**Global prioritisation of endemic zoonotic diseases for conducting surveillance in domestic animals to protect public health**

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Abstract

Zoonotic diseases (zoonoses) originating from domestic animals pose a significant risk to people’s health and livelihoods, in addition to jeopardising animal health and production. Effective surveillance of endemic zoonoses at the animal level is crucial to assess the disease burden and risk, and provide early warning to prevent epidemics in animals and spillover to humans. Here we aimed to prioritise and characterise zoonoses for which surveillance in domestic animals is important to prevent human diseases at a global scale. A multi-criteria qualitative approach was utilised, where disease-specific information and documentation were obtained across literature and databases of the leading international health organisations. Thirty-two zoonoses were prioritised, all of which have wide geographical spread and cause unexceptional human infections as a consequence of transmission from domestic animals. Most diseases involve multiple animal hosts and/or modes of zoonotic transmission, and where a lack of specific clinical signs in animals further complicates surveillance. We discuss the challenges of animal health surveillance in endemic and resource-limited settings, as well as potential avenues for improvement such as the use of multi-disease and integrated surveillance approaches and modern technologies. Our study will support global capacity building efforts to strengthen the surveillance and control of endemic zoonoses at their animal sources.

**Keywords**:

disease prioritisation; endemic zoonoses; surveillance; domestic animals; public health

1. Introduction

It is estimated that at least 60% of known infectious diseases and 75% of emerging infectious diseases in humans are zoonotic in origin [[1](#_ENREF_1),[2](#_ENREF_2)], with zoonotic disease outbreaks increasing globally in both total number and richness [[3](#_ENREF_3)]. Zoonoses are largely classified as either emerging/re-emerging or endemic zoonoses [[4-7](#_ENREF_4)]. Most emerging infectious diseases of humans are believed to originate from wildlife [[8](#_ENREF_8)]. They often have small-scale direct health impact, but a small minority can lead to epidemics or even pandemics in humans [[1](#_ENREF_1),[9](#_ENREF_9)], such as the severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) epidemics and the 2009 H1N1 and SARS-CoV-2 pandemics. If not properly controlled, emerging and re-emerging infectious diseases can become endemic and persistent. Endemic zoonoses, such as rabies, brucellosis, cysticercosis, and bovine tuberculosis cause constant and regular outbreaks in areas where the conditions favour their maintenance and spread [[10](#_ENREF_10)], and they would be considered as emerging zoonoses if introduced to a new territory or host species or evolved new traits. They mostly affect people in low- and middle-income countries (LMICs) who live in close proximity with their animals, resulting in billions of illnesses and millions of deaths in humans every year [[7](#_ENREF_7),[11](#_ENREF_11)]. In addition to the public health significance, endemic zoonoses impact livestock production and trade, jeopardising human livelihoods and food security [[10](#_ENREF_10),[12](#_ENREF_12)]. Livestock production is one of the fastest growing agricultural sectors in LMICs, as driven by population and economic growth and the associated increasing demand for livestock products [[13](#_ENREF_13),[14](#_ENREF_14)]. While LMICs tend to bear a higher burden of zoonoses, along with the expanding livestock productions and high human-livestock interactions, they are also at disadvantage in terms of existing capacity to tackle the disease risk [[7](#_ENREF_7),[11](#_ENREF_11),[15](#_ENREF_15)]. Inadequate surveillance in animals can lead to delayed detection and response to disease outbreaks, increasing the risk of onward spread and zoonotic transmission.

Driven by the epidemics/pandemics caused by zoonotic influenza, SARS-CoV, MERS-CoV, and more recently SARS-CoV-2, strengthening the capacity for the surveillance and response of emerging zoonoses with pandemic potential has become the focus of public health interests [[16](#_ENREF_16),[17](#_ENREF_17)]. Compared to their emerging zoonoses counterparts, endemic zoonoses often receive much less policy and research support, are rarely targeted by formal surveillance systems, and thus their frequencies and burden are largely unknown and underestimated [[10](#_ENREF_10),[11](#_ENREF_11)]. This underestimation in turn leads to ‘neglect’ due to a lack of evidence for decision-makers on the importance of these diseases and eventually serious consequences in terms of funding for control initiatives [[10](#_ENREF_10),[12](#_ENREF_12)]. The persistence of these endemic zoonoses thereby plays an important role in perpetuating poverty and hindering the progress towards the United Nations Sustainable Development Goals (UN SDGs).

