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From Reacting to Preventing Pandemics

Building Animal Health and Wildlife Systems for One Health in East Asia and Pacific

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Table of contents

Table of Figures

List of Tables

List of Boxes

Asian veterinarian holding for moving the pig in hog farms, animal and pigs farm industry.
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From Reacting to Preventing Pandemics

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Foreword

The ongoing COVID-19 pandemic posed an unprecedented challenge to public health, food systems, and economic growth globally, leading to the loss of several millions of lives and tens of millions of people at risk of falling into extreme poverty threatening to reverse decades of development progress. The world is witnessing an increasing trend of public health threats such as emerging infectious diseases (EIDs) and zoonoses and antimicrobial resistance, many due to novel pathogens that spillover from wildlife to animals and humans with the potential to become pandemics. The East Asia and Pacific region is a global hot spot for disease emergence and is disproportionately vulnerable to economic losses due to pandemics. Furthermore, frequent occurrence of transboundary animal diseases (TADs) is confronting the agri-food systems, trade, and food security. This is emblematic of weaknesses in One Health systems to predict, prevent, and detect disease outbreaks before they reach regional or global proportions, which calls for a coordinated multi-sectoral response for transitioning *'from reacting to preventing pandemics'* at the source.

COVID-19 may not be the last pandemic. The reduction of pandemic risk by early actions to prevent EIDs is a global public good and risk management requires a whole-of-society preparedness to respond to the pandemics at the country, regional, and global levels. A team comprising experts from the World Bank and FAO and leading veterinary, wildlife, and One Health experts from around the world have worked together to analyze the drivers of zoonoses and EIDs and assessed the management of animal and wildlife systems, using risk-based approaches, for their ability to identify and respond to emerging threats and protect the health, agricultural production, and ecosystem services. The report brings together the latest global knowledge and evidence for providing a road map along with critical and actionable solutions, policy improvements, institutional strengthening, and investments.

Finally, this report complements the findings of a related report 'Reducing Pandemic Risks at Source - Wildlife, Environment and One Health Foundations in East and South Asia', jointly published by the World Bank and FAO around the same time.The second report analyzed the risks of EIDs of wildlife origin and proposes how to reduce emerging pandemic threats at their source and provided recommendations for strengthening systems to prevent, detect, and manage EID outbreaks caused by wildlife trade, wildlife farming, food systems, and habitat degradation. We hope these reports will foster policy dialogues among countries in East and South Asia and the Pacific, regional institutions, and the international community to strengthen the animal health and wildlife systems and the One Health operationalization. Our goal is to trigger investments in policy, institutions, and capacity building for the strengthening of One Health approaches in the region and globally.

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Abbreviations and acronyms

ACCAHZ	ASEAN Coordinating Centre for Animal Health and Zoonoses
ADB	Asian Development Bank
AHA	Animal Health Australia
AMC	Antimicrobial consumption
AMR	Antimicrobial resistance
AMU	Antimicrobial usage
APSED	Asia Pacific strategy for emerging diseases and public health emergencies
ARAHIS	ASEAN Regional Animal Health Information System
ARES	ASEAN rabies elimination strategy
ASEAN	Association of Southeast Asian Nations
ASF	African Swine Fever
BSL	Biosafety Level
CAHEC	China Animal Health and Epidemiology Center
CECC	Congressional-Executive Commission on China
CoV	Coronavirus
COVID-19	Coronavirus Disease 2019
CSF	Classical swine fever
DALY	Disability-adjusted life year
DFAT	Department of Foreign Affairs and Trade (of Australia)
EAD	Exotic Animal Disease
EAP	East Asia and Pacific
ECTAD	Emergency Centre for Transboundary Animal Disease (of FAO)
EID	Emerging Infectious Disease
EPT	Emerging Pandemic Threats (EPT)
EU	European Union
EU-HPED	European Union - Highly Pathogenic and Emerging Diseases
FAO	Food and Agriculture Organization of the United Nations
FAO-RAP	Regional Office for Asia and the Pacific (of FAO)
FAOSTAT	FAO statistics database
FETP	Field Epidemiology Training Program
FETPV	Field Epidemiology Training Program for Veterinarians
FMD	Foot-and-mouth disease
GASI	General Agency for Specialized Inspection
GAVS	General Authority for Veterinary Services
GBD	Global Burden of Disease
GDP	Gross domestic product
GF-TADs	Global Framework for the Progressive Control of Transboundary Animal Diseases
GHP	Good Hygiene Practices
GHSA	Global Health Security Agenda
HACCP	Hazard Analysis Critical Control Point
HIV	Human Immunodeficiency Virus
HPAI	Highly pathogenic avian influenza
IBD	Infectious Bursal Disease

iSIKHNAS	Sistem Informasi Kesehatan Hewan
IT	Information technology
JEE	Joint External Evaluation (of WHO)
LIMS	Laboratory Information System
LMT	Laboratory Mapping Tool
MARA	Ministry of Agriculture and Rural Affairs
MARD	Ministry of Agriculture and Rural Development
MERS	Middle East Respiratory Syndrome
MoH	Ministry of Health
MOIT	Ministry of Industry and Trade
NAPHS	National Action Planning for Health Security
ND	Newcastle disease
NEMA	National Emergency Management Agency
NTD	Neglected Tropical Diseases
OECD	Organisation for Economic Co-operation and Development
OHZDP	One Health Zoonotic Disease Prioritization
OIE	Office International des Epizooties, now called World Organisation for Animal Health (WOAH)
PIC	Pacific Island Country
PPP	Public-private partnership
PPR	Peste des Petits Ruminants
PRRS	Porcine reproductive respiratory syndrome
PVS	Performance of Veterinary Services (of WOAH)
QALY	Quality-adjusted life year
RFID	Radio-frequency identification
SARS	Severe Acute Respiratory Syndrome
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SEAOHUN	Southeast Asia One Health University Network
SEARO	Southeast Asia Regional Office (of WHO)
SOPs	Standard Operating Procedures
SPAR	State Party Self-Assessment Annual Reporting
SPC	Secretariat of the Pacific Community
TAD	Transboundary Animal Disease
TCP	Technical Cooperation Programme (of FAO)
US-CDC	Centers for Disease Control and Prevention (of the US)
USAID	United States Agency for International Development
WAHIS	World Animal Health Information System
WHO	World Health Organization
WOAH	World Organisation for Animal Health, formerly Office International des Epizooties (OIE)
WPRO	Western Pacific Regional Office (of WHO)
WTO	World Trade Organization

CHINA
Cattle breeding in Inner Mongolia, China
Photo credit: FAO/De Balogh

Executive summary

The reduction of pandemic risk is a quintessential global public good and risk management that requires whole-of-society to respond to the pandemics at the country, regional, and global levels. This joint World Bank-FAO report analyzes the drivers of zoonotic and emerging infectious diseases (EID) and offers strategic recommendations for preventing their spread in animals and humans using a cross-sectoral approach. Building on the latest global knowledge and evidence, practical guidance is provided for policy improvements, institutional strengthening, and investments in animal health and wildlife systems in East Asia and Pacific (EAP).[1] The report complements and deepens an associated report "Reducing Pandemic Risks at Source - Wildlife, Environment and One Health Foundations in East and South Asia" (World Bank and FAO 2022) that analyzes risks of EIDs from wildlife and the gaps in wildlife systems.

The COVID-19 pandemic has caused an unprecedented setback in the worldwide effort to end extreme poverty and reduce inequality. Reversals in development caused by the COVID-19 pandemic threaten people's lives, jobs, and livelihoods. By April 3, 2022, the number of infected had reached 492 million, with nearly 6.1 million deaths. Recent estimates by the World Bank indicate global gross domestic product (GDP) declining by 5 percent. In EAP, the COVID-19 shock is expected to have increased the number of people living in poverty by 32 million in 2021. The number of poor in developing EAP countries is, however, expected to decline to its 2019 level in 2022. The pandemic has triggered a two-track economic recovery, as low-income countries face high inflation, too few jobs, more food insecurity, and the high cost of adapting to climate change. This is worsening inequality; reversing gains in education, health, nutrition, and gender equality; fueling a debt crisis; and affecting all aspects of commercial activity and trade.

Infectious disease outbreaks are occurring more frequently in the EAP region, including those transmissible between humans and animals

Epidemic-prone infectious diseases have been occurring more frequently and are recognized as pandemic threats. These include diseases transmissible between animals and humans, such as Ebola, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), and the COVID-19 in humans, and the epidemic of animal diseases such as highly pathogenic influenza viruses, African Swine Fever (ASF), and Peste des Petits Ruminants Virus (PPR). The examples of human infections have demonstrated that once either secondary epidemiological cycles are established or pathogens adapt fully to the human host, fast-spreading outbreaks occur and are incredibly difficult to manage and have a dramatic impact on human health and well-being.

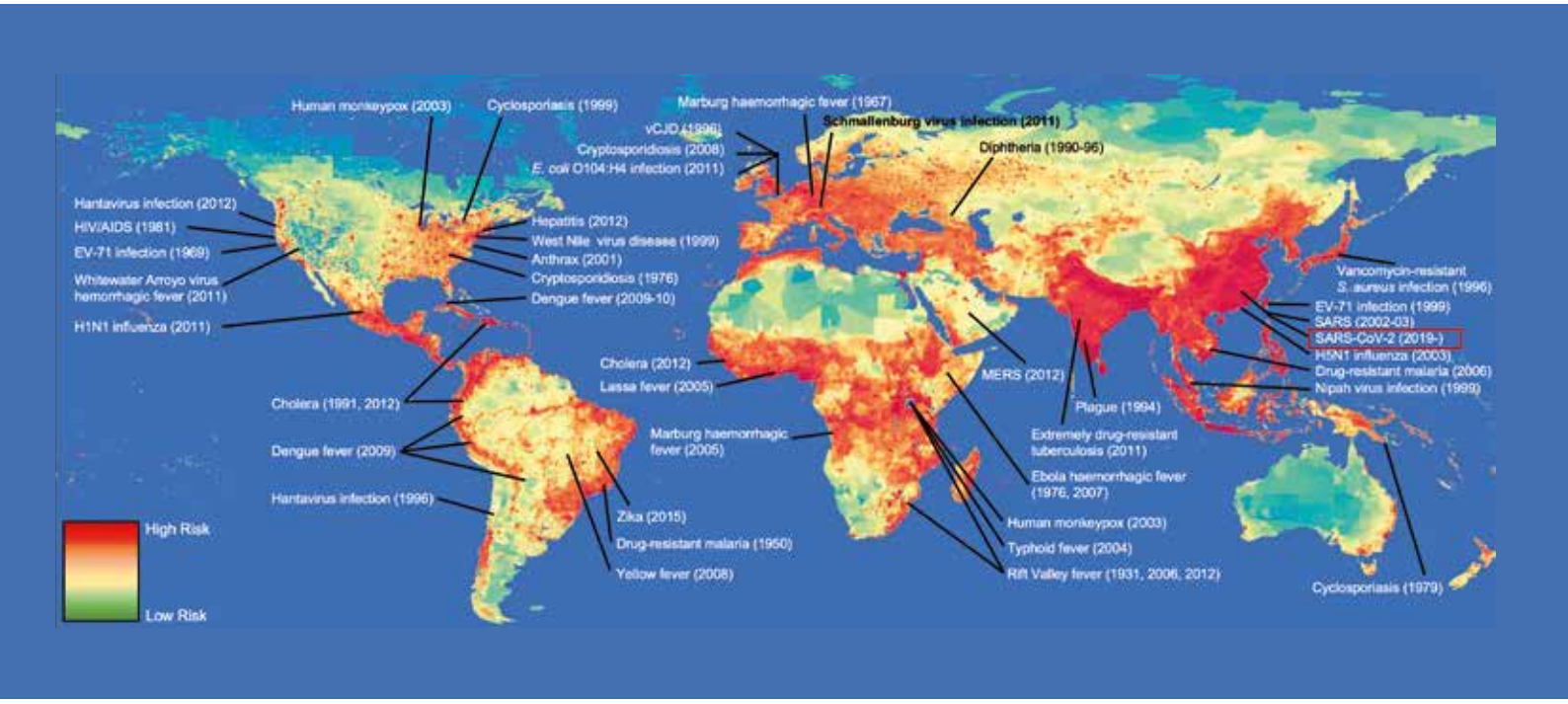


Figure E.1: Global hot spots for emerging zoonotic diseases *Source:* Authors, based on Lipkin 2013.

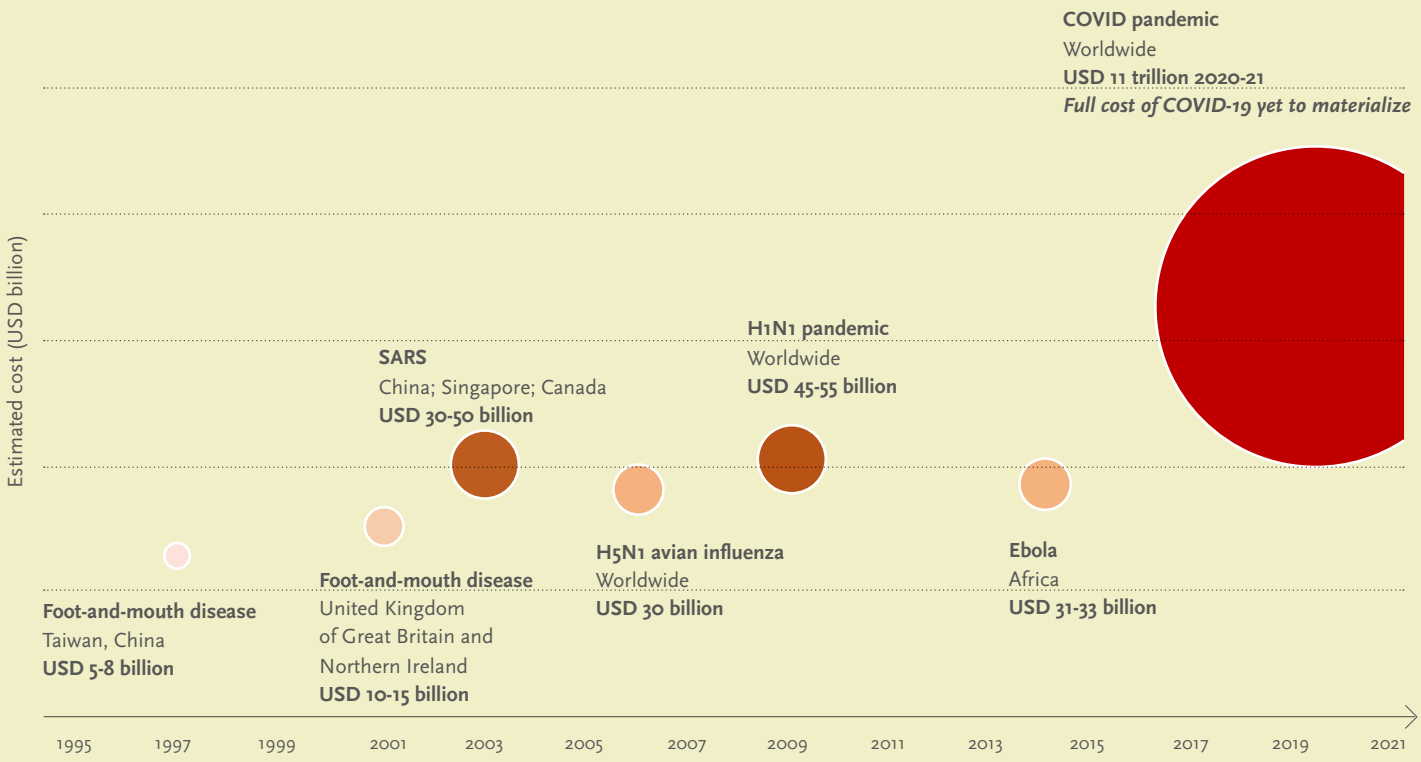


Figure E.2: The rising global costs of animal disease and human health epidemics 1995-2021 *Source:* Bio-era, adapted by the authors.

