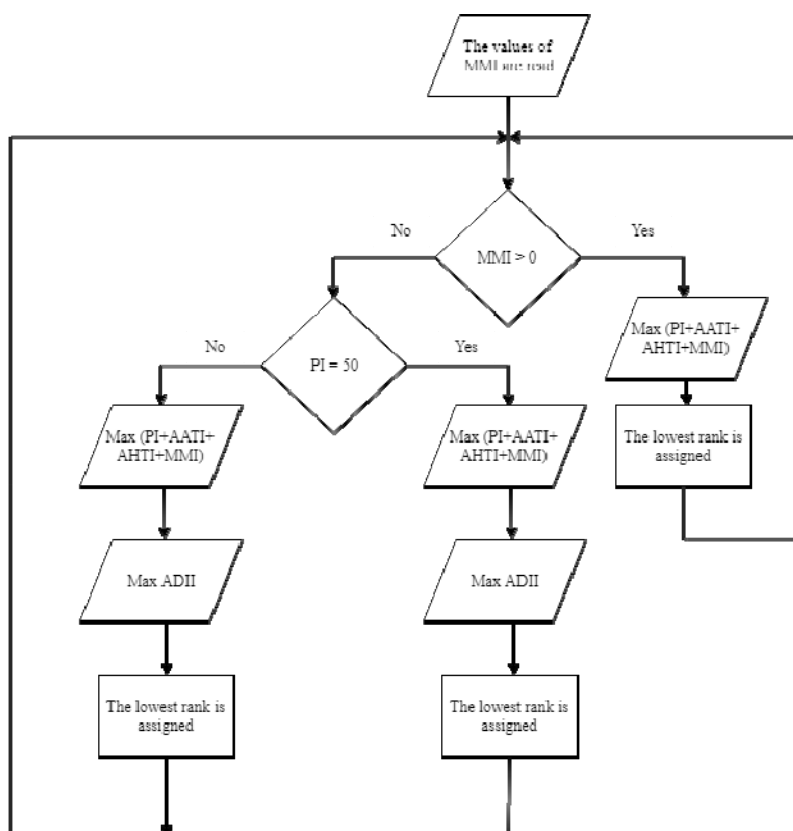
Source: Made by author based on Australian Government, Department of Health and Ageing, Office of the Gene Technology Regulator, 2005; Spickler, 2009; Spickler, 2013; Spickler, 2015; Spickler, 2016a; Spickler, 2016b; Spickler, 2018; OIE, 2018c.

Taking into account the values of PI, AATI, AHTI and MMI, the most dangerous specific cattle diseases, infections and infestations are the bovine spongiform encephalopathy, the bovine tuberculosis, the bovine genital campylobacteriosis, and the trypanosomiasis. This cattle disease scale is due mostly to the values of PI and MMI which have high values for the four diseases previous mentioned.

Instead, the bovine anaplasmosis, the contagious bovine pleuropneumonia, the infectious bovine rhinotracheitis/ infectious pustular vulvovaginitis, the lumpy skin disease, and the theileriosis are less dangerous specific cattle diseases, infections and infestations. The vaccine is available for these diseases and the transmission is only animal-to-animal.

The values of ADII and of the sum of PI, AATI, AHTI and MMI for specific cattle diseases, infections and infestations are presented in table 3. Data show that it is not possible to compute a final value for each disease, infection and infestation due to the different spread of the values of these indicators, i.e. the higher values of PI, AATI, AHTI and MMI will be cancelled but the extreme higher levels of ADII, so the values of PI, AATI, AHTI and MMI will count no more. Further, the calculation of a rank average for each disease, infection and infestation for the ranks from table 1 and table 2 will generate the same result as if the values were summed.

The option is to apply an algorithm proposed by author which is described in Figure 3. This algorithm considers firstly the values of MMI and PI and secondly the values of ADII because the human mobility and mortality and the availability of the vaccine for the corresponding cattle disease, infection and infestation is more important than the total cattle dead, slaughtered and destroyed.



**Fig. 3.** The algorithm for ranking the specific cattle diseases, infections and infestations

Source: Made by author

The algorithm is based on an iterative process and implies the following steps:

- The values of MMI for all disease, infection and infestation are read in table 2;
- If the values of MMI are higher than zero (the values indicate the number of people dead at 100,00 population due to the disease), then the maximum value of the sum of PI, AATI, AHTI, and MMI is searched in table 2. The lowest rank it will be assigned to the disease with the maximum value of the sum of PI, AATI, AHTI, and MMI.
- If the value of MMI is zero in table 2, then the values of PI is check in Table 2:
  - If the value of PI is 50, which means that the vaccine is not available, then the maximum value of the sum of PI, AATI, AHTI, and MMI is searched in table 2. In the case that there are similar values of maximum value of the sum of PI, AATI, AHTI, and MMI, the lowest rank is assigned to the disease with the maximum value of ADII in table 1;
  - If the value of PI is not 50, which means that the vaccine is available, then the maximum value of the sum of PI, AATI, AHTI, and MMI is searched in table 2. In the case that there are similar values of maximum value of the sum of PI, AATI, AHTI, and MMI, the lowest rank is assigned to the disease with the maximum value of ADII.