An important obstacle to combat endemic zoonoses is, however, the institutional division between human and animal health sectors, as their control requires close collaboration between the two sectors that have different mandates and priorities [[18-20](#_ENREF_18)]. While the World Health Organization (WHO)’s new Neglected Tropical Diseases (NTDs) Roadmap sets a global strategy to tackle 20 NTDs by 2030, including a named subset of zoonoses, the listed targets and approaches mostly concern human infections [[21](#_ENREF_21)]. The public health risk of endemic zoonoses is widely recognised, yet the most effective and economic approach is often to control them at the animal sources [[7](#_ENREF_7),[22](#_ENREF_22)]. However, veterinary authorities tend to prioritise diseases having more serious impacts on animal production and trade, especially in face of limited resources, and subsequently endemic zoonoses often fall into the gap between public health needs and veterinary responsibilities [[18](#_ENREF_18),[23](#_ENREF_23)]. Increased awareness, commitment and alignment with the One Health vision to tackle zoonoses are urgently needed to achieve the dual benefits of protecting both animal and human health. This includes improved disease surveillance in the animal hosts and strengthened early warning and response systems at the animal-human interface. To boost the international attention and global efforts to tackle endemic zoonoses at the animal level, the present study aimed to: 1) prioritise endemic zoonoses at a global scale for conducting disease surveillance in domestic animals to prevent human infections; and 2) characterise the prioritised diseases to inform recommendations to improve surveillance in endemic and resource-limited settings. This study is part of the Food and Agriculture Organization (FAO) project on the development of animal health surveillance guidelines for endemic zoonoses, relevant to the One Health Joint Plan of Action (2022-2026) Actions 3.1 and 3.2 [[6](#_ENREF_6)].

1. Methods

*2.1 Initial list of diseases*

We aimed to start with a broad list of diseases to encompass as many zoonoses of international importance as possible. The listed diseases by the World Organisation for Animal Health (WOAH, founded as OIE) are diseases that have the potential for very serious and rapid cross-border spread, cause particularly serious socio-economic or public health consequences, and are of major importance in the international trade of animals and animal products [[24](#_ENREF_24)]. In addition, the WOAH Manual of diagnostic tests and vaccines for terrestrial animals covers WOAH-listed diseases and some other important animal diseases including zoonoses [[25](#_ENREF_25)]. Moreover, the One Health Companion Document to the WHO NTDs Roadmap 2021-2030 includes a subset of zoonotic NTDs that can impose a devastating health, social and economic burden [[26](#_ENREF_26)]. Hence, an initial list was created by compiling diseases from the following three international publicly accessible sources:

1. 90 WOAH-listed terrestrial animal diseases as of May 2022 [[27](#_ENREF_27)];
2. 111 diseases/disease groups from the WOAH Manual of diagnostic tests and vaccines for terrestrial animals as of May 2022 [[25](#_ENREF_25)]; and
3. 11 zoonotic NTDs/groups of NTDs from the WHO One Health Companion Document to the WHO NTDs Roadmap 2021-2030 [[26](#_ENREF_26)].

Bee diseases from the WOAH list and Manual were excluded for analysis. For diseases that overlapped between different lists (e.g. leishmaniasis and rabies, etc), only one was included. For diseases or infections that are caused by distinct agents and exhibit distinguishable epidemiological features in different animal species, they were separated by the animal host (e.g. bovine brucellosis, porcine brucellosis, and caprine and ovine brucellosis). Likewise, for diseases that have been grouped together within the original listing, such as the foodborne trematodiases, these were separated by individual disease (e.g. fascioliasis, paragonimiasis, clonorchiasis and opisthorchiasis).