Various factors have made the region a zoonotic disease hot spot: large human/animal populations, urbanization, environmental degradation, poor livestock biosecurity and inadequate hygiene

The EAP region is one of the global hotpots for emerging infectious zoonotic dieases (Figure E.1). The region is considered one of the most vulnerable to disease emergence, incursions, and spread. SARS, COVID-19, Nipah disease, and highly pathogenic avian influenza (HPAI) H5N1 and H7N9 viruses all emerged from East Asia and Southeast Asia, and research predicts that the next global pandemic is likely to arise again in this region. Multiple risk factors in the region include the large and concentrated human and livestock populations, high levels of urbanization, environmental degradation, poor livestock biosecurity and food hygiene practices, increased consumption of wildlife, extensive trade in animals (both domestic and wild), and the often close contact between animals and humans. Vector-borne diseases such as Zika, Lumpy Skin Disease, and so on have also been increasing in the region in part driven by climate change and changing vector patterns. The Pacific Island countries appear to have been free of emerging infectious diseases and major transboundary diseases, likely due to isolation and the low densities of people and animals, but they face other One Health threats such as food safety similar to other parts of the region.

Beyond direct human health impacts, emerging infectious zoonoses (i.e., animal diseases including those with zoonotic potential that are transmissible to humans) have caused significant costs to the livestock and public health sectors, threatening economic development and resilience to disasters and ecosystem sustainability and integrity. The impact and cost of major disease outbreaks and zoonoses have increased dramatically in recent years (Figure E.2). Recent International Monetary Fund (IMF) estimates show that prolonged impact of COVID-19 into the medium term could reduce the global GDP by a cumulative of USD 5.3 trillion over the next five years, further to the estimated loss in output relative to the pre-pandemic projected path of USD 11 trillion during 2020-21. McKinsey estimates that by 2025, COVID-19 will have cost the world between USD 16 trillion and USD 35 trillion. EAP has seen the highest economic losses from epidemics of any region in the world and the costs of disease outbreaks have increased dramatically over the past decades. Moreover, the inability to effectively manage diseases such as food-borne zoonoses, emerging vector diseases, and antimicrobial resistance (AMR) due to the improper use of antibiotics in animal husbandry and poor compliance with appropriate food safety standards also have significant human and economic impacts.

The origins of epidemic-prone infectious diseases of both humans and animals need urgent attention by global health authorities using a One Health approach that is cross-sectoral coordination among the human, animal (domesticated and wild), and the environmental sectors. The current system of assessing the epidemiology and risk of epidemic-prone infectious diseases is limited by a lack of cohesion across the sectors, that is, a lack of applying a One Health approach. Collaboration and coordination are limited by mixed terminologies for emergence, and the analyses cover a wide variety of diseases (including novel pathogens from evolution or host switching, re-emerging pathogens, changing geographies of pathogens or affected communities, and variants on old or known microorganisms such as antimicrobial-resistant organisms). These result in any generalizations on emerging infectious disease and their origins being uncertain and at worst misleading.

Increasing Risks of Spillover of Emerging Pathogens

The 'spillover' of microorganisms between species can lead to the emergence of novel human and animal pathogens and disease syndromes. Figure E.3 shows the relative sources of spillover and zoonoses. This occurs at the interface between species, and for human diseases, it is particularly common where there are animal species (domesticated or wild) which are adapted to human domains and is now hugely amplified through large-scale animal production and trade for human use. Direct naturally transmitted infection (zoonosis) from wildlife to humans in nature is extremely rare but biodiversity plays a key role in the evolution of microorganisms and ultimately novel pathogens. Prediction of emergence is a very inexact science and precautionary principles on reducing emergence pathways to prevent spillover are urgently needed.

As a result of its rapid development and increased consumption of animal products the EAP region is at high risk of EIDs

The EAP region is at high risk of EIDs, rooted in the rapid economic development and dramatic increases in consumption of animal products. Livestock production has increased to meet rising consumer demand, and this has resulted in unprecedented ecological and socio-cultural changes, with increased damage to natural ecosystems and biodiversity. Notably, FAOSTAT[1] shows that the livestock population of cattle, horses, sheep, and goats in EAP increased from 356 million in 2010 to 420 million in 2019. Similarly, poultry also increased from 15.5 billion in 2010 to 22.2 billion in 2019. However, the pig population declined from 819 million to 712 million during the same period. There was a sharp decline of nearly 156 million pigs in 2019 alone because of the ASF outbreak. Though animal husbandry and farm biosecurity measures have improved, barriers to disease entry remain highly variable. This has led to increased opportunities for pathogens to spillover from wild animals to humans and domestic animals and has resulted in a series of epidemics of transboundary animal diseases (TADs), such as the HPAI.

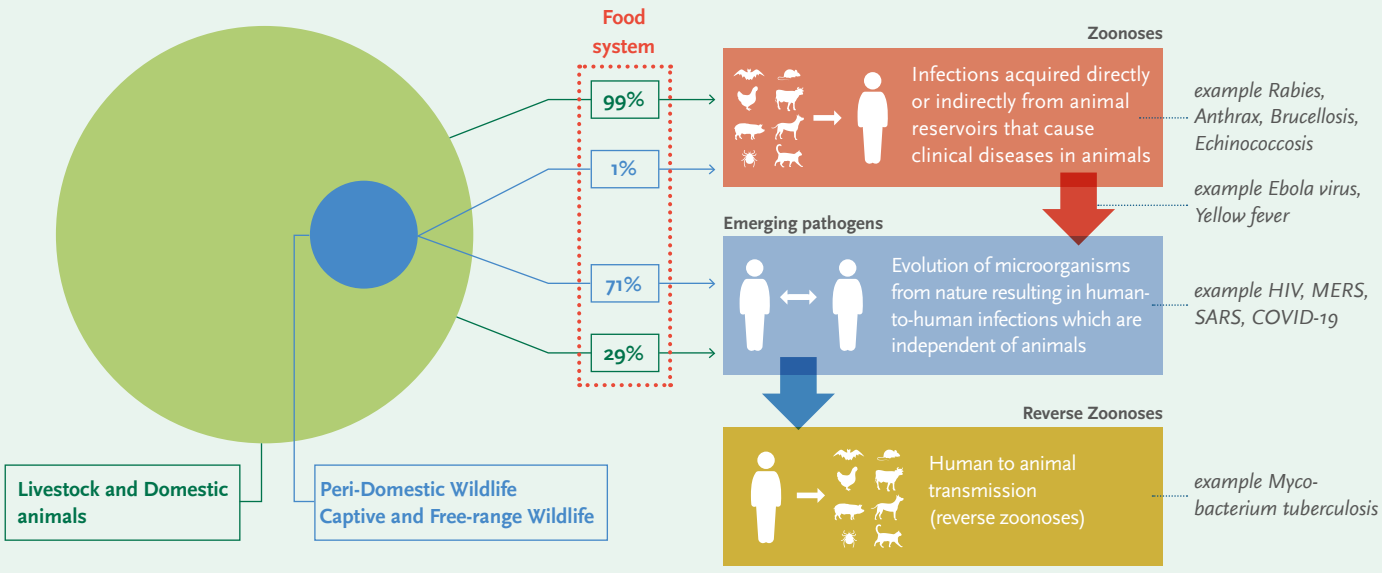


Figure E.3: Diagram showing relative sources of spillover and zoonoses *Source:* Haider et al. 2020, adapted by the authors.

1 FAOSTAT provides a reference to farmgate prices but information is not always updated by countries and it provides only a single fixed price per species across the country, thus ignoring the variability by animal breed, type, sex and age, season, and locality in the country.

In addition, human health continues to be compromised by the relatively high frequency of food-borne zoonoses (e.g., salmonellosis, campylobacteriosis, listeriosis), endemic zoonotic diseases (e.g., rabies, brucellosis), and increased AMR in meat value chains, particularly in low- to middle-income countries in the region. The demand for wildlife products has also been increasing for many years resulting in increased local wildlife hunting and farming and growing global trade in the region for exotic animals/wildlife and products. Captive wildlife farming has developed into a significant industry in some countries, but with very limited if any supervision by government veterinary or wildlife authorities. Wildlife farming has become a significant industry in some countries. For example, it is estimated to be a USD 20 billion industry in China, employing 15 million people. A survey in one region of Vietnam found that there were over 4,000 wildlife farms, farming 182 animal species. Wildlife farming in EAP includes rats, deer, foxes, bears, porcupines, civets, wild boars, and assorted birds including waterfowl.

Many zoonotic diseases are transmitted through defective food systems and exacerbated by poor or unenforced food safety standards

Food systems are important transmission pathways for several zoonotic diseases and EIDs in EAP. Many emerging and reemerging hazards originate or are amplified in food systems. This can occur due to improper handling and slaughter of animals and unsanitary conditions and poor handling of animal products in production, traditional markets, and distribution systems, from livestock species, both harvested or in captivity, and from wildlife. The problem is exacerbated by poorly enforced food safety standards with lack of oversight, monitoring, and enforcement. These create an opportunity in food systems for zoonoses including those caused by viruses, such as the COVID-19, to cross-contaminate products, to be amplified and therefore pose serious risks to human and animal health.

The complex value chains of both livestock and wildlife in EAP compromise the management of infectious diseases and food safety. With live animals and animal products often traded over long distances and by multiple actors along the value chains, live animals are often aggregated at collection points or in traditional markets with high frequency of contact between animals and between animals and humans, which increases the risk of disease transmission. Increasing demand for wildlife products, poor management of wildlife capture, farming, and trade, encroachment into wildlife habitats, and climate change all contribute to an increased risk of infection spillover in EAP.

The Pacific Island countries are particularly vulnerable to adverse impacts from animal diseases due to low levels of social and economic resilience combined with exposure to climate change and multiple natural disasters. These countries have few resources and poor resilience capacity. They are also exposed to increasing risks of waterborne, vector-borne, and food-borne diseases. Their animal health systems are very weak or absent due to limited resources, capacities, or effective programs.

One Health Approach

Because the origin and breadth of human and animal/wildlife diseases and zoonoses are complex and cut across multiple sectors, effective zoonoses and animal disease management must be risk-based and require proactive, coordinated actions through a One Health approach for effective disease risk management (Figure E.4). The One Health approach provides a framework for an integrated multi-sectoral and inter-disciplinary approaches to improving the health of animals, people, and the environment. It is rooted in a risk-based approach that considers points of interactions between humans, livestock, and environment including wildlife and in the value chains for animal products.

To effectively manage the risks of spillover between species, critical control points must be identified which will guide the planning and coordination of subsequent effective control actions with control measures being commensurate with the risk assessed. A risk-based approach identifies the threats (spillovers and disease incursions) and considers the likelihood of their occurrence (probability) and the likely consequences (impacts). This requires systems for identifying and assessing the actual risks, collecting and analyzing relevant information, and converting findings into targeted policy, programs, and response.

The COVID-19 pandemic has demonstrated that once the spread of the disease among humans is established, it can be difficult to control and can have an escalating impact on human health and on national economies (Figure E.5). It is therefore apparent that the reactive model of outbreak control

needs to be changed, with greater emphasis shifted to the early stages of the transmission pathway, that is, prevention at source before these highly infectious diseases are transmitted from animals to humans. Early action limits the rising costs of control and prevents broader impact globally. World Bank economic analysis shows that investments in One Health systems for prevention and control of zoonotic diseases offers extraordinarily high expected benefits, with high rates of return far above those of other public and private investments. Every year, an investment of USD 3.4 billion would produce an expected benefit of USD 30 billion for the international community. The annual expected rate of return would be between 44 percent and 71 percent (corresponding to, respectively, half or all mild pandemics being prevented). The increasing threat of emerging pathogens and pandemic infectious diseases has been brought to the attention of authorities repeatedly, but the necessary mechanisms to proactively reduce the risk of spillover and prevent animal infections or diseases from escalating into future animal or human pandemics have not been adequately established. Greater emphasis must be placed on increasing mechanisms for prevention, early detection, and effective response and resilience to disasters.

Early detection of EIDs depends on timely reporting of disease outbreaks but producers and field staff may not see the benefits of this

Surveillance and the early detection of EIDs and novel pathogens with unknown disease epidemiology and transmission routes rely largely on passive surveillance, that is, systems for timely reporting of unusual disease outbreaks and unexpected health events. Inadequacies in surveillance and information failures are exacerbated by the lack of perceived benefits to producers and field staff. Policy must calibrate producer responsibility and market-based incentives for reporting disease outbreaks with catastrophic financing instruments to compensate for any economic losses. Upgrading scientific investigation infrastructure and capabilities is an important prerequisite for lowering the cost of action at source. Recent research by McKinsey shows that smart investments of as little as USD 5 per person per year globally can help ensure far better preparation for future pandemics, making a strong business case for strengthening the world's pandemic response capacity at the global, national, and local levels.

Assessing EAP's Readiness to Avert Spillover and Disease Spread

Many countries have updated their legislation related to animal health, zoonoses, and food safety, but there are still considerable gaps in their effectiveness due to under-investment in animal and public health for the control of zoonoses and the lack of risk-based approaches to animal disease management. Animal health and food safety policies for the livestock value chain are generally inadequate or absent. In effort to address the growing threat of AMR, most countries in the EAP region have developed national action plans but implementation is weak. Moreover, the science-policy interface required for the development of effective policies and programs to reduce the risk from EIDs and to promote One Health is generally weak across the region. Furthermore, data on, e.g., disease risks, environmental risk factors, and populations at risk, are not routinely being shared between human health, animal health, and the environmental health sectors.

A regional assessment found that currently animal health systems in the EAP region have limited ability to reduce the threat to human health and well-being, because there is insufficient capacity and commitment to implementing and institutionalizing the One Health approaches required.[2] Figure E.6 shows that country risks (using INFORM Epidemic Risk) and their capacity (as indicated by the size of the bubbles) to prevent, detect, and respond to EIDs, zoonoses, and food-borne infections vary markedly and correlate closely with a country's GDP per capita.

All countries in the region have at least basic capacity to detect and respond to EIDs and emerging issues but capacity to prevent disease is very limited. Public health emergency of international concern has been declared at least five times globally since the International Health Regulations were created in 2005. Nevertheless, preparedness has been undervalued, underfunded, and largely treated as optional in several countries. There is also little development of policies and programs to support recovery that could reduce the impacts on food security, livelihoods, and economic development. Instead, across the region, the emphasis has been on outbreak detection and response. A strategic approach to threat identification and risk management is rarely undertaken.

2 The assessment was conducted to study the systems, institutional capacity, and performance of the two pillars of animal health services (both domestic and wildlife) in EAP, by using the available WOAH Performance of Veterinary Services (PVS), WHO Joint External Evaluation (JEE), and the 'State Party Self-Assessment Annual Reporting' (SPAR) tool reports.

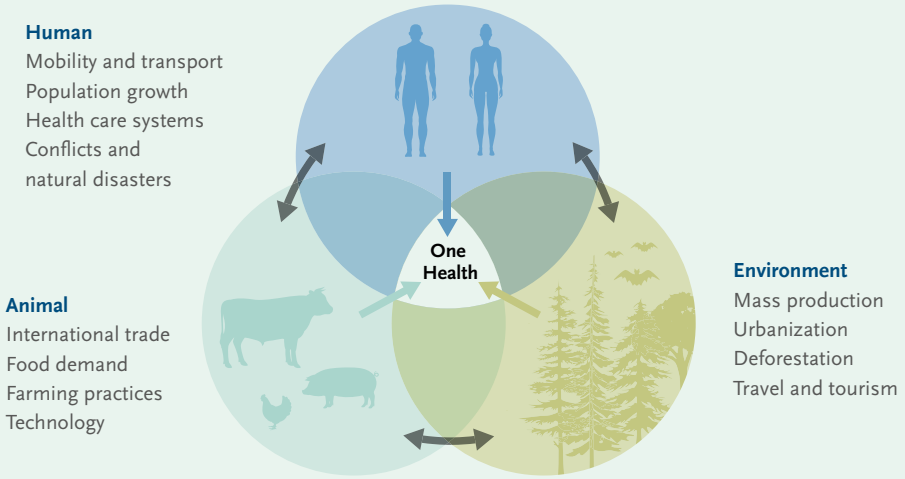


Figure E.4: One Health for effective management of spillovers and zoonotic diseases *Source:* adapted from Bedford et al. 2019.