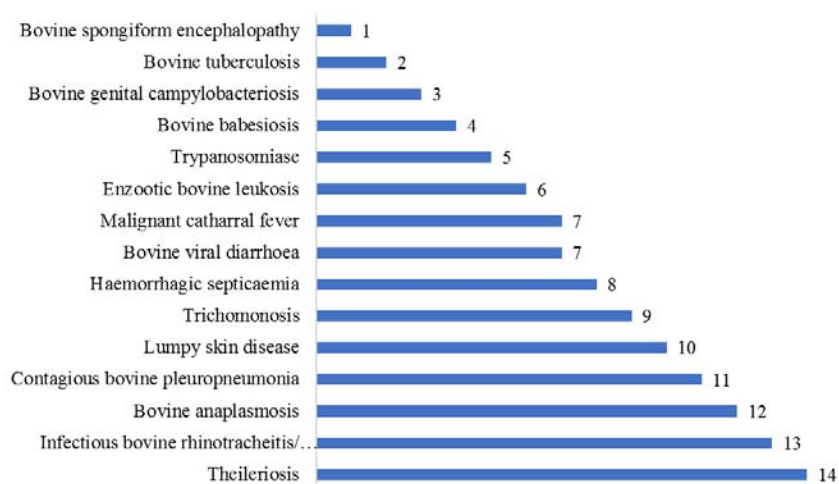
For example, it starts by reading the values of MMI for all disease, infection and infestation in Table 2. There are 4 disease that have the value of MMI higher than zero, i.e. the bovine babesiosis, the bovine genital campylobacteriosis, the bovine spongiform encephalopathy, and the bovine tuberculosis. For these diseases, the maximum value of the sum of PI, AATI, AHTI, and MMI is searched in table 2 and it is 180. It corresponds to the bovine spongiform encephalopathy and to this disease is assigned the lowest rank, i.e. 1. By repeating this procedure, it results that the bovine tuberculosis has rank 2, the bovine genital campylobacteriosis has rank 3 and the bovine babesiosis rank 4.

Because there are no more values of MMI higher than zero, the values of PI are checked in table 2. There are 6 diseases with PI = 50: the ovine spongiform encephalopathy, the bovine tuberculosis, the bovine viral diarrhea, the enzootic bovine leukosis, the malignant catharral fever, and the trypanosomiasis. Since the ovine spongiform encephalopathy and the bovine tuberculosis have already assigned a rank, these diseases will not be analyzed. For the 4 remaining diseases, the maximum values of the sum of PI, AATI, AHTI, and MMI is searched in table 2. This is 150 and it corresponds to the trypanosomiasis. Thus, this disease is assigned with the rank 5. Another search in the values of the sum of PI, AATI, AHTI, and MMI is undergone, and since all 3 hanging diseases have the values of 100, the maximum value of ADII for these diseases is searched in table 1. The trypanosomiasis disease has the highest value (568.3), but it has already assigned rank 5, so the rank 6 is assigned to the enzootic bovine leukosis because has the higher value of ADII (6.4). Further, the remaining diseases, i.e. the bovine viral diarrhea and the malignant catharral fever have the same value of 100 to the sum of PI, AATI, AHTI, and MMI and no information about ADII. Therefore, both received the same rank (7).

Since there are no more values of PI that equals 50, the maximum values of the sum of PI, AATI, AHTI, and MMI is searched in table 2. The haemorrhagic septicaemia and the trichomonosis have the same value (100) of the sum of PI, AATI, AHTI, and MMI. The value of ADII is used as second criterion for delimitation. The haemorrhagic septicaemia has the highest value of ADII (539,075.8) and the rank 8 is assigned to it. The trichomonosis has no value of ADII and receives rank 9.

Further, all remaining diseases have the same value of the sum of PI, AATI, AHTI, and MMI namely 50, but a different value of ADII. Thus, the lumpy skin disease (ADII = 21,254.1), the contagious bovine pleuropneumonia (ADII = 2,481.8), the bovine anaplasmosis (ADII = 234.6), the infectious bovine rhinotracheitis/ infectious pustular vulvovaginitis (ADII = 91.5), and the theileriosis (ADII = n/a) have assigned the ranks 10, 11, 12, 13 and 14 in this order.

Figure 4 shows the scale of the dangerous cattle diseases, infections and infestations according to the ranks previous determined. Thus, the bovine spongiform encephalopathy, the bovine tuberculosis, the bovine genital campylobacteriosis, the bovine babesiosis and the trypanosomiasis are the top 5 dangerous specific cattle diseases.



**Fig. 4.** The rank of the specific cattle diseases, infections and infestations

*Source:* Made by author based on data in table 1 and table 2 and applying the algorithm form figure 3.

On the contrary, the theileriosis, the infectious bovine rhinotracheitis/ infectious pustular vulvovaginitis, the bovine anaplasmosis, the contagious bovine pleuropneumonia, and the lumpy skin disease are the less dangerous specific cattle diseases.

## Conclusions

There are at least 15 specific diseases, infections and infestations which can affect the cattle's health. Worldwide, between 2007 and 2017, approximately 53.3% of diseases determined the death of 138,687 cattle, two-thirds of the diseases caused the slaughtering of 4,965 cattle, and 60% of diseases lead to the destruction of 25,945 cattle. Thus, 564,021 cattle were affected by these diseases. It is possible that this number to be higher because the analysis of cattle diseases was made based on data reported by each country.

It must be highlighted the fact that only 60% of the specific cattle diseases, infections and infestations have an available vaccine. Further, all 15 diseases are animal-to-animal transmission and 46.6% of disease are animal-to-human transmission. Approximately 57.14% of the diseases which are animal-to-human transmission produced 102 deaths at 100,000 population.

The analysis of the 15 specific diseases, infections and infestations showed that the most dangerous diseases are: the bovine spongiform encephalopathy, the bovine tuberculosis, the bovine genital campylobacteriosis, the bovine babesiosis, and the trypanosomiasis.

Another issue that must be underlined is that there is no available vaccine for the bovine spongiform encephalopathy and the bovine tuberculosis, which are in the first and second place in the top 5 of hazard to human health. This condition should rise worry for humans' health in the future. Therefore, it is important for countries to finance the researches to develop vaccines for these diseases.

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