*2.2 Algorithm and criteria for disease prioritisation*

We aimed for a rapid assessment to narrow down the initial list of diseases to be considered as candidates for developing international animal health surveillance guidelines to protect public health. Thus, a qualitative algorithm was utilised with the aim of minimising the exclusion of specific diseases due to a lack of available data [[28](#_ENREF_28)]. The algorithm comprises the following selection criteria to prioritise diseases for which surveillance in domestic animals is important to prevent human infections (Figure 1):

1. the disease is recognised as a zoonosis by the WOAH Terrestrial Code, Manual or the WHO One Health Companion Document to the WHO NTDs Roadmap;
2. domestic animals (e.g. cattle, buffalo, goat, sheep, pig, camel, equid, poultry, rabbit, dog and cat) play an important role in the disease life cycle (e.g. serve as a natural reservoir, amplifier host, intermediate host, or definitive host) or epidemiology (e.g. surveillance and control);
3. the disease is endemic in domestic animals across multiple regions, as opposed to geographically-restricted to a specific region/agroecosystem;
4. human infections are not rare, and/or have led to epidemics or pandemics; and
5. a. human infections often result from infections in domestic animals (zoonotic transmission), as opposed to being predominantly due to non-zoonotic sources such as infected humans or environmental reservoirs; or

b. domestic animals serve as sentinels for disease surveillance.

*2.3 Literature search and disease assessment*

Literature searches were conducted in English by four authors (IM, JG, JPW and YQ) to collect information against the above-mentioned criteria for all the diseases included in the initial list. Different sources, including the WOAH Terrestrial Animal Health Code and Manual, technical disease cards from WOAH and Center for Food Safety & Public Health (CFSPH) of Iowa State University, FAO and WHO publications, and the United States Centers for Disease Control and Prevention (US CDC) website were searched. A Microsoft Excel spreadsheet (Supplementary Table 1) was developed to select/drop diseases based on yes/no choices. ‘Negligible’ was used to indicate that the zoonotic risk of a disease is negligible despite the sporadic infections reported in humans, and ‘uncertain’ was used to indicate where information was insufficient to make a conclusion. Any discordance in the judgement was resolved through the authors’ internal discussions. For each prioritised disease, a more in-depth literature review was conducted by one author (YQ), and information about the causative agent, animal hosts, geographic distribution, clinical signs, and modes of zoonotic transmission were collected.

1. Results

*3.1 Prioritised zoonoses*

The initial list included 123 diseases, with 58 known to be zoonotic, and ultimately 32 were prioritised following the application of the algorithm. Of the prioritised diseases, 29 are included in the WOAH Terrestrial Manual, 20 are WOAH-listed diseases, and 8 are WHO-listed zoonotic NTDs (Figures 1 and 2; Supplementary Table 1).

*3.2 Characterisation of the prioritised zoonoses*

For each prioritised disease, information about the causative agent, domestic animal hosts, geographic distribution, clinical signs, and modes of zoonotic transmission are summarised in Table 1. Of the 32 prioritised zoonoses, 13 are bacterial, followed by parasitic (helminthic, protozoal or external) (n=11) and viral (n=8) diseases. Most prioritised zoonoses have broad host ranges, with ruminants (cattle, buffaloes, sheep or goats) being the most common. Twenty-nine diseases are reported to be able to affect animal hosts without obvious clinical illness. Twenty diseases can be transmitted to humans by more than one mode, most commonly through the direct mode (i.e. close contact with infected animals or their products), followed by ingestion of contaminated food, and through fomites, water, aerosol or vectors. All the diseases except for enteric zoonoses have limited human-to-human transmission if reported.

In terms of geographic distribution, certain enteric diseases (campylobacteriosis, cryptosporidiosis, salmonellosis and infections with verocytotoxigenic *E. coli*) and foodborne trematodiases (fascioliasis and paragonimiasis), avian and ovine chlamydiosis, Q fever, scabies, swine influenza, toxoplasmosis, tularemia and West Nile fever (WNF) affect both high- and lower-income countries. Certain diseases, namely anthrax, three livestock brucellosis, bovine and porcine cysticercosis, bovine tuberculosis, cystic echinococcosis, high and low pathogenicity avian influenza (HPAI and LPAI), trichinellosis, and rabies have been successfully controlled or even eliminated in domestic animals in many high-income countries and they present a burden primarily to LMICs. Certain diseases are highly dependent on environmental factors, such as temperature, rainfall, presence of wildlife reservoirs and/or competent vectors, for their maintenance and transmission and they are primarily found in tropical and subtropical regions. These include vector-borne diseases leishmaniasis, Crimean-Congo Haemorrhagic Fever (CCHF), Rift Valley Fever (RVF), as well as water-borne diseases leptospirosis and schistosomiasis. Certain diseases are closely associated with the pattern of animal husbandry. These include MERS that is endemic in dromedary camels in the Middle-East as well as its neighbours, swine influenza and salmonellosis that are most prevalent in areas of intensive animal husbandry, porcine cysticercosis and trichinellosis that are usually found in areas with poor hygiene and free-scavenging or backyard pig production, and echinococcosis caused by *Echinococcus granulosus* that is usually found in communities where grazing animals are reared together with dogs.