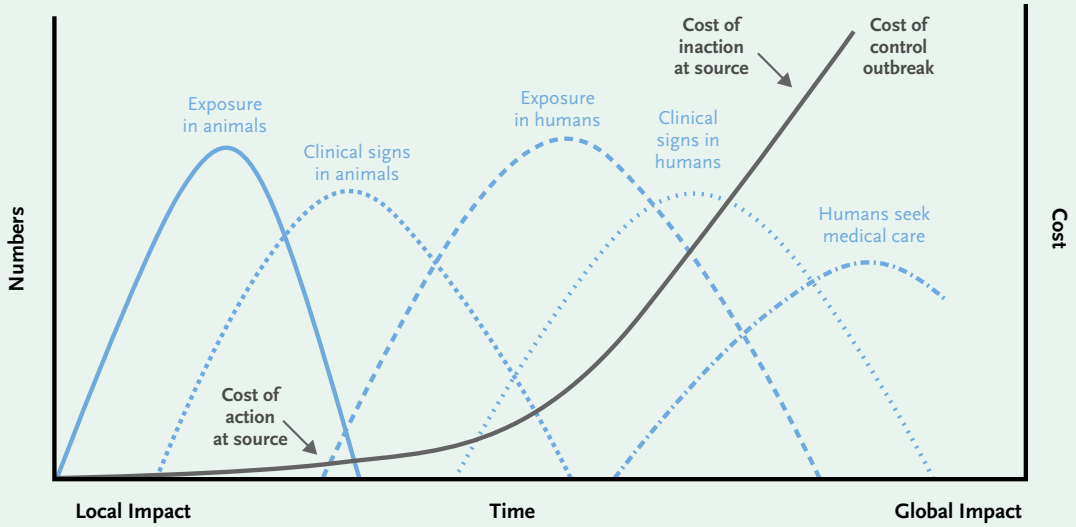


Figure E.5: Cost of actions and inaction as the pandemic traverses from local to global proportions *Source:* World Bank 2012 adapted by the authors.

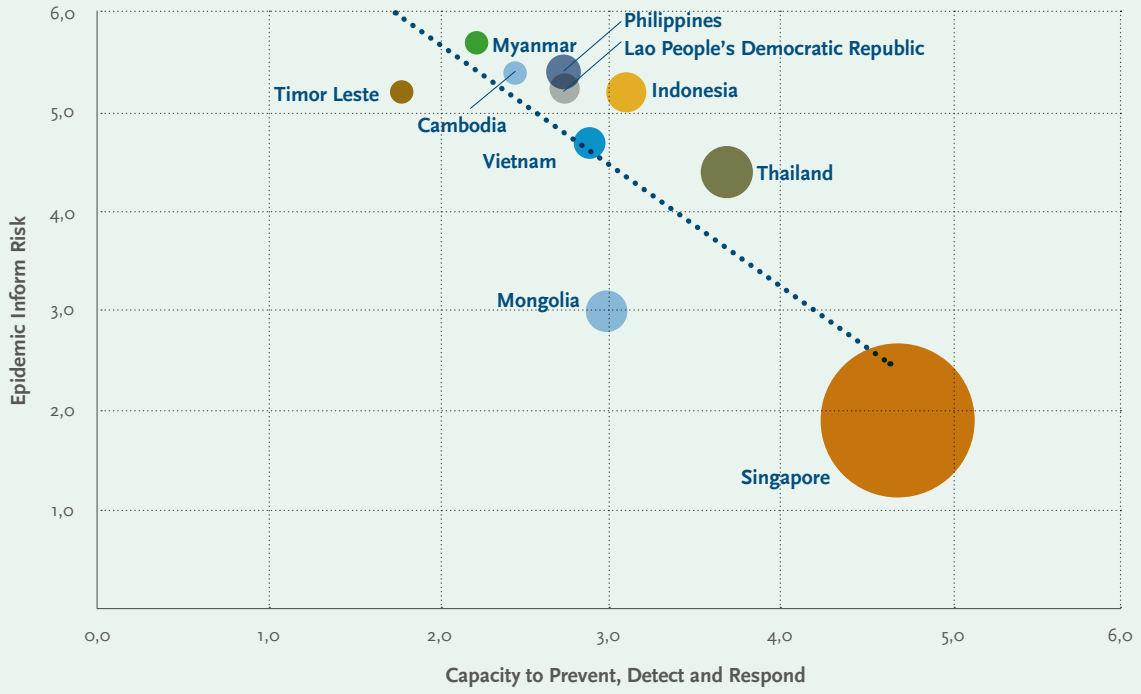


Figure E.6: Institutional capacities for managing EIDs linked to livestock, zoonoses, and food-borne infections *Source:* Authors' own elaboration.

The capabilities and capacity of veterinary services in the region are dependent on the level of development in countries and there is considerable variation in the quality and quantity of relevant infrastructure. Lower-income countries generally have the weakest veterinary services even in countries where the investment in livestock is significant. Animal health field services are often provided by poorly qualified staff with insufficient veterinary supervision. The region lacks capacity in epidemiology and there is little integration between national and sub-national systems for economic assessments, disease prevention, detection, and response. All countries in the region have some surveillance capability but with varying levels of reliability and timeliness. In terms of infrastructure and equipment, a number of countries have limited equipment at all levels, while others have adequately equipped facilities in the national headquarters and the main national and regional laboratories but lack the necessary infrastructure at the sub-national levels. It can be noted that although there is a lack of laboratory information management systems (LIMS) and bioinformatics capabilities, the availability of information management systems, internet access, and smart phones in better resourced countries has resulted in improved communications, data capture, and lines of reporting. Also, the technical quality of veterinary laboratories in the region varies considerably, but many are now operating at high standards with good reliability.

The quality and availability of veterinary services varies greatly, with poorly qualified staff providing unsupervised field services in some countries

Across the region, there is little evidence of dedicated institutional mandates for wildlife health and emerging disease prevention, detection, and response. Wildlife health systems and programs in the region are underdeveloped. There is a lack of clarity over the responsibility for the different wildlife subsectors – free-ranging, captive, and farmed wildlife. Few or no veterinarians are employed to monitor wildlife health in most countries. There are few wildlife disease surveillance programs in EAP. Moreover, the lack of a clearly defined mandate for wildlife health results in a lack of ownership with no or only a few programs that monitor wildlife health and changes in health status which could provide early warning of increased threats to wildlife and of potential spillover to humans and domestic animals. A key challenge for the systematic strengthening of national wildlife health programs is the lack of a dedicated tool to study a country's ability to assess and manage wildlife and wider environmental functions and to prioritize areas of investment. Efforts to date in the region have largely focused on specific diseases and/or species, rather than building systems. Globally, investment in wildlife services is limited, of which only 5 percent goes to support wildlife health.

Adopting One Health approaches in EAP has been a slow process, with respect to both policy development and implementation in most countries across the region. Cross-government coordination to deliver One Health has been initiated in almost all EAP countries, but they often lack sufficient commitment. An important challenge for establishing effective One Health coordination with improved policies and programs is the different priorities set by the different ministries.

Cross-regional coordination is limited as no single entity covers the whole East Asia and Pacific region. A Tripartite Regional One Health Coordination Group has been established in the EAP region covering FAO, WHO, and WOAH and their regional and sub-regional offices. Regional and international agencies and development partners have developed a number of regional programs and frameworks to support laboratory capacity building, disease control in livestock production, and trade, with a focus on a number of prioritized animal diseases in the region. These programs, however, have not been fully effective in delivering successful prevention or sustainable control of the diseases. Collaboration was established also with UNEP on AMR especially.

Building Animal Health and Wildlife Systems for One Health

Public health systems (wildlife, animal, and human) need to be strengthened through a coordinated One Health approach to better understand the epidemiology and risk factors for zoonoses and to reduce the burden of zoonoses more effectively. A simple Theory of Change shows how establishing a One Health approach can deliver improved human health and well-being by reducing the risks from emerging pathogens and zoonotic diseases from improvements in wildlife, animal health, and public health systems (Figure E.7). The Theory of Change demonstrates the interconnectedness and array of coordinated activities at the regional, national, and sub-national levels that must be addressed to effectively reduce the threat from existing and emerging zoonoses and the promotion of food security, improved production efficiency, and a reduced impact on the environment.

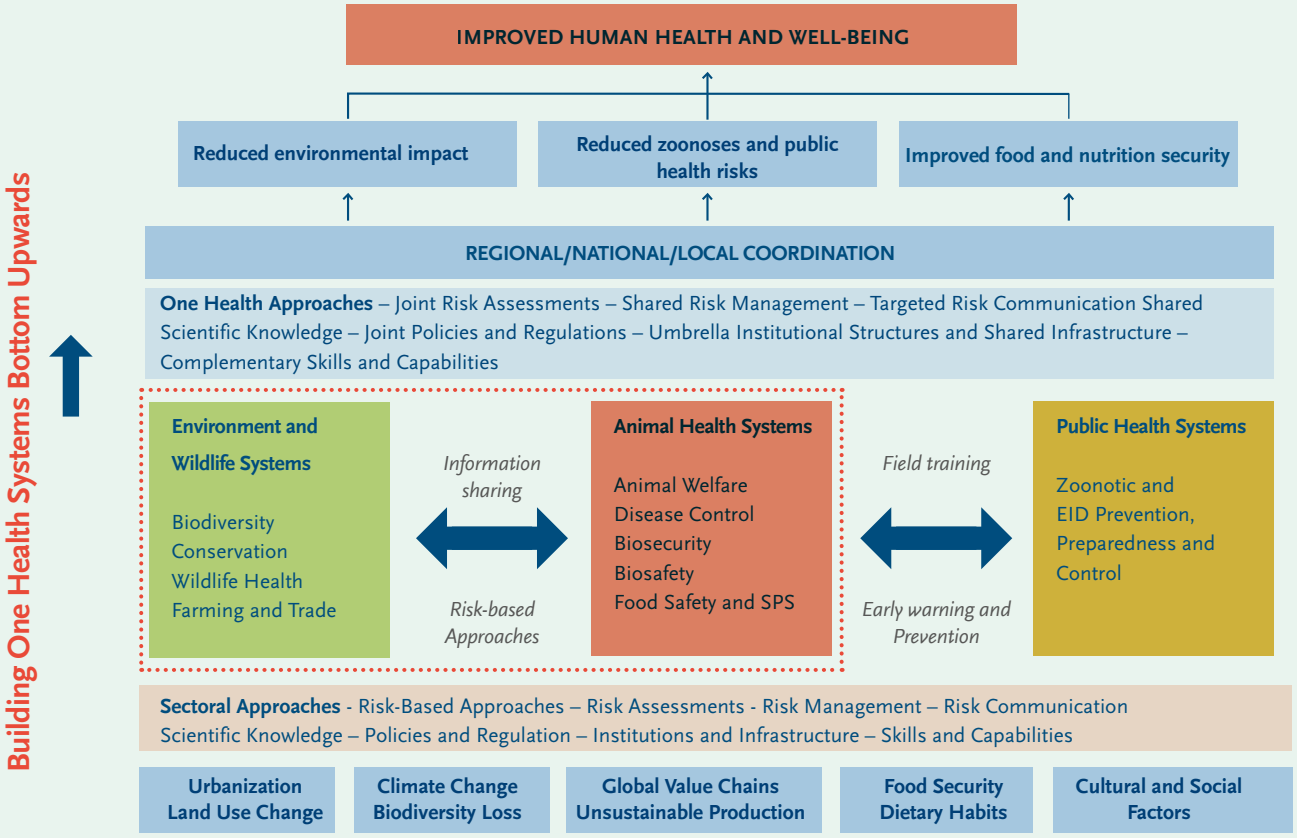


Figure E.7: Theory of Change for building animal health and wildlife systems for One Health *Source:* Authors' own elaboration.

Aligning incentives for local actions in wildlife and animal health with global public health benefits under One Health, however, involves complex political economy issues. Most arguments for investments in One Health are rooted in the cost savings from preventing nationally and globally significant public health crises. However, the returns from upstream preventive measures and surveillance for human health related to One Health investments might not fully compensate the local governments, the private sector, and the communities for their investments in animal and wildlife health unless additional value and revenue streams are created to increase the pool of local benefits and improve investment efficiency. While transfers or ecological compensation mechanisms could be instituted for transmitting global benefits to local areas, taking a food system approach for preventing zoonotic diseases, enhancing food safety, and reducing AMR could add up to significant local benefits.

Developing effective One Health systems in EAP

Political leaders and senior managers need to understand the many, well documented benefits of One Health policies and programs

One Health systems need to be developed and harmonized in EAP to protect and promote human health, animal health (including livestock health and production and wildlife health), and environmental health to reduce the risks of spillover. Key gaps are found when addressing the majority of zoonoses that arise from animal-based food systems and the weak wildlife and environment health institutions and capacities. Legislation covering animal health services (including wildlife), the risk management of wildlife and animal use systems, and emergency preparedness and response should be reviewed and revised. This includes providing the authority to take the necessary rigorous surveillance and control measures for emergency response, particularly funding and the development of required systems and staff resources. Cross-sectoral training and development of capacity in epidemiology and One Health should support this.

Enhanced national commitment to One Health policies and programs should be developed through advocacy to political leaders and senior managers using evidence-based information on the benefits of this approach. These include fostering improved knowledge of livestock demographics and trading patterns, the wildlife trade, disease surveillance in animals and people, and economic impact and cost-benefit studies. One Health risk governance and cross-sectoral engagement should be established through legal commitment, functional coordination, and establishment of operational mechanisms with the line ministries.

One Health approaches are needed to strengthen governance structures and institutions at national and sub-national levels to meet the challenges from emerging pathogens, EIDs, and zoonoses to human and animal health. This requires a clear mandate with well-defined roles and responsibilities and how coordination and collaboration is to take place between the relevant ministries and agencies (e.g., Ministries of Agriculture and Food, Environment, Public Health, Transport, Commerce, Food Safety, and other related agencies). Institutions, their systems, staffing, and budgets will need to be developed to provide the necessary capabilities in risk reduction. It is important to remember that strengthening animal health is not a one-off activity but a process that needs to be integrated into the institutional setup and processes. Table E.1 shows that One Health approaches can be built through multi-sectoral, multi-domain, and multi-level coordination between wildlife systems, animal health, and public health agencies.

Table E.1: Building One Health system with multi-sectoral, multi-domain, and multi-level coordination *Source:* Authors' own elaboration.

	Country Level	Regional Level
Domain Specific	- Engaging with politicians and senior decision-makers to advocate for One Health policies and programs - Developing One Health champions within key institutions - Addressing legislative, regulatory, and institutional voids and harmonizing with global standards - Strengthening analytical base for risk-based approaches - Aligning animal disease and wildlife health programs with risk-based approaches with strong One Health links - Improving enforcement capacity with transparency and accountability - Incentivizing private sector for responsible production, biosecurity, hygiene, and safety compliance	- Establishing One Health leadership forums - Support harmonizing legislative, policy, and regulatory frameworks with global standards - Technical assistance, training, and capacity building - Investing in surveillance programs for emerging infectious disease and transboundary animal diseases (TAD) and wildlife health programs - Information networking, developing data standards, and regional data sharing - Promoting safety standards, trade protocols, and inspection procedures for 'fail-safe' systems regional disease surveillance and control
Multi-Domain	- Bridging sectoral mandates, institutional arrangements, and enforcement mechanisms - Using economic analyses to optimize utilization of resources - Sharing risk analytics and improving risk communication promoting trust and respect - Information systems using 'dashboard approach' on a need-to-know-and-act basis - Strengthen early warning using novel approaches and disruptive technologies, e.g., syndromic surveillance, social media - Collaborative research, academic courses, and capacity building on One Health in medical and veterinary schools - Market-based and consumer approaches for food safety and to reduce the risks from AMR, zoonotic, and EIDs	- Facilitate regional One Health policy forums engaging with WHO, WOAH, ASEAN, APEC, etc. - Strengthen evidence base for One Health risks - Information exchange on cross-border risks and emerging risks - Reciprocal exchanges and mutual assistance to provide enhancing surge capacity for combating pandemics - Regional funding mechanisms to promote One Health investments in member countries - Networking One Health facilities and capabilities complemented by remote diagnostic and surveillance technologies - Support for regional centers of academic excellence for advancing One Health research

Fixing the weak links in animal health and wildlife systems first

The 'chain of command' of veterinary services needs to be re-established to ensure efficient and effective service delivery with clear lines of authority or clear mechanisms of coordination and information flow. Veterinary services in EAP countries need to be enhanced with greater emphasis on and integration with national and regional disease monitoring and prevention systems, strengthened disease intelligence with improved analysis and reporting (greater use of epidemiology and economics), improved detection and response mechanisms, and clearly defined communication channels.

There is an urgent need for wildlife management services to be strengthened with close coordination and integration with the human and livestock health services to support prevention, detection, and risk reduction of pathogen spillover, EIDs, and zoonoses. Greater understanding of the legal and illegal wildlife trade (including free-ranging wildlife, captive wildlife, and wildlife farming) needs to be developed to identify the high-risk pathways that require urgent attention, taking into account the socio-cultural drivers of demand and the economics of supply. The risks posed by the increasing encroachment into wildlife areas arising from activities such as farming, logging, mining, tourism, urbanization, etc. and the threats from climate change should be assessed, options for reducing the risks identified, and a program of risk reduction needs to be implemented. Enhanced cross-sectoral coordination among sectors would improve the efficacy of wildlife surveillance systems, the identification and management of the risks of wildlife disease and pathogen spillover, and more broadly ecosystem health and population ecology.

Efficient and effective sectoral surveillance programs need to be supported by structured scientific risk assessment to identify and prioritize risks using the One Health lens. This, in association with public health surveillance systems, will provide early warning for pathogen emergence and provide the evidence base for the development of controls to minimize risks to human health. National information management systems should be developed to ensure that timely and reliable information is available to develop targeted risk-based surveillance programs to address the prioritized risks for EIDs, zoonoses, and food-borne infections. Mapping out the complex interactions between humans, livestock, and wildlife all along value chains for animal products and the changing interactions with wildlife through trade, farming, and ecosystem change should form the basis for the risk assessment. Having identified the highest risks, mitigation measures need to be implemented to reduce these risks, based on coordinated One Health approaches with functional cross-sectoral systems that can rapidly detect spillover events and are able to respond quickly and effectively.

Applying a One Health approach to food systems will address many of the world's emerging threats to human health, such as food safety and AMR

Cultivating One Health practice during peacetime

Applying One Health approaches to food systems would address some of the emerging priorities and global public health threats such as food safety and AMR. Working across multiple sectors has demonstrated that strengthening food safety along the food value chain aligns closely with the One Health approach and provides entry points to address emerging infectious diseases and zoonoses (See Figure E.8). Risk assessments should be undertaken with a sound understanding of domestic animal and wildlife diseases, food-borne infections and residues, and the risk from potential zoonotic pathogens and how they could be transmitted through the food value chain. Quality assurance programs should be used to support investment in food safety and the reduction of food-borne disease risks. Animal and animal product identification and traceability are essential for food safety assurance and improvement in disease control. Traders, markets, and other 'aggregation points' such as collection yards, live animal markets, and slaughterhouses pose a high risk for disease transmission between animal populations and humans. Programs that reduce this risk should be developed using the principles of science-based structured risk assessments.

One Health systems for EIDs and zoonotic diseases can build on and benefit from experience of adopting a holistic approach to addressing the threat of AMR. Countries in EAP should further develop the necessary legislation and enforcement to minimize and eventually stop the misuse of critically important antimicrobials and strengthen surveillance of antimicrobial usage and AMR. Animal production practices need to be significantly improved throughout the region to reduce the need to use antimicrobials. The reduction in the use of antimicrobials needs to be supported by increased awareness building of the AMR problem among producers and consumers and be combined with targeted investment and programs to incentivize the improved biosecurity measures to reduce the risk of disease. Improved biosecurity measures should address poor production practices and utilize in situ risk management protocols such as zoning and compartmentalization, tracking of movement of live animals and animal products, Good Animal Husbandry Practices (GAHP), Good Hygiene Practices (GHP), Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Points (HACCPs), etc.

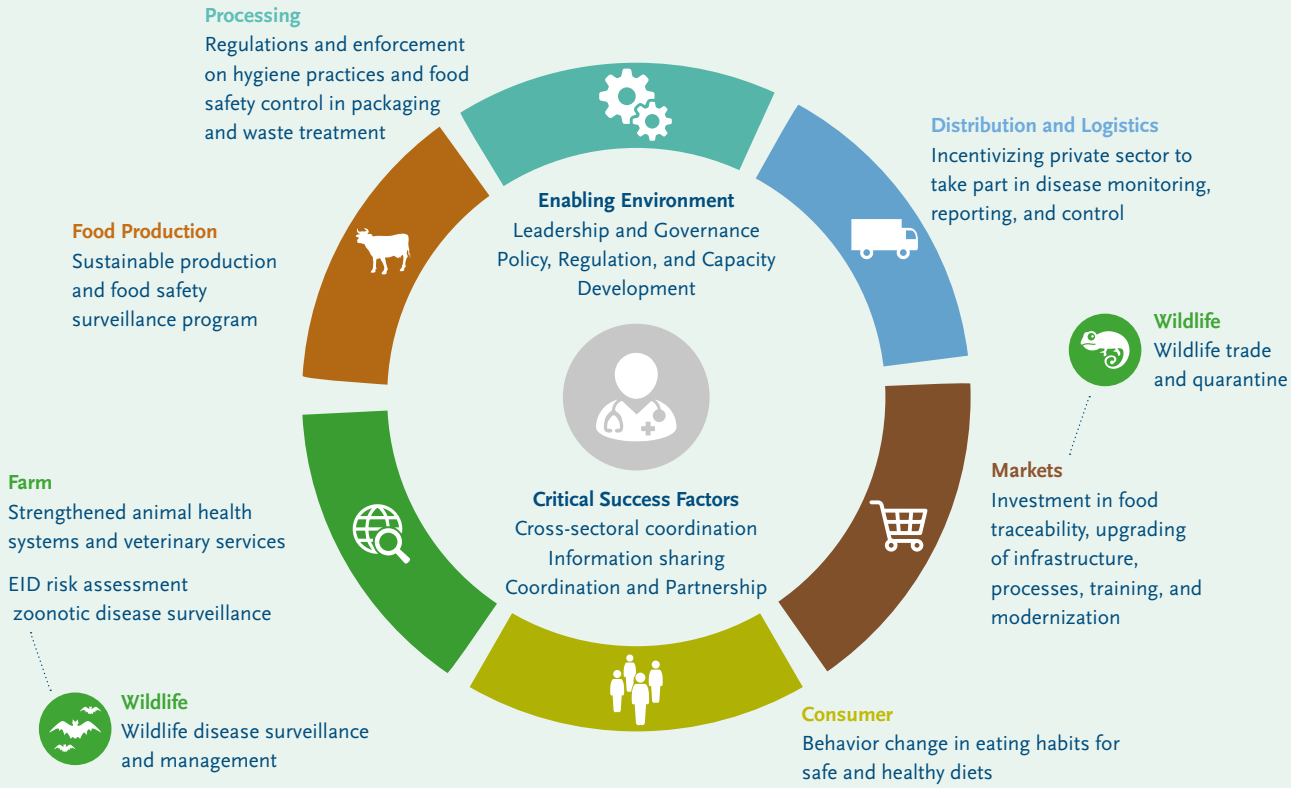


Figure E.8: Entry points for One Health approach in food systems *Source:* Authors' own elaboration.

A food systems approach to prevent zoonotic diseases, improve food safety and reduce AMR bring many benefits that fully justify public and private investment

Coordination beyond local jurisdictions for preventing pandemics

The global benefits of local actions in wildlife and animal health 'with global public health benefits' under One Health justify mobilizing international public financing for this purpose. Taking a food-systems approach for preventing zoonotic diseases, enhancing food safety, and reducing AMR generate significant local benefits and thus justify public and private investments in animal and wildlife health by local actors such as communities, private sector entities, and local governments. Nevertheless, local benefits to these actors may not be immediate compared to the urgent national, regional, and global need for these preventive investments and the significant global public good that they create. Surveillance everywhere is of value, but the global returns to investment will be highest in the countries in which surveillance is weakest. The cost savings from preventing nationally and globally significant public health events that investments in One Health would bring could justify instituting national and international public transfers or ecological compensation mechanisms to certain local private and public investments, given that they generate global public benefits.

Regional policy support should be strengthened to better coordinate and improve the policy, legislative, and regulatory environments across countries in the region. Regional centres should be further developed as regional resources to support less developed countries – this applies particularly to the Pacific Island countries. Evaluations, such as the World Organisation for Animal Health – Performance of Veterinary Services (WOAH-PVS) and the World Health Organization – Joint External Evaluation (WHO-JEE), should be encouraged and supported. In parallel, a dedicated equivalent tool should be developed to sufficiently assess the capacity needs for wildlife and environmental health services to cover the full One Health 'triad'. Regional information sharing and coordination systems should be further strengthened and mandated with full transparency and dynamic real-time sharing of data and information. National animal health information systems will be important platforms to support the more efficient exchange of data across the region. Promoting regional collaborative programs to harmonize protocols, guidelines, and standard operating procedures and developing capacity especially to monitor pathogen mutation and spillover risks are also needed.

Lessons from the Field

Experiences from several developing countries provide real-case examples of One Health that illustrate how the concepts explained in the report are applied in practice along with the key elements for successful programing enumerated in the report including the following.

Risk-based human animal disease prevention and control

The implementation of effective global, regional, and national programs for the prevention and control of EIDs, zoonoses, and food-borne infections requires strong commitment for the development of well-resourced, coherent One Health policies and programs to support risk-based approaches. The global program for the eradication of rinderpest in 2011 demonstrated that risk-based approaches for disease control can be used to successfully control and eradicate priority animal diseases with multiple hosts at the global, regional, national, and sub-national levels. Several global strategies are also in place to prevent and control major animal diseases such as the global strategic plan to end human deaths from dog-mediated rabies by 2030, Global Foot and Mouth Disease (FMD) Control Strategy, and the Global Strategy for the Control and Eradication of PPR (peste de petits ruminants) and several other diseases such as brucellosis and ASF.

Food safety as a driver for change

Food safety is a major driver of change as consumers' demand and knowledge increase which in turn also provide impetus for higher-level political support. For example, Ho Chi Minh City has a strong commitment to improving food safety and has largely been successful in banning the sale of live animals in traditional markets. This approach of providing consumer confidence in the product rather than simply banning a traditional market source of animals is being well accepted and is also benefiting the better producers with higher market returns. Compared with other parts of the country, Ho Chi Minh City now has a significantly higher proportion of consumers using improved markets than traditional markets which continue to suffer from compromised hygiene and sanitation.

Greater consumer knowledge and demand can be a major driver for change in the area of food safety

Targeted approach to reducing AMR

Setting priorities provides leadership and structure for changing paradigms. As part of the global effort in combating AMR, China issued a multi-ministerial national action plan to contain antimicrobial resistance. Under the plan, a series of actions are being taken to strengthen the surveillance, supervision, and management of antimicrobial usage, to carry out pilot projects on reduction of on-farm antimicrobial use, and to introduce a traceability scheme for evidence-based veterinary drug use. The approach requires a high level of government commitment, public awareness, and monitoring to ensure its effectiveness to ensure progress is made and sustained.

Traditional markets

The traditional markets vary in terms of EID, zoonotic, and biodiversity risks. The key features that determine their risk profile include (i) the presence of higher-disease-risk species, (ii) the presence of live animals, (iii) hygiene conditions, (iv) market size, (v) animal density and interspecies mixing, and (vi) complexity of the supply chain. When classified based on the presence or absence of live domestic and wild animals, traditional markets can be categorized along a continuum of risks to human health and biodiversity and would show the proportionately small number of traditional markets selling live, wild animals that have been the source of many previous EID outbreaks. Looking forward, policy makers should prioritize regulating the traditional markets and taking steps to prevent resurgence of their most high-risk aspects. These factors impede the coordinated approach that is essential to improve hygiene standards and food safety in markets.

Digital technology and disruptive innovation

Digital technology is radically changing the world and providing opportunities for improved forecasting, better identification of emerging issues, optimized application of risk mitigation measures, and monitoring of residual risks. In Sri Lanka, an Infectious Disease Surveillance and Analysis System was launched, as part of which 40 field veterinarians were recruited and trained in the use of the mobile phone for data capture of animal health events for three species (chickens, cattle, and buffaloes), including global positioning service (GPS) data on locations. The increase in real-time information flow compared to the previous situation where data was summarized and only reviewed monthly resulted in early notification of suspected cases.

Public-private sector opportunities

The public and private sectors working together can provide real opportunities for synergy for achieving improved delivery of animal and veterinary services. It also opens the possibility for potential cost sharing for program delivery. For example, the Guangdong provincial authorities in China and the private owners of a large live bird market jointly funded a public-private partnership (PPP) to improve biosecurity in the market. The project involved a detailed analysis of the market and its operations and provided recommendations on how to improve its biosecurity measures. This partnership resulted in the construction of privately operated facilities for the wash-down of trucks, crates, cages, and equipment, the design of improved workflows, replacement of crates, redesign of the drainage system, improved processes for cleaning, and the reduction of time in market. Staff were also trained in improved hygiene and biosecurity practices.

By working together the public and private sectors can together deliver better animal and veterinary services, sharing the delivery costs

Country-Specific Recommendations

There is considerable variation among the countries in the EAP region with respect to their animal health and wildlife management systems capacity. Therefore, countries need to strengthen animal health and wildlife systems based on their individual context and risks. Table E.2 summarizes the key priority actions for each country.

Table E.2: Recommendations for strengthening One Health systems in select EAP countries *Source:* Authors' own elaboration based on NAPHS, JEE, PVS reports and expert reviews.

Country	Recommendations	
	Animal Health	**Wildlife Systems**
Cambodia	Improve coordination and service delivery. Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Train veterinarians and paraprofessionals. Develop cross-sectoral rapid response teams for a coordinated response. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
China	Strengthen enforcement of laws and adoption of good practices to improve biosecurity, food safety, and AMR control stewardship along the agri-food production and value chains to better prevent the EIDs like H7N9 influenza, COVID-19, etc.	Review and define institutional mandates for wildlife health risks and harmonize the regulations and enforcement procedures to address vulnerabilities in the detection of emerging disease. Reduce contact between wildlife, animals, and humans at farms, aggregation, and markets. Improve community engagement and promote public awareness.
Indonesia	Improve coordination and chain of command of animal health services. Strengthen One Health coordination and collaboration. Strengthen cross-sectoral emergency preparedness and response systems. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies and specialist veterinary skills.	Strengthen surveillance systems and improve One Health coordination and collaboration. Train staff at provincial and district levels. Promote public awareness. Reduce contact between wildlife, animals, and humans at markets. Improve food safety at markets and slaughterhouses. Provide resources for activities and development of institutional capacity and systems.

Lao People's Democratic Republic	Improve coordination and service delivery. Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Strengthen mechanisms for intersectoral collaboration, including with environmental health. Increase information sharing between sectors for timely response. Develop cross-sectoral rapid response teams for a coordinated response with the use of the Field Epidemiology Training Program (FETP) and the Regional Field Epidemiology Training Program for Veterinarians (FETPV). Provide resources for programs. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
Mongolia	Strengthen One Health coordination and collaboration. Strengthen emergency preparedness and response systems and provide resources. Increase use of risk assessments for disease surveillance, control and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies and specialist veterinary skills. Strengthen cross-sectoral emergency preparedness and response systems.	Develop human resources for wildlife surveillance and management. Undertake surveillance and develop mechanisms for sharing information across the human, animal, and wildlife sectors. Provide resources for activities and development of institutional capacity and systems.
Myanmar	Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Increase support and coordination for the One Health approach. Improve wildlife disease surveillance and the integration of information across sectors. Develop human resources for wildlife surveillance. Provide resources for activities and development of institutional capacity and systems.
Philippines	Further develop One Health coordination and collaboration. Strengthen coordination for emergency preparedness and response systems and provide resources. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies and specialist veterinary skills.	Improve wildlife surveillance and the harmonization, data exchange, and multi-sectoral analysis of data between human and the animal/wildlife sectors.
Timor-Leste	Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Improve coordination and service delivery. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses.	Develop human resources for wildlife surveillance and management. Undertake surveillance and develop mechanisms for sharing information across the human, animal, and wildlife sectors. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
Vietnam	Improve coordination and service delivery. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Strengthen border control. Develop staff competencies and specialist veterinary skills.	Improve coordination between the wildlife, animal, and human sectors – both for wildlife hunting/trade and farming. Reduce contact between wildlife, domestic animals, and humans at markets. Contribute to planning, data sharing, and coordinated response to zoonoses. Provide resources for activities and development of institutional capacity and systems.