1. Discussion

Our study prioritised 32 zoonoses for implementation of disease surveillance in domestic animals to prevent human infections. This broad list was used to inform the FAO project on the development of surveillance guidelines for endemic zoonoses. We started from an initial list of diseases compiled from WOAH and WHO, which are of significance in terms of animal and/or public health. It is noteworthy that some zoonotic diseases of wildlife origins, such as SARS, Lyme disease, plague and hantavirus infection were not included in the WOAH list and Manual, which mostly concentrate on domestic animals. As such, these diseases were excluded from our prioritisation exercise. Some zoonoses from regional or national databases such as hepatitis E and yersiniosis are assumed to have close links between infections in livestock and public health risk, but they were not included in our assessment, presenting a limitation of this study. Nonetheless, our priority diseases list includes all the ‘top 13 zoonoses’ identified by the International Livestock Research Institute (ILRI) [[11](#_ENREF_11)], except for hepatitis E and listeriosis; for the latter food processing environments rather than livestock reservoirs present the major sources of human infections [[29](#_ENREF_29)]. Our priority list is also broader than the WHO lists of neglected zoonotic diseases (NZDs) and zoonotic NTDs [[21](#_ENREF_21),[22](#_ENREF_22)], as it includes some diseases spreading worldwide such as enteric zoonoses and toxoplasmosis. Of note, some regional important zoonoses such as human African trypanosomiasis and Chagas disease were not prioritised in this study, as they are geographically restricted to a specific region or agroecosystem only. Some zoonoses such as HPAI, RVF, CCHF, MERS, WNF and leishmaniasis are endemic in some countries but regarded as emerging or re-emerging diseases by others, given their substantial potential of transboundary spread. The endemicity of the prioritised diseases in domestic animals poses a continuous risk to humans living in the local communities, while the public health risk tends to be lower in high-income countries due to better application of sanitary measures and access to health care. Although not assessed by this study, the severity of infection in humans is also relevant when judging the overall risk of a zoonotic pathogen. For example, although human infections caused by Nipah virus are rare, the case fatality rate can exceed 70%, and thus the disease is considered as a priority in Bangladesh where human infections have been reported [[30](#_ENREF_30),[31](#_ENREF_31)].

An important finding but also a challenge of this study was the significant data gaps that exist for the frequency and adverse impacts of most zoonoses in both humans and animals. Many endemic zoonoses are not notifiable and as a result not recorded in official statistics. Even for a notifiable disease such as rabies, both human and animal cases are considerably underreported in endemic countries, and the global burden of canine rabies could only be estimated through modelling studies [[32](#_ENREF_32)]. In another example, brucellosis is assumed to be one of the most widespread zoonoses in the world. Yet, two WHO-commissioned studies published in 2012 concluded that it was not possible to accurately determine the global frequency of human brucellosis due to significant data gaps [[33](#_ENREF_33),[34](#_ENREF_34)]. Likewise, studies of brucellosis in ruminants showed that the predicted annual cases based on seroprevalence studies may be 103 -106 times higher than the numbers reported to WOAH [[11](#_ENREF_11)]. This data scarcity largely precludes disease prioritisation based on ‘hard’ figures of the disease frequency as we initially attempted. Similarly, we did not include disease impact evaluations as the one conducted by ILRI, given this could have strongly biased the results towards diseases for which such data exist, often because they are of importance in settings where resources have been made available for their study. Ultimately, we applied a qualitative prioritisation approach, which is usually preferred to quantitative methods when evidence is highly scarce or of high uncertainty [[35](#_ENREF_35)]. The five criteria used in this study are simple, qualitative and inclusive, enabling diseases to be realistically judged with limited available data.