PHILIPPINES
Plastic sheets used to enforce social distancing are seen in the stalls at a market in Las Pinas, Metro Manila, Philippines.
Photo credit: Jim Caro/FAO

Chapter 1. Introduction

This joint World Bank-FAO report analyzes the drivers of zoonotic and emerging infectious diseases (EID) and offers strategic recommendations for preventing their spread in animals and humans using a cross-sectoral approach. Building on the latest global knowledge and evidence, practical guidance is provided for making policy improvements, institutional strengthening, and investments in animal health and wildlife systems in East Asia and Pacific (EAP). The report complements and deepens an associated report 'Reducing Pandemic Risks at Source - Wildlife, Environment and One Health Foundations in East and South Asia' (World Bank and FAO 2022) that analyzes risks of EIDs from wildlife and the gaps in wildlife systems. The COVID-19 pandemic has been one of the greatest challenges ever to human health and well-being and has resulted in significant ill health, mortalities, and an economic recession globally. Initial investigations suggest that the causal virus of COVID-19, SARS-CoV2, was probably transmitted directly from wild animals to humans or indirectly through domestic animals. The consequences of failing to prevent or effectively control COVID-19 at source have already been dramatic, compromising human health and well-being globally, and resulting in worldwide economic contraction. The global economy entered into a recession in 2020: economic growth is estimated to have contracted by 5 percent with significant negative impacts for countries and their people (World Bank 2021). Furthermore, the resulting rising debt that many countries have had to accumulate will remain a long-lasting economic burden for years to come.

The EAP region has been identified as a global hot spot for EIDs, including zoonoses (i.e., an infection that is naturally transmissible from animals to humans). Since 2000, multiple EID outbreaks have occurred in the region including SARS, multiple types of avian influenza, and african swine fever (ASF). A number of zoonoses, including SARS, have originated especially in East Asia and Southeast Asia and have spread as human-to-human diseases between countries in the region and beyond. COVID-19 has been the most devastating, but previous EID outbreaks have also had important human health, animal health, food security, livelihoods, and economic impacts, revealing that adequate structures to manage zoonoses and animal diseases were not in place. Vector-borne diseases such as Zika, Lumpy Skin Disease, and so on have also been increasing in the region in part driven by climate change and changing vector patterns. The region is particularly vulnerable to EIDs owing to the multiple risk factors including the large and increasing human and livestock populations, increasing levels of consumption of and trade in animal products, and high levels of urbanization, leading to environmental degradation and encroachment on natural habitats, poor animal husbandry and food safety practices, and cultural norms which bring humans and animals into close proximity. The Pacific Island countries appear to have been free of emerging infectious diseases and major transboundary diseases, likely due to isolation and the low densities of people and animals. They, however, face a similar range of food safety threats to the other parts of the EAP. These include common organisms that are endemic in farm animals including Campylobacter, E. coli, Salmonella, and Listeria.

The EAP region has suffered greater economic losses from epidemic diseases than any other region in the world

The direct and indirect costs of these diseases are significant and EAP has seen the highest economic losses from epidemic diseases of any region in the world. Recent International Monetary Fund (IMF) estimates show that prolonged impact of COVID-19 could reduce the global GDP by a cumulative of USD 5.3 trillion over the next five years (World Economic Outlook, IMF, October 2021), further to the estimated loss in output relative to the pre-pandemic projected path of USD 11 trillion during 2020-21 (Gopinath 2020). McKinsey estimates that by 2025, COVID-19 will have cost the world between USD 16 trillion and USD 35 trillion (McKinsey 2021a). EAP's total cost of the previous pandemics was estimated at USD 200 billion per year or 0.9 percent of the region's GDP, and these costs of disease outbreaks have increased dramatically over recent decades (World Bank 2017). Beyond the human health impacts, animal diseases inflict significant costs on the livestock sector as seen in the epidemics of avian influenza and ASF. Between 2003 and 2013, more than 175 million poultry were culled across Southeast Asia to control H5N1 Highly Pathogenic Avian Influenza (HPAI). The cost of ASF through much of Southeast Asia during 2018-2019 was estimated to be between USD 55-130 billion from animal mortality, control activities, replacement animals, and foregone revenue (Weaver and Habib 2020). Importantly, diseases disproportionately affect smallholders and consumer prices with consequences for food security and nutrition and food safety. Diseases also have indirect effects on the environment from control measures such as animal culling, the use of disinfectants, etc.

Despite the rapid growth of the livestock sector in the region, the institutional infrastructure for domestic and wild animal health has not adopted the necessary risk-based approaches necessary for effective disease management. The COVID-19 pandemic has exposed these institutional deficiencies. Livestock production, supply chains, and trade have increased dramatically in recent years with the increasing affluence in the region and rising demand for meat and other animal products. However, regulatory frameworks and animal health services are often not based on actual risks in the sector, nor have they sufficient capacity to perform the surveillance, disease monitoring, and control that are necessary for effective disease management. While some livestock husbandry practices have improved, they commonly remain poor with a high dependency on antimicrobials to avoid high mortalities and morbidities. This has resulted in very high rates of antimicrobial usage and consequently high levels of antimicrobial resistance (AMR) in many countries in EAP.

Wildlife trade (wild and farm sourced) has increased in the EAP region and is recognized as the greatest threat to human health from the spillover of emerging pathogens, but wildlife management systems are currently inadequate to address this risk. The weak wildlife systems across the EAP region are limited by lack of policy frameworks, unclear institutional mandates/lack of a clear responsible authority, poor cross-sectoral collaboration, inadequate investment, insufficient staff and staff training, and ad hoc, fragmented surveillance systems, if any. There is a need to address these limitations and also the broader context of environmental degradation, biodiversity management, and land use, to limit the risk to human and domestic animal health from the wildlife trade.

To address the threats from EIDs and zoonoses, there is a need to develop animal health and wildlife health systems by assessing and mitigating risks and coordinating human, animal, and environmental health through the One Health approach. Domestic animal systems involve an ongoing cost to human health from endemic and food-borne zoonoses whereas the risk from wildlife is of a much lower probability but has a potentially catastrophic impact (as COVID-19). Risk-based animal disease and wildlife health management should identify and target critical points for improved prevention, detection, and recovery. Furthermore, it should prioritize diseases that have been assessed to – or potentially to – have the highest negative impacts. The One Health approach identifies the need for close cooperation among the human health, animal health (both domesticated and wild animals), and environmental health sectors, to work together using cross-sectoral and inter-disciplinary approaches. Risk-based animal disease and wildlife management and coordination across the three sectors are central components in the One Health framework but are underdeveloped. The COVID-19 pandemic has emphasized the need for effective One Health systems to be established around the world. By taking a One Health approach to reducing the risk of EIDs, policies and programs can be developed and strengthened, and these will also provide a broad benefit of improved control of transboundary animal diseases (TADs) and other animal diseases. This also contributes to food security and food safety and promotes economic development and resilience to disasters.

The objectives of this report are to assess the status of policies, institutional structures, systems, and programs for animal health and wildlife management systems in EAP, identify the gaps and challenges faced, and provide recommendations to strengthening these systems for improved One Health in the region. This report does not cover the public health aspects of One Health as this topic is addressed in separate studies. Countries in EAP are immensely diverse with wide variations in governance and administrative structures, population sizes and densities, livestock populations and production systems, GDP per capita and stages of economic development, as well as environmental degradation and pressures on wildlife resources. The report provides a framework and recommendations on how to strengthen the policies and institutions in the region for improved animal (domestic and wildlife) health management. Consideration is given to the different approaches being used as an opportunity to develop a 'lessons learned' approach and as an indicator of how to address country and regional limitations.

This report assesses policies, systems and programs in EAP animal health and wildlife management, identifying gaps and challenges with recommendations for improved One Health

This report was developed in response to the COVID-19 pandemic and provides recommendations to Governments in the EAP and development partners, on how to strengthen their policies and structures for animal health and wildlife management. It should be viewed as an urgent first step towards developing coherent effective One Health systems to reduce the risk from future pandemics at the national and regional levels in the EAP region. The report focuses on animal health systems, both domestic animals and wildlife, and the measures that are required to support the delivery of effective One Health systems. It reviews national capabilities and capacities and also examines the regional support programs. While the report refers at times to food safety, which is a topic that overlaps with animal health, food safety regulations and infrastructure are not assessed in depth in this report, as they are covered under another study on 'The Safe Food Imperative: Accelerating Progress in Low- and Middle-Income Countries' (Jaffee et al. 2019).

The report is structured as follows: Chapter 2 provides an overview of the socioeconomic impacts of zoonotic diseases and epidemics in EAP and assesses the costs, including the impacts on human health. Chapter 3 examines the emerging infectious diseases in the region and the increased risks of animal diseases and identifies the points for spillover of emerging zoonotic diseases between animals and humans. Chapter 4 outlines the One Health framework that guides effective animal health and disease management systems, namely the risk-based approach and the Theory of Change for necessary coordination across affected sectors. Chapter 5 provides an overview of the livestock and wildlife sectors in EAP including the size of the sector and the structure of supply chains. Chapter 6 assesses existing animal health policies and institutions across the region for averting spillover and disease spread. Finally, Chapter 7 provides a set of overarching recommendations for building animal health and wildlife systems for One Health, along with case studies illustrating different countries' experiences in and outside the region on how to reduce the risks of animal disease outbreaks through risk-based approaches. Annex 1 presents an analysis of the costs and benefits of transforming animal health and the wildlife systems. Annexes 2 and 3 provide additional data supporting the findings of the report.

Farmer feeding a chicken from his hand.
Photo credit: Shutterstock

Chapter 2. The Increasing Socioeconomic Impacts of Zoonotic Diseases and Epidemics in EAP

This chapter discusses the economic costs of zoonotic diseases and epidemics in EAP and how these costs affect vulnerable populations and threaten to increase poverty and inequality in the region. It also provides insights into the increasing costs and threat from AMR.

COVID-19 has impacted on human health and food security as well as on livestock production, trade and economic well-being

The COVID-19 pandemic has had unprecedented impacts on many aspects of human health and well-being. In addition to its direct effects on human health, food security has been affected. With a few exceptions (e.g., mink farming), there are no indications that COVID-19 directly affects animal health, though occasional infections have been detected in companion animals and some other species. COVID-19 has disrupted livestock value chains with major impacts on livestock production and trade, reducing food security and economic well-being in many countries. It has affected the sector at multiple levels: (i) animal production (reduced availability of animal feeds and day-old chicks, access to technical and other services, reduced market access, etc.), (ii) processing (lower capacity utilization, logistical disruptions, compromised storage, loss of 'informal' supply chains), (iii) transport (movement restrictions domestically and internationally), and (iv) sales (change of distribution and retailing, closure of restaurants and services sectors, decline in tourism, and reduced consumer liquidity/purchasing power). Though the impact of a pandemic such as COVID-19 is severe in many sectors of the economy, it has hit informal workers the hardest. Many agricultural workers are informal, often migrants, and many are women with little security of employment. Women workers are often the hardest hit by any downturn in agricultural activity, including in livestock production. The consequence of the pandemic is reduction in regional growth and there is substantial uncertainty about the strength and durability of the anticipated upturn beyond 2021. The recovery is also likely to take time to reverse the damage from the pandemic (World Bank 2021).

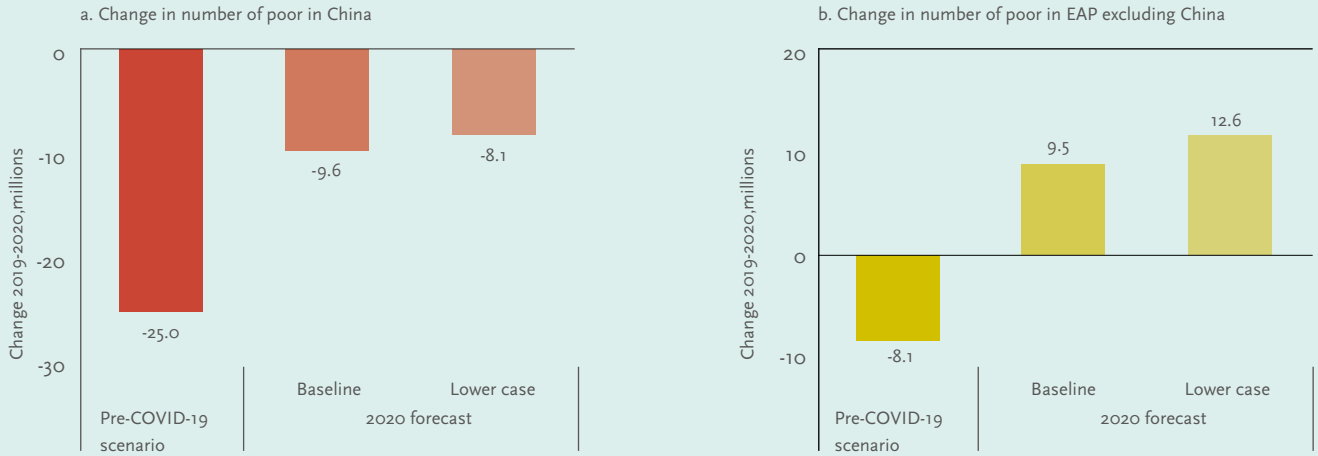


Figure 2.1: Change in number of poor in China and rest of EAP *Source:* World Bank 2020.

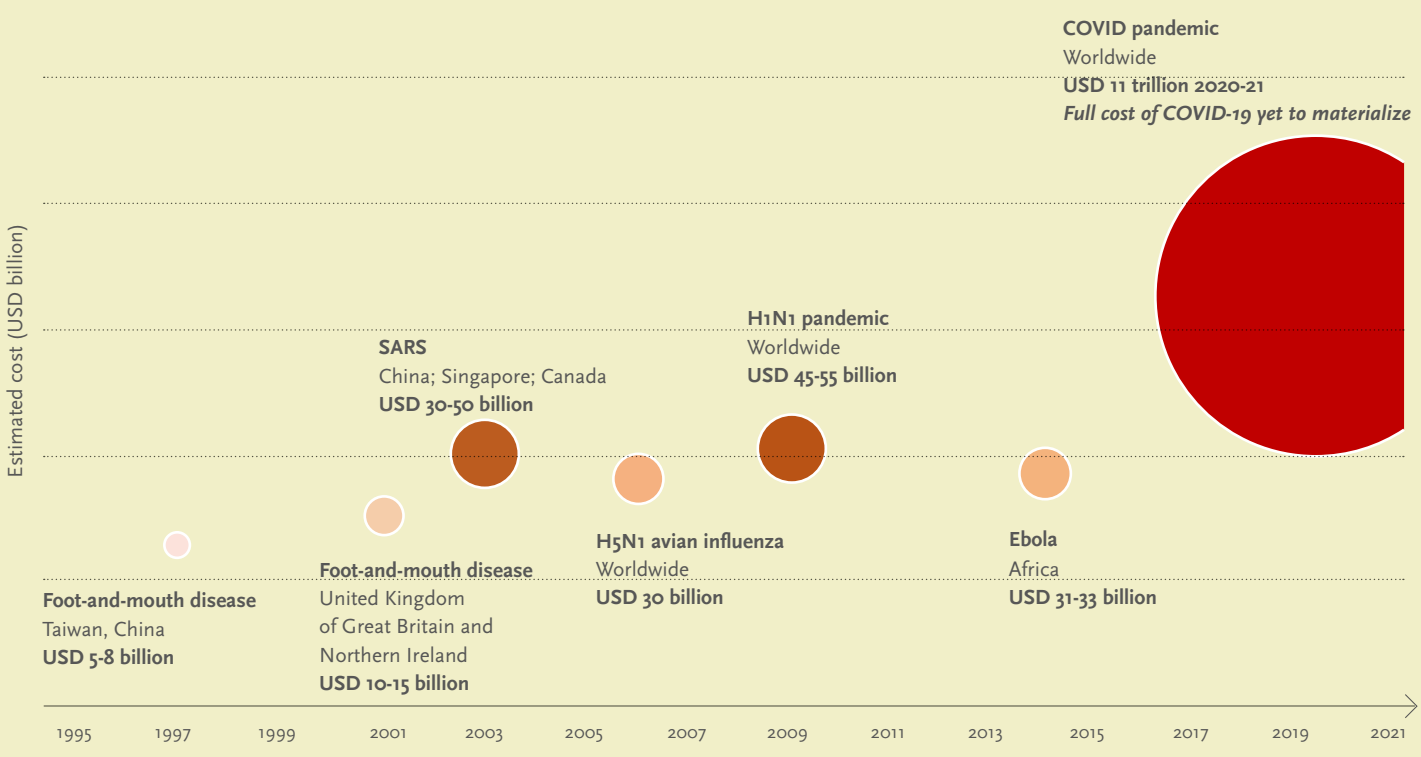


Figure 2.2: The rising global costs of animal disease and human health epidemics 1995-2016 *Source:* Bio-era, adapted by the authors.

In the EAP, COVID-19 threatens to cancel out progress already made and increase poverty and inequalities

The COVID-19 pandemic threatens to increase inequalities and negate progress made on poverty reduction in EAP. The EAP region is now facing a setback with the uneven recovery across countries and sectors. China, Indonesia, and Vietnam have already surpassed pre-pandemic levels of output, while Cambodia, Malaysia, Mongolia, the Philippines, and Thailand are expected to do so in 2022. The year 2021 saw no decline in poverty in countries other than China (World Bank 2022). The employment has declined, poverty will persist, and inequality is increasing across several dimensions. The regional employment rate dropped by about 2 percentage points on average in 2020 compared to 2019, with the sharpest declines observed in Cambodia, Myanmar, and the Philippines. The COVID-19 shock is expected to have increased the number of people living in poverty by 32 million in the region in 2020-21 than previously expected. There were 24 million more poor people in 2021 than expected pre-COVID-19 in EAP, based on the USD 5.50/day poverty lines. More than 90 percent of those who will remain poor are expected to come from Indonesia, the Philippines, and Myanmar. Additionally, unemployment has risen rapidly: global data suggests that unemployment hits women workers the hardest. EAP countries that are heavily reliant on trade, tourism, and external financing, e.g. Cambodia, Lao People's Democratic Republic, and Mongolia, experience larger contractions given the global recession. School closures and the subsequent movement to distance learning and/or hybrid learning models have had significant impacts on learning in many EAP countries. It is estimated that the students stand to lose an average of about two-thirds of a year of learning-adjusted years of schooling (LAYS), with significant variations across the EAP subregions (World Bank 2021).

Incursions of major transboundary animal diseases (TADs), that is, major epidemic diseases that are highly contagious with the potential for rapid spread, including across national borders, are also occurring more frequently and are having a dramatic impact on livestock production systems, livelihoods, food security, economies, and trade. Examples of TADs include ASF, foot-and-mouth disease (FMD), and Peste des Petits Ruminants (PPR). The susceptibility of animal populations and the impact of TADs through mortality, morbidity, and reduced productivity of livestock result in decreased market value, loss of market access and more broadly trade access, reduced food security, and increased environmental impacts. The lack of prevention and control of animal diseases comes at substantial cost to livelihoods and both public and private sector interests. Endemic and emerging TADs have repeatedly compromised livestock producers in East and Southeast Asia, hampering livestock productivity, causing market disruptions, and limiting trade in animals and animal products.

EIDs and zoonoses threaten economic development, animal and human health and well-being, and ecosystem sustainability and integrity. The impact and cost of major disease outbreaks and zoonoses have increased dramatically in recent years, which puts the costs of COVID-19 upwards of USD 11 trillion during 2020-21 even before the full economic impacts have been assessed (see Figure 2.2). Epidemics in people have direct costs on the health system, often limiting the capacity to deal with routine health issues compounding the immediate disease impact. Beyond direct effects, epidemics force both the ill and their caregivers to miss work or be less effective in their jobs, driving down and disrupting productivity. Fear of infection can result in social distancing or closed schools, enterprises, commercial establishments, transportation, and public services – all of which further disrupt economic and other socially valuable activities.

EAP has seen the highest economic losses from epidemics of any region in the world and the costs of disease outbreaks have increased dramatically over the past decades. EAP's total cost of previous epidemics was estimated at USD 200 billion per year or 0.9 percent of the region's GDP (World Bank 2017). This can be compared with the direct costs of zoonoses, which globally have been estimated at more than USD 20 billion and indirect losses at over USD 200 billion (Barratt et al. 2019; World Bank 2017). Table 2.1 shows disproportionate vulnerability to economic losses from pandemics in different regions.

Table 2.1: Estimated vulnerability to economic losses from pandemics *Source:* World Bank 2017.

Region	Population (billions)	2015 GDP (USD trillion)	Expected annual pandemic loss (USD billion)	Expected annual pandemic loss (% GDP)
East Asia and Pacific	2.23	21.2	196.9	0.9
Europe and Central Asia	0.89	20.1	110.3	0.5
Latin America and Caribbean	0.63	5.4	59.4	1.1
Near East and North Africa	0.46	3.1	27.8	0.9
North America	0.36	19.6	86.5	0.4
South Asia	1.74	2.7	53.3	2
Sub-Saharan Africa	1.02	1.6	27.9	1.7

EIDs and zoonoses have been occurring more frequently. Table 2.2 lists the major EIDs that have occurred since 2000, with the main countries affected, and provides an estimate of the numbers of human cases. In almost all of the major EIDs that have occurred since 2000, the index case has been detected in the EAP region or the region has seen large numbers of cases.

Table 2.2: Major EIDs occurring since 2000 *Source:* Authors' own elaboration.

Emerging infectious diseases	Year	Number of countries/ economies affected	Documented number of human cases reported
HPAI H5N1	2003-ongoing	17- Mainly Southeast Asia countries	861
SARS-CoV	2002	26- China; Hong Kong SAR, China; Taiwan, China; Singapore and Vietnam	8,096
A(H1N1) pandemic	2009	Global	60.8 million
MERS-CoV	2012	27- including Saudi Arabia, United Arab Emirates, and the Republic of Korea	2,494
Avian influenza A(H7N9)	2013	China	1,568
Ebola virus	2014-16	Guinea, Liberia, Sierra Leone	28,616 (11,310 deaths)
Zika virus	2015	84- including Americas	223,477
SARS-CoV2	2019	Global	229.4 million 4.7 million deaths (21 September 2021)

Beyond the impact on human health and well-being, animal diseases cause significant costs to the livestock sector. For example, to control the HPAI outbreak between 2003 and 2013, more than 175 million domestic birds were culled in Southeast Asia. In many countries, backyard and small poultry producers were the worst affected with many small and medium-scale commercial poultry producers ceasing business and many backyard producers losing a major source of protein and an important financial asset. It was estimated that in the early years of the epidemic, countries such as Thailand and Vietnam lost 0.3 percent and 1.8 percent of GDP due to impacts on the poultry sector, respectively. In Indonesia, the direct cost alone of poultry being culled to control the early outbreaks of H5N1 HPAI was estimated to be between USD 16.2 and 42.4 million (Rushton et al. 2005).

Early interventions to prevent and control TADs are the most cost-effective and efficient. The incursion and spread of ASF in China in 2018 and its subsequent spread through Southeast Asia and into the Pacific show the extensive impacts that animal diseases can have on livelihoods, economics, and trade. Initial analysis indicated the direct costs of the disease on China and the region as USD 55-130 billion, with USD 28-46 billion attributed to initial losses to disease and culling, USD 4-7 billion to the cost of replacement animals, and USD 23-77 billion in lost revenue (Weaver and Habib 2020). Furthermore it has been suggested that if the disease had been successfully contained in the early stages in a single province, then initial losses would have been limited to USD 3.6-5.2 billion.

Diseases disproportionately affect smallholders and consumer prices and have indirect effects on the environment. For example, for the many smallholders who raise pigs as a critical livelihood and safety net, diseases such as ASF increase poverty and food insecurity (Box 2.1). The supply-side shock has driven up pork, other meats, food, and general prices for consumers in China and sparked an increase in pork prices globally as China increased imports. The effects of disease on human health security, trade, the climate, resilience to disasters, and damage to local environments are considered substantial.

Box 2.1: Impact of transboundary animal disease on global food markets – African swine fever

African Swine Fever (ASF) causes a major economic impact on smallholders and emerging commercial farmers. The disease negatively affects the livelihoods of the many poor households that depend on pigs as a source of protein and income, as a means to capitalize savings, and as 'safety nets' during times of hardship. Many such farmers have lost or will lose their businesses because of ASF. Simultaneously, market prices have soared: in China, retail prices rose by 78 percent (month to month) in September 2019, affecting consumers. At the national level, one major consequence of ASF is the loss of status for international trade and the costs of implementing drastic measures to control the disease. In Vietnam, it is estimated that nearly 6 million pigs were culled, representing approximately 20 percent of the pig population. This is significant in a country where the pig sector was valued at USD 4.03 billion, nearly 10 percent of the national agriculture sector.

Globally, the main economic impact of ASF is in China, where annual pork production had grown by more than 50 million tons since 2010. Prior to ASF, half of the world's pork was produced in China. By the end of 2019, the Chinese national pig herd had fallen by half, and production by over 25 percent in 2019 and 2020, and this has affected global agricultural markets. China alone experienced direct economic losses of USD 141 billion in 2019. ASF quickly spread across Southeast Asia and as far as Timor-Leste and Papua New Guinea and is affecting food security, financial resilience to disasters, and cultural well-being.

The ASF outbreaks in Asia have affected global agricultural markets. Impacts include a 15 percent reduction in pig meat consumption in China and an increase in consumption of other livestock products (eggs, poultry, and fish in particular). Chinese pig meat imports are expected to increase by 2.6 tons above levels foreseen in the absence of ASF and this demand has caused an increase in international pig meat prices – by almost 9 percent above previous levels. The shock of reduced Chinese pig meat output is spilling over into the feed market, causing a 50 tons reduction in Chinese feed use and a 5.5 tons reduction in Chinese imports of maize, soybean, and other coarse grains. If the shock from ASF induces a permanent restructuring of Chinese protein demand, then the medium-term effects of ASF on global agricultural markets will be significant (Frezal et al. 2021).

As global pig production is threatened by ASF, tensions have grown along the supply chain. According to the FAO Food Outlook dated May 2019, global meat output was expected to decline because of a fall in the pig meat component, primarily in China; this gap will not be compensated for by expansions in beef, poultry, and sheep meat production. ASF is having a noticeable worldwide effect on both meat and animal feed markets with China's total consumption of animal feeds, such as soy, dropping by 17 percent in 2019.

Source: Authors' own elaboration.

AMR and food-borne diseases will increase as the livestock sector in the region is unable to manage such diseases or comply with crucial hygiene standards

The inability of the livestock sector to effectively manage diseases and comply with hygiene standards also results in significant human health and economic impacts from antimicrobial resistance (AMR) and food-borne diseases. Worldwide, pathogens with significant AMR are estimated to already cause 700,000 deaths each year and it has been predicted that this may rise to 10 million deaths and a global cost of USD 100 trillion by 2050 (O'Neill 2014). The current high use of antimicrobials in animal production in Asia is expected to grow dramatically in the coming years with further intensification of livestock industries (Tiseo et al. 2020). Globally, it is estimated that more than 600 million cases of food-borne illness occur every year, with costs to human health of over 5.5 million disability-adjusted life years (DALYs)[3] and causing over 400 000 deaths (Havelaar et al. 2015). This is mirrored in Asia. This amounts to very significant economic costs. In Vietnam, the annual economic loss from food-borne diseases is estimated at USD 740 million per year, and related medical costs of treating food-borne illness likely exceed USD 200 million. In addition, global commercial losses from poor production and unsafe food handling practices are estimated at USD 2 billion per year apart from reputational and market loss risks (Steven 2020). Further the lack of effective control of endemic diseases results in excessive use of antimicrobials with increased risk of AMR and reduced production efficiency with depressed growth rates and increased production of greenhouse gases per production unit.

Wildlife disease

The deteriorating environment is making many wildlife species less resilient and highly susceptible to sudden changes including disease incursions. Increasingly degraded ecosystems, greater encroachment into previously undeveloped areas, pollution, climate change, and aggressive harvesting of some species make many wildlife populations more susceptible to diseases and threaten their long-term survival. Environmental change is causing ecological stress, and this is resulting in increasing risk of emerging infectious diseases in humans, domestic animals, and wildlife (Gibbs et al. 2020; Tompkins et al. 2015).

Animal (domestic and wild) and human populations are susceptible to the introduction of novel pathogens. Naïve populations are more likely to suffer ill health as they have no prior exposures and immunity. The catastrophic chytrid fungus has pushed some species to extinction and this demonstrates the impact of disease introduction in wildlife. Box 2.2 describes how an outbreak of Peste de Petits Ruminants (PPR) in Mongolia pushed saiga antelope to the verge of their extinction.

Box 2.2: Mongolian saiga antelope on the verge of extinction because of spillover from livestock

As an example of a wildlife disease catastrophe, in Mongolia in 2017, saiga antelope, Siberian ibex, and goitred gazelle were severely affected during an outbreak of PPR. On review it was considered that the outbreak occurred as the national vaccination campaign was insufficient to control the disease in livestock with consequent spillover to the wildlife species. Although the Government of Mongolia sought to adequately protect livestock in the affected area of the country, sufficient virus continued to circulate and infect the saiga antelope and other wild ruminant species. The mortality of saiga antelope was estimated to be over 80 percent of their total population and critically compromised the survival of this species.

Source: Authors' own elaboration.

3 Assessing the economic impact of zoonoses on human health includes the value (or the number) of human lives lost, the value of lost productivity through illness, and the costs of treatment. Several systems of assessing the economic impact of disease have been developed using parameters such as the 'value of a statistical life', disability-adjusted life years (DALYs), and quality-adjusted life years (QALYs). There are no simple metrics for calculating these parameters when developing economic models.

Top

INDONESIA

The farmer was assisted under a social protection program PKH at Cirebon, Indonesia.

Photo credit: Nugroho Sunjoyo/World Bank

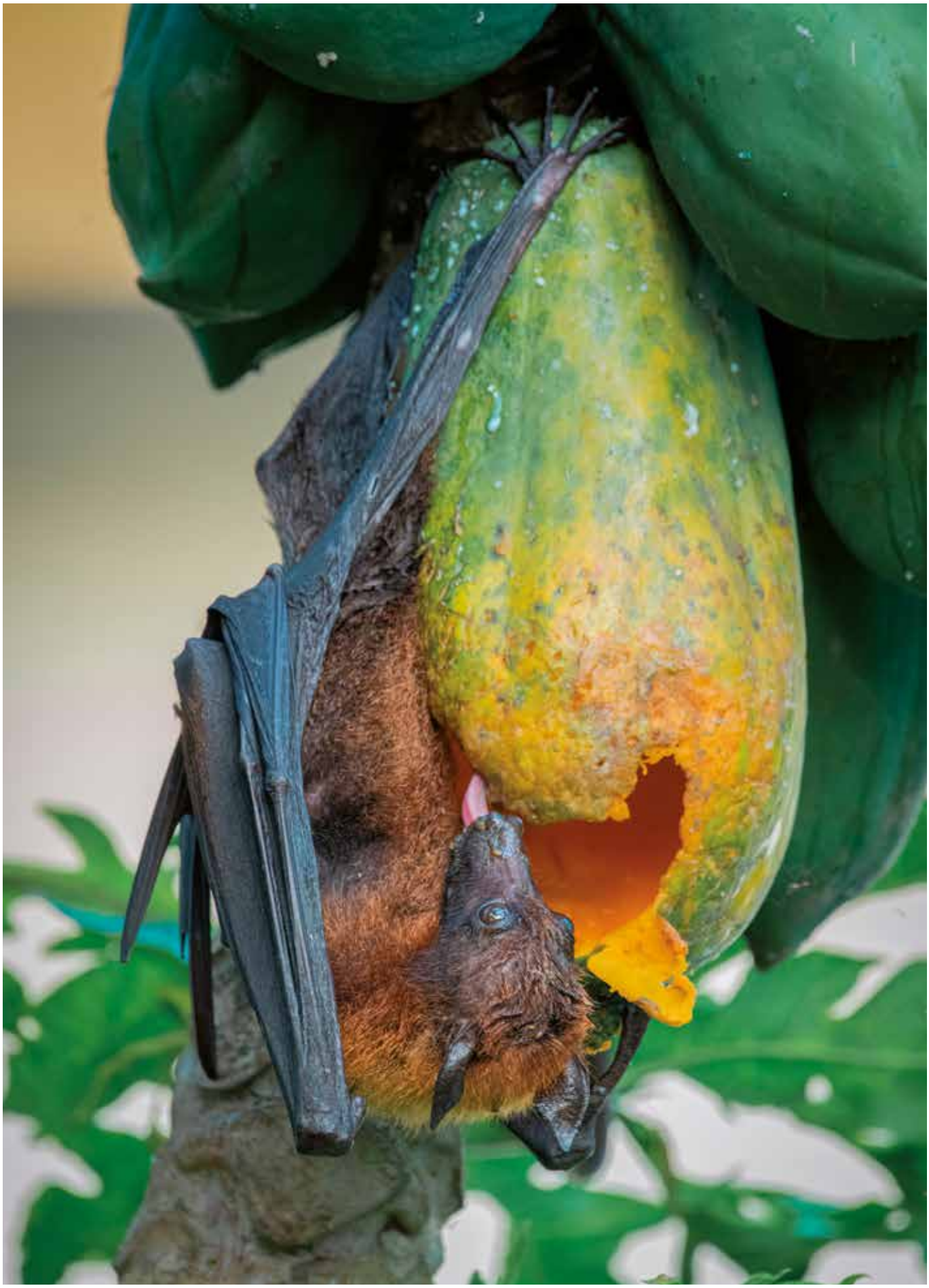
Bottom

PHILIPPINES

Man and water buffalo in rice fields, Philippines.