Disease prioritisation exercises were mostly performed at a national level and to a lesser extent at a regional level, but rarely at a global scale [[28](#_ENREF_28),[36](#_ENREF_36)]. Prioritisation exercises typically take a broadly similar approach, which includes formulating a list of candidate diseases for prioritisation, selecting and weighting the criteria, scoring diseases against the criteria and creating a ranking based on the scores [[35](#_ENREF_35)]. Here we utilised a multi-criteria qualitative approach specifically adapted to meet the purpose of this study and accommodate severe data gaps, which differs from some other commonly used processes in several aspects. Firstly, we did not give weight to the criteria or score the diseases, as the ultimate aim of our study was not to rank the diseases comprehensively but to identify an inclusive list of zoonoses to inform the FAO global project on surveillance guidelines development. The limited number of criteria and the simplified process are easy to understand and adapt, improving the transparency and reproducibility of the study. The prioritisation matrix developed for this study, available in the supplementary material, can be adapted to prioritise diseases at a regional or national level, as well as to inform more comprehensive risk-ranking exercises for particular contexts and requirements. Secondly, our prioritisation exercise did not involve external expertise consultation due to time and resource constraints, and instead, we relied on the literature and databases from the leading international health organisations to mitigate biases related to the authors’ opinions. Still, our study had a component of subjectivity especially relating to the assessments of ‘the limited occurrence in humans’ and ‘the importance of zoonotic transmission’, for which evidence was sometimes highly scarce and can vary greatly between regions and over time. It is anticipated that more evidence will emerge through enhanced surveillance and research, and the disease prioritisation will need to be updated. Thirdly, our prioritisation process did not invite direct input from different One Health sectors through a participatory approach, as done by the US CDC One Health Zoonotic Disease Prioritisation (OHZDP) process [[37](#_ENREF_37)]. While the latter has additional benefits of strengthening the results’ ownership of each sector and facilitating multi-sectoral collaboration, it is primarily applied to identify priorities at a subnational or national level [[38](#_ENREF_38),[39](#_ENREF_39)], or a small-regional level [[40](#_ENREF_40)].

For all the prioritised 32 diseases, effective surveillance of endemic zoonoses in their animal hosts is critical for understanding the real burden of the diseases, for timely detection and control of diseases before further spread in animals, and for providing sentinel warnings to humans. For instance, experience from Kenya showed that enhanced syndromic surveillance of RVF in livestock can serve as an effective early warning for epidemics in livestock and spillover to humans [[41](#_ENREF_41)]. Surveillance data of good quality are also highly desirable to inform effective disease control programmes in animals. In the example of brucellosis control in livestock, when the disease prevalence is high, control relies on vaccination. As prevalence decreases test-and-removal of seropositive adults can be considered [[42](#_ENREF_42),[43](#_ENREF_43)]. In this respect, the detection of infected herds/flocks and assessment of the disease prevalence are crucial. However, several important challenges exist for the surveillance in LMICs, in addition to the infrastructure limitations. Firstly, most of the prioritised zoonoses are associated with asymptomatic or non-specific clinical presentations in animal hosts, making their identification difficult without laboratory confirmatory testing. This often presents a significant challenge to LMICs where diagnostic tools are not always accessible [[44](#_ENREF_44)]. Secondly, for zoonoses that do not cause obvious clinical signs in animals, it can be difficult to engage agricultural stakeholders in animal health surveillance and interventions solely to benefit public health. Thirdly, the majority of prioritised diseases involve multiple animal hosts (sometimes also including wildlife) and/or multiple pathways of zoonotic transmission, presenting additional challenges to quantifying the contribution of each host/pathway to public health risk and prioritising control activities [[45](#_ENREF_45)]. Lastly, surveillance programmes mostly operate separately for the human and animal health sectors, and surveillance in animals is under-resourced even more than surveillance in humans, especially in LMICs [[46](#_ENREF_46)]. As such, zoonotic agents are often not diagnosed until human outbreaks have been observed, which subsequently leads to the disease investigation and detection in animals rather than the reverse [[46](#_ENREF_46),[47](#_ENREF_47)].