Photo credit: Edwin Huffman/World Bank

INDIA
Fruit bat (flying fox) eating papaya Kerala, India.
Photo credit: Shutterstock



Chapter 3. Understanding Emerging Infectious Diseases

This chapter provides an overview of the type and origins of emerging infectious diseases and the extent to which EAP has become a hot spot for many of these diseases. The chapter describes the spillover of pathogens between animals and humans and provides insights into the drivers of the increasing risks of emerging infectious diseases, disease transmission, and disease outbreaks.

Emerging Infectious Diseases

Globally, Emerging Infectious Diseases (EIDs) are occurring more frequently. The threat of EIDs has been widely recognized, with one study estimating that over the last century, every year, on average, two new viruses have spilled over from their natural hosts to humans (Woolhouse 2012). Furthermore, previously controlled infectious diseases are re-emerging, for example ASF was eliminated in Europe in the early 1990s but re-emerged in Europe in 2007 (Cwynar et al. 2019). Also, new pathogen variants such as those exhibiting AMR are increasing. Epidemic-prone infectious diseases, such as Ebola, influenzas, and the coronaviruses, such as those that cause Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), have been recognized as pandemic threats for many years (Daszak et al. 2000, 2004). Both domestic animals and wildlife are sources of EIDs of humans, as shown in Figure 3.1.

Over the last century on average two new viruses have spilled over each year globally from their natural hosts to humans while previously controlled diseases have re-emerged

Reviews have identified RNA viruses, such as influenza and coronaviruses, as being the most likely source of EIDs. Both the SARS and the MERS outbreaks were caused by coronaviruses and raised concerns about the future risk from this group of viruses. A number of influenza epidemics have been identified in the last 100 years, including most recently the H1N1 'swine flu' epidemic in 2009. Concerns over the risks posed by the coronavirus have been substantiated by the global COVID-19 pandemic, caused most likely as a result of spillover from bats. Coronaviruses have been detected in hosts including humans (the common cold) and a range of domesticated and wild animal species such as cattle, sheep, goats, pigs, poultry, dogs, cats, and particularly bats. These coronavirus infections are typically species specific in animals and not easily transferable from species to species, nor are they commonly zoonotic. Coronavirus infections can cause severe disease in animals, causing high mortality and loss of production, e.g., infectious bronchitis in poultry, epidemic diarrhea in pigs.

EAP has been identified as a global hot spot for EIDs including zoonoses. Multiple risk factors in the region include the large and concentrated human and livestock populations, high levels of urbanization, environmental degradation, poor livestock biosecurity and food hygiene practices, increased consumption of wildlife, extensive trade in animals (both domestic and wild), and the often close contact between animals and humans. Vector-borne diseases such as Zika, Lumpy Skin Disease, etc. have also been increasing in the region, in part driven by climate change and changing vector patterns. The region is considered one of the most vulnerable to disease emergence, incursions, and spread. SARS, COVID-19, Nipah disease, and the HPAI H5N1 and H7N9 viruses all emerged from East Asia, and research predicts that the next global pandemic is likely to arise again in this region. Figure 3.2 shows the global hot spots for emergency zoonoses considering such risk factors; the East Asia and South Asia regions are shown to be at particularly high risk.

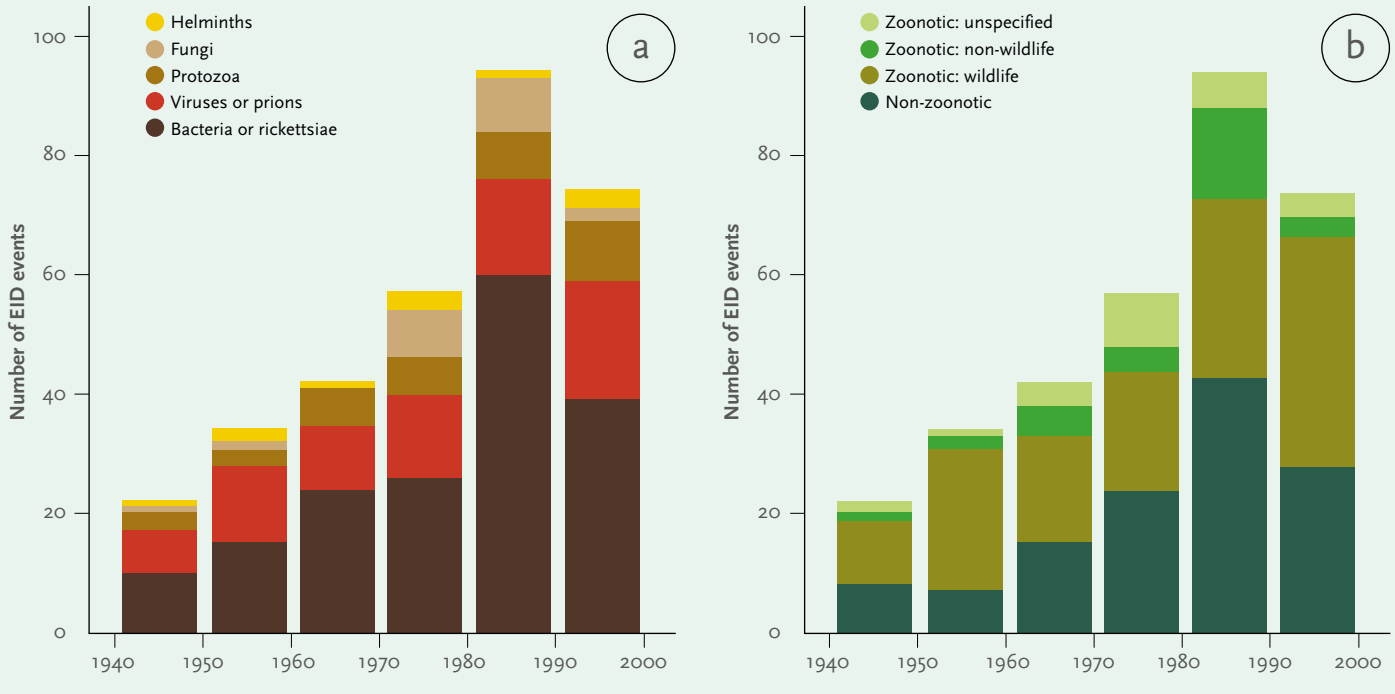


Figure 3.1: Number of emerging infectious disease events per decade by a) pathogen type; and b) transmission type *Source:* Jones et al. 2008.

The Pacific is not considered to be a high risk for emerging diseases but is highly vulnerable to incursions of EIDs, zoonoses, and TADs from trade and tourism. The potential impact in the Pacific is extremely high with the low levels of social and economic resilience, increasing threats from climate change and multiple other civil disasters, and limited capacity to respond. Animal health services in much of the Pacific are very limited – an example is the recent incursion of ASF into Papua New Guinea.

In addition to EIDs, endemic zoonoses continue to severely impact human health in the region. Rabies is present in all countries in mainland Asia and also in much of Indonesia and the Philippines and is estimated to kill many hundreds annually, though reports are unreliable with significant underreporting. Rabies control programs are in place in all countries, but the disease persists and has recently spread into previously disease-free areas. Other major zoonoses are present in all countries including brucellosis, leptospirosis, and cysticercosis, and these further compromise human health and well-being. Current control programs have failed to reduce the impact or endemic zoonoses on human health.

Despite control programs in place, rabies is persistent and kills many hundreds annually in Asia, with significant underreporting

There are several major drivers for the high risk of EIDs in the East Asia. Risk factors in the region include both vulnerabilities of human and animal populations and the lack of capacity to detect and respond. Drivers of increased vulnerabilities are the following:

- Dramatic growth in human and animal populations with trade and rapid movement of people, animals, and animal products (domestic and wild) within the region and from around the world. Close association of animals and people at traditional markets, at live animal markets, at cultural events, and in mixed low biosecurity smallholder production systems.
- Increasing ecosystem degradation with habitat and biodiversity loss, increasing encroachment with the development of greater 'edge' effects that facilitate high levels of exposure between wildlife, people and livestock, and the extensive hunting, farming, distribution, marketing and consumption of wildlife.

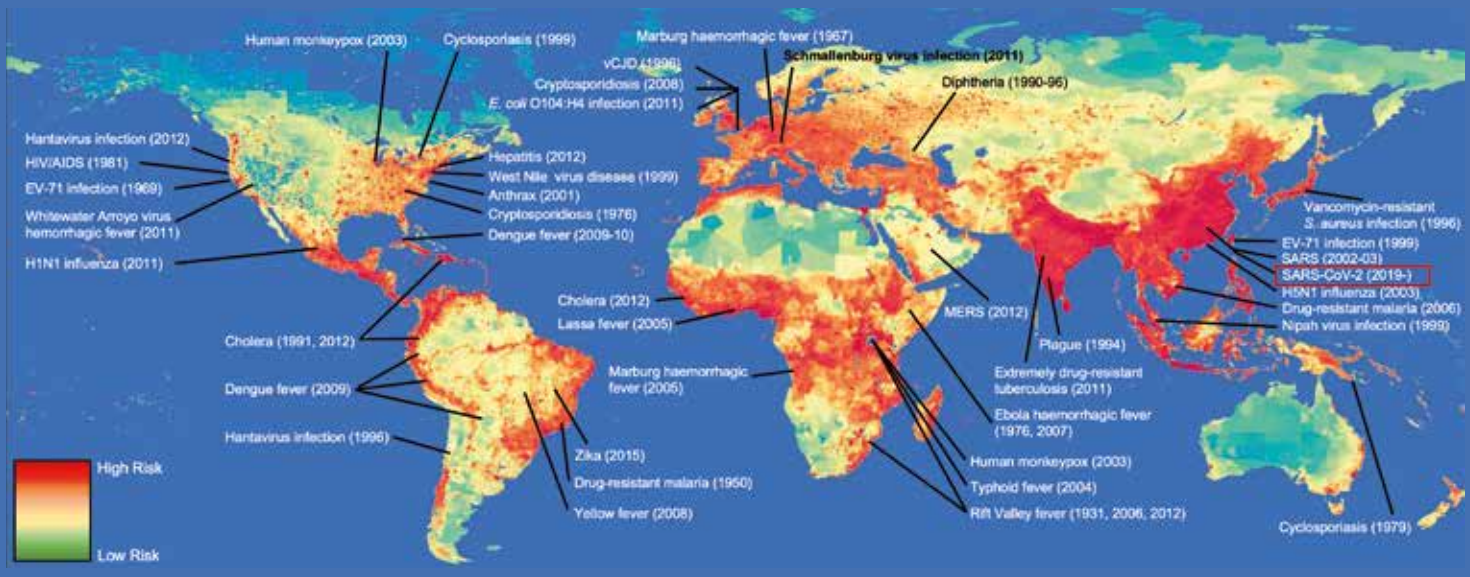


Figure 3.2: Global hot spots for emerging zoonotic diseases *Source:* Authors, based on Lipkin (2013).

- Significant growth in livestock production with limited investment in good husbandry practices and animal health systems resulting in low biosecurity and increased likelihood of disease, the greater use of antimicrobials and consequent increased AMR, reduced production efficiency and greater environmental impact.
- Complex supply chains with multiple players and nodes making quality assurance, traceability, attribution, and disease control more difficult. Food safety has been a low priority. Very little progress in developing systems for animal and animal product through chain of custody and traceability.
- Inadequate food system safeguards to detect, trace, and eliminate threats from zoonoses, resulting in escalation of outbreaks to large-scale epidemics such as the coronaviruses, influenza viruses, Ebola, and Nipah virus.
- Weak animal health and wildlife services across the region with inadequate legislation, coordination of policies and programs, and insufficient resources (skilled staff, funding, equipment, and materials). There is a high risk of cross-border disease transmission with the high volumes of trade and informal movement of animals and animal products in the region.
- The lack of effective commitment and application of One Health approaches to disease prevention and control in many countries further limits the ability to protect human health and promote human well-being.
- The science-policy interface for developing evidence-based policies and programs is weak.

The Spillover of Disease Between Wildlife, Livestock, and Humans

COVID-19 is the most recent example of a spillover event to humans; others include measles, tuberculosis, and malaria

Many of the major human diseases such as measles, tuberculosis, and malaria began as spillover events before becoming established in humans; COVID-19 is only the most recent example of a spillover event. A spillover is said to occur when a pathogen moves from one host population (or environmental reservoir) to another host population and arises from interactions between people, animals (domestic and wild), pathogens, and the environment. Zoonoses emerge when a pathogen is transmitted from an animal host directly or indirectly to humans. Diseases such as COVID-19 started as a zoonosis with transmission from animals to humans but is now a human disease with human-to-human transmission.

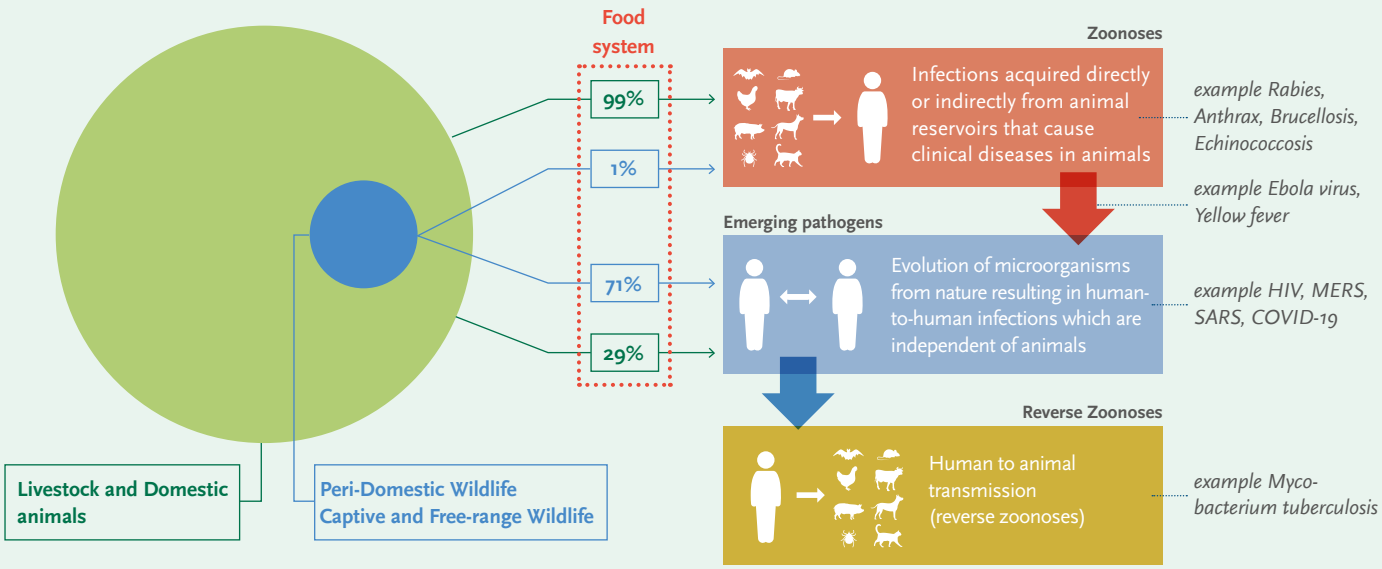


Figure 3.3: Diagram showing relative sources of spillover and zoonoses *Source:* Haider et al. 2020, adapted by the authors.