To address the above challenges, practical recommendations to improve the efficiency and cost-effectiveness of surveillance are highly desirable. However, literature focusing on animal health surveillance of individual endemic and neglected zoonosis is relatively limited, in contrast to increasing guidelines developed for the early detection of emerging infectious diseases with pandemic potential and to demonstrate freedom from transboundary animal disease to support international trade [[48](#_ENREF_48)]. Furthermore, when available, such literature is frequently applicable to resource-rich contexts or considers animal health surveillance in silos. This presents a significant gap that could be addressed by surveillance guidelines adapted to endemic and resource-limited settings. As shown in Table 1, prioritised zoonoses are often co-circulating and share common surveillance-related characteristics, which suggests that the multi-disease surveillance approach may be considered to improve surveillance efficiency. For example, surveillance based on clinical indicators (i.e. syndromic surveillance) such as stormy abortion, excess mortalities in young animals, or neurological signs can increase the sensitivity and timeliness of event detection [[48](#_ENREF_48)]. For diseases that cause subclinical infections in livestock as in the case of bovine tuberculosis, porcine and bovine cysticercosis, cystic echinococcosis, fascioliasis, and trichinellosis, abattoir surveillance can be a highly cost-effective way to collect data on multiple diseases concurrently while preventing zoonotic transmissions through the food chain [[49](#_ENREF_49)]. Thanks to the proliferation of modern information technologies, digital surveillance is increasingly common. Participatory approaches using web- or mobile phone-based syndromic surveillance show promise to facilitate reporting of animal diseases with severe clinical signs in rural communities [[50](#_ENREF_50),[51](#_ENREF_51)]. Also, digitalisation of slaughterhouse data can facilitate data integration and interoperability within the national surveillance system to monitor disease frequency and identify risk areas [[49](#_ENREF_49),[52](#_ENREF_52)]. Furthermore, there is growing interests in applying integrated One Health surveillance to tackle zoonoses, which encourages close cross-sectoral collaboration to improve data collection, analysis, and sharing, and to reduce duplicated efforts or investments [[5](#_ENREF_5),[53](#_ENREF_53)]. As an example, the Integrated Bite Case Management (IBCM) approach directly links animal health and public health sectors in the investigation of animal bite cases through shared digital communication platforms, and it has been demonstrated to significantly increase rabies case detection, as well as improve the administration and cost-effectiveness of post-exposure prophylaxis [[54](#_ENREF_54),[55](#_ENREF_55)]. The Tripartite Zoonoses Guide (TZG) has been developed by WHO, FAO and WOAH in 2019 to support countries to build capacities for implementing a multi-sectoral, One Health approach to tackle zoonoses [[56](#_ENREF_56)]. The aforementioned approaches and development would ideally be considered by the surveillance guidelines for endemic zoonoses in LMICs.

The coronavirus disease 2019 (COVID-19) pandemic has further galvanised the global interests and investments in the surveillance of emerging zoonoses with pandemic potential. Hotspots for emerging zoonoses are predicted to be mostly concentrated in lower-latitude LMICs, which coincide with areas of weakest disease surveillance capacity [[8](#_ENREF_8)]. Surveillance of emerging zoonoses is normally challenged by the lack of a clear case definition and laboratory diagnostic tools, which implies the need for approaches that are more comprehensive than those that have existed [[5](#_ENREF_5),[46](#_ENREF_46)]. In addition, it does not generate tangible benefits for the immediate health and development problems in LMICs, which usually face a greater threat from endemic and neglected diseases and are under-resourced for disease surveillance and response [[4](#_ENREF_4),[7](#_ENREF_7)]. By comparison, surveillance of endemic zoonoses can be regarded as low-hanging fruit given tools for disease detection are often available for both humans and animals [[5](#_ENREF_5),[25](#_ENREF_25)]. It can also generate immediate benefits to the local communities and thus is more likely to be sustainable [[4](#_ENREF_4)]. Capacity building for the surveillance and control of endemic zoonoses would not only mitigate the risk of endemic zoonoses in its own right but also simultaneously improve the core capacity to detect and respond to emerging or exotic disease threats and future pandemics.

1. Conclusions

We prioritised 32 endemic zoonoses at a global scale for which disease surveillance in domestic animals is important to prevent human infections. This broad list would contribute to increasing the awareness and commitment in the animal health service to tackle these diseases aligned with the One Health vision. The severe data gaps about the disease frequency and burden encountered in this prioritisation exercise once again highlight the need for improved surveillance. The characteristics of the prioritised endemic zoonoses suggest that a multi-disease, integrated surveillance approach, taking advantage of the modern technologies, would improve the efficiency and cost-effectiveness of surveillance in resource-limited settings. Our study will support the overall capacity building for zoonoses surveillance and response, protect livestock production and farmers’ livelihoods, and contribute to poverty alleviation, the global health security agenda, and the UN SDGs.

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| Box 1: glossary  Zoonosis (plural zoonoses): a disease, infection or infestation naturally transmissible from vertebrate animals to humans.  Endemic zoonosis: a zoonosis that is present constantly in a given geographic area or population group where conditions for their maintenance or spread exist. Examples include brucellosis (*Brucella abortus*, *B. melitensis* and *B. suis*), leptospirosis (*Leptospira spp.*), and bovine tuberculosis (*Mycobacterium bovis*) in some parts of the world.  Emerging zoonosis: a zoonosis that is either newly recognised, newly introduced or newly evolved, or has existed previously but rapidly changed in incidence or expansion in the geographic, host or vector range. Examples include Middle East respiratory syndrome (MERS), avian influenza (H5N1 and H7N9), Nipah virus (NiV) infection, and Ebola virus disease (EVD).  Re-emerging zoonosis: a zoonosis that was previously under control or even nearing elimination or eradication but has a resurgence. Examples include the re-emergence of trichinellosis in southeastern Europe in 1990s as a result of political and economic changes, and the re-emergence of schistosomiasis in Sichuan, China in early 2000s as a result of environmental and socioeconomic changes.  Neglected Tropical diseases (NTDs): are, as defined by the World Health Organization, a diverse group of 20 conditions that are mainly prevalent in tropical and subtropical areas, where they mostly affect impoverished communities and generate significant health burden and losses. Of these, 11 diseases are  recognised as zoonotic NTDs by the One Health Companion Document to the WHO NTDs Roadmap 2021-2030, including Chagas disease, dracunculiasis (Guinea-worm disease), echinococcosis, foodborne trematodiases, human African trypanosomiasis (sleeping sickness), zoonotic leishmaniasis, rabies, scabies and other ectoparasitoses, schistosomiasis, snakebite envenoming, taeniasis/cysticercosis.  Epidemic: the occurrence of disease in a population with a frequency that clearly exceeds the normally expected level for a given area and/or season. Examples include the severe acute respiratory syndrome coronavirus (SARS-CoV) epidemic in China in 2003-2004, and the West Nile virus (WNV) epidemic in the United States in 2002-2003.  Pandemic: an epidemic that occurs across international boundaries or worldwide, and affects a large number of people. Examples include the 2009 H1N1 pandemic and the coronavirus disease 2019 (COVID-19) pandemic.  Reservoir: the host or habitat in which an infectious agent normally lives and multiplies and from which it can be transmitted. The reservoir can be a single or multiple species of living organisms or inanimate matter (such as soil). For example, wild aquatic birds are the natural reservoirs of avian influenza viruses and soil is the natural reservoir of anthrax spores.  Amplifier host: a host in which infectious agents multiply rapidly to high levels, providing an important source of infection to other susceptible hosts. For example, pigs serve as the amplifier hosts for Japanese encephalitis virus.  Intermediate host: a host that harbours the pathogen before transmitting it to the final hosts. In parasitology, it is the host in which asexual forms of a parasite develop. For example, pigs act as the intermediate hosts for *Taenia solium* and cattle are the intermediate hosts for *Taenia saginata*.  Definitive host: a host in which the sexual maturation of a parasite occurs. For example, humans are the definitive hosts for *T. solium* and *T. saginata*.  Domestic animals: are animals that have been selectively bred and genetically adapted over generations to live alongside humans, including food-producing animals (cattle, buffalo, sheep, goat, pig, poultry, rabbit, etc), companion animals (dog, cat, etc) and working animals (equid, camel, etc).  Vector: an invertebrate carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings. The organism may or may not pass through a developmental cycle within the vector. For example, mosquitoes are the vectors for the transmission of Rift Valley Fever (RVF) virus and WNV. |

**Figure captions:**

Figure 1. Qualitative algorithm for the prioritisation of endemic zoonoses for conducting surveillance in domestic animals to protect public health

Figure 2. Prioritised diseases and their inclusion in the World Organisation for Animal Health (WOAH) notifiable list and manual for terrestrial animal diseases, and the World Health Organisation (WHO) list of Neglected Tropical Diseases (NTDs).