Spillover of emerging pathogens that originate from wild animals to humans is considered the most likely cause of EID epidemics or pandemics. Spillovers occur either directly from wildlife to humans, or indirectly from wildlife to other animals and then onto humans. Spillovers or emerging pathogens may also occur from domestic animals to humans. Domesticated and peri-domestic[4] (synanthropic) animals[3] can serve as pathogen source or bridging species between other wild animals and humans; their more frequent and direct contact with people increases the likelihood of transmission. Examples of such transmission are leptospirosis and the bubonic plagues from rodents (Figure 3.3). There is also the risk of spread to animals from humans (zooanthroponoses or reverse zoonoses), e.g., the spread of SARS-Cov2 to mink and to some other species.

Direct transmission of emerging pathogens is rare despite the large reservoir in livestock and wild animals and the risks from animal density and poor husbandry

The actual risk of pathogen spillover is not easy to assess because even though the reservoir of pathogens in livestock and wild animals is large, direct transmission of emerging novel pathogens to humans is uncommon. Some risk assessments have suggested that there is a greater risk of spillover of certain types of pathogens and that surveillance systems should focus on these, but a high level of uncertainty remains. Early detection of emerging pathogens may be further limited, as both wildlife (farmed and free-living) and domesticated animals may be asymptomatic or show few clinical signs but be a source of infection for humans. A further high risk for spillover of emerging pathogens into humans is from the large populations and high densities of livestock, which allow pathogen amplification and genetic adaptation. Poor animal husbandry and high densities of livestock also increase the risk of emerging pathogens with increasing AMR. The progression of a pathogen from an endemic cycle of infection, with or without disease, in wildlife to a spillover into domesticated animals and onto people is shown in Figure 3.4. The diagram highlights the risk of rapid amplification of case numbers and possible spillover into the human population – either directly from wildlife or following its spillover and amplification in domestic animals.

The co-circulation of pathogens can lead to changes in pathogenicity, transmissibility, and the creation of novel pathogen types to which the population (people and animals) have little or no immunity. This has been seen in the transmission of avian influenza viruses to humans in China, where co-circulation of the viruses allowed the exchange of genetic materials and the development of novel types with changes in their epidemiology such as their transmissibility, pathogenicity, and immunogenicity (with the loss of vaccine efficacy). Co-circulation of bacteria can also result in changes in a pathogen's epidemiology, such as with the transfer of AMR genes between different species and classes of bacteria with resulting increased threats to human health.

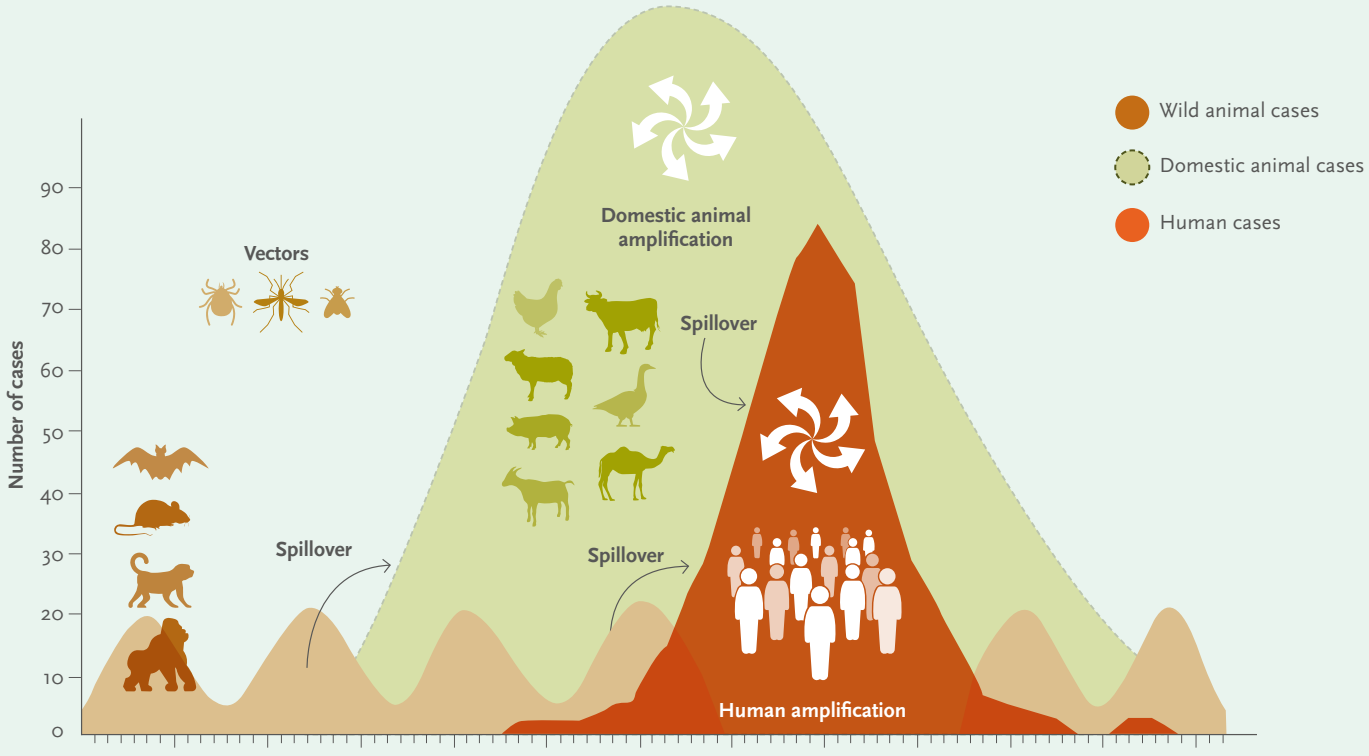


Figure 3.4: Zoonotic pathogen circulation and spillover and transmission dynamics *Source:* Karesh et al. 2012.

4 Peri-domesticated animals are wild animals living in close association with humans, such as rodents.

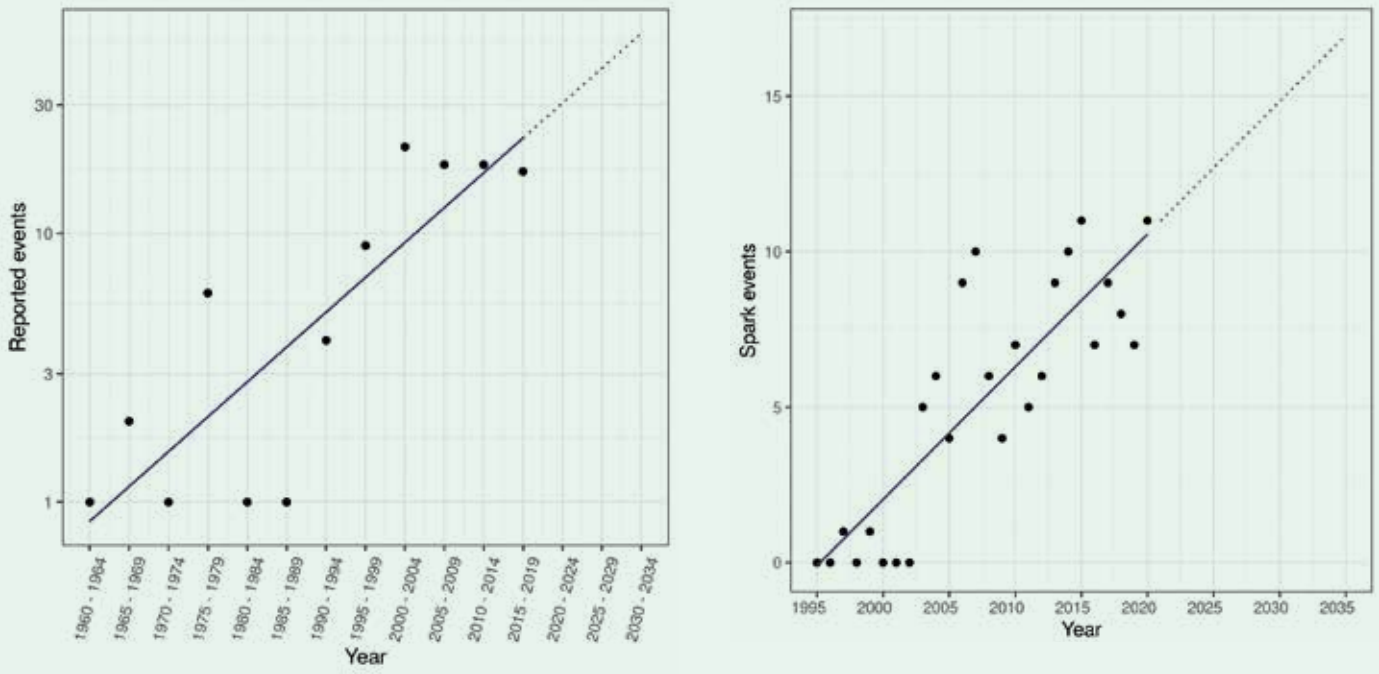


Figure 3.5: Increasing frequency of wildlife zoonotic and influenza spillover events (log-normal scale) *Source:* Adapted from Metabiota, G20 High Level Independent Panel 2021.

Figure 3.5(a) shows the frequency of epidemics caused by wildlife zoonoses. There has been a clear increase in such epidemics, which increased in frequency by a factor of about 3 every 20 years. Figure 3.5(b) shows the number of influenza spillover events. There have been around 10 influenza spillover events each year in recent years, compared to hardly any 25 years ago. Both charts fit a log-linear model to the observed data.

EID prevention is always the best use of resources, along with early detection and rapid response while outbreaks are still small and localized

Prevention is always the most cost-effective and efficient use of resources to eliminate the risk from EIDs but can never be absolute, so early detection and rapid effective response are critical to reducing the impact from EIDs. Detecting emerging problems quickly provides the best opportunity to implement effective control measures while the outbreaks are small and localized, and so control is much more likely to be successful and to be most cost-effective (see Figure 3.4). This is the 'flattening of the curve' logic as promoted by health services in the face of COVID-19. Animal (health) and wildlife systems must be established to optimize the likelihood of preventing EIDs and have the capacity for early detection and effective response.

Increasing Risk of Zoonosis Spillover and Food-borne Diseases in EAP

Food systems are important transmission pathways for many EIDs, including zoonoses. Transmission can occur from both livestock and wildlife through improper handling and slaughter of animals and from unsanitary conditions and poor handling of animal products in production and distribution systems. The problem is exacerbated by illegal and informal food systems and from poorly enforced food-safety standards with a lack of oversight, monitoring, and enforcement. Food systems pose a risk for transmission of zoonoses including viruses, such as the coronavirus, to cross contaminate products, to be amplified, and therefore pose serious risks to human and animal health (Aiyar et al. 2020).

Agricultural practices and associated food systems influence the occurrence of EIDs including zoonoses. Studies have found that since 1940, agricultural drivers were associated with more than 25 percent of all and more than 50 percent of zoonoses that have emerged in humans, proportions that are likely to increase as agriculture expands and intensifies (Rohr et al. 2019). The interaction of humans with animal products and live animals (domestic, wild, and peri-domestic) is a major risk factor for EIDs. The recent history of outbreaks has illustrated that these emerging zoonoses, originating from animals in food systems, especially in live animal and traditional markets, threaten human health. Table 3.1 provides an overview of the potential for spread of zoonotic pathogens through food systems and in markets and identified high-risk areas.

Table 3.1: An overview of zoonotic pathogens spread through food systems and markets *Source:* Naguib et al. 2021.

Pathogens	Potential for spread in markets	High-risk area
Crimean–Congo hemorrhagic fever virus	Live ruminants brought to markets	Africa, the Balkans, the Middle East and Asia
Ebola viruses	Sale of live exotic animals or bush meat brings the pathogen close to humans	West and Central Africa
Hantaviruses	Scavenging rodents may bring the pathogens close to the markets and contaminate products	Worldwide
Hepatitis E virus	Spread through food products or contacts with live animals at market	Worldwide
Avian influenza virus	Infected birds can transmit the virus to humans	Worldwide (mainly in Southeast Asia and the Middle East)
Marburg virus	Bats sold at markets or products contaminated by bats	Sub-Saharan Africa
Monkeypox virus	Through bush meat or live animals sold at markets	West and Central Africa
Nipah virus	Contaminated food products or live animals sold at markets	South and Southeast Asia
Coronaviruses	Viruses could be brought by live animals taken to the market	Worldwide
Vector-borne viral disease	Traditional markets could provide breeding grounds for mosquitoes and ticks in urban settings	Worldwide
Leptospira spp.	Could be brought to markets through infected animals for sale	Worldwide

Consumption of animal products has been increasing dramatically, but food safety institutions and practices are generally poor and have not kept up with the changing demand, structure, and scale of the sector. Complex value chains with multiple actors and long-distance transport of live animals have evolved without adequate hygiene standards or practices and without traceability systems. In many countries traditional markets remain the preferred source of animal products and for the sale of live animals, and often the slaughtering of animals with few hygiene measures, and limited provisions for food safety or veterinary inspections. Many governments have not identified food safety as a high priority. Legislation, policies, and programs are inadequate; resources such as skilled staff, equipment, and funding are often insufficient; and the development of identification and traceability systems for animals and animal products, a central component of a modern livestock sector providing safe food, has been slow. The lack of and enforcement of food safety standards have allowed such traditional markets, that trade livestock products locally, to become potential infectious disease hot spots, as in the cases of Ebola, SARS, and COVID-19 (Aiyar et al. 2020).

The Pacific Island countries are particularly vulnerable to the impact of animal diseases due to the low levels of social and economic resilience combined with exposure to climate change and multiple natural disasters. These countries also have increasing risks of waterborne, vector-borne, and food-borne diseases. For example, the emergence of COVID-19 in early 2020 occurred at the same time as Cyclone Harold severely affected several countries. Animal health systems are very weak or absent with limited resources, little capacity, and no effective programs. Cross-sectoral multi-disciplinary approaches are not adequately applied to develop One Health capacity and to build resilience with integrated emergency management systems capable of managing disease threats. Livestock production in these countries is traditional and lacks adequate biosecurity measures. For example, ASF control in Papua New Guinea (PNG) has been badly challenged by the practice of free-ranging pigs that are frequently in contact with feral boars.

Increased Wildlife Trade in EAP Increases the Risk of Disease Spillover

Increasing demand for wildlife products, poor management of wildlife hunting, farming and trade, encroachment on wildlife habitats, and climate change all contribute to an increased risk of disease spillover in EAP. Encroachment by humans and livestock production into wildlife habitats and the exposure to peri-domestic species creates opportunities for increased exposure and risk of spillover. Contact is greatest at degraded habitat margins, for example, during deforestation, development of mining, through tourism, or the expansion of human settlements and livestock rearing. Such changes may displace wildlife, restrict their habitat, increase feed searching ranges and behaviors, and disrupt migration paths and the distribution of species. Degraded wildlife habitats may also result in changes in species balance with more aggressive opportunist species such as rodents dominating. Among some communities, wildlife hunting is an important source of nutrition and subsistence income (McEvoy et al. 2019) and their loss of income due to the COVID-19 pandemic is likely to have increased hunting frequencies and volume and also to have increased their risk.

Supply chains, wildlife farms, long-distance migration of animals and birds, climate change, and ecosystem degradation all increase the risk of disease spillover from wildlife

The supply chains for wildlife and wildlife products in EAP pose risks for potential spillover, both directly from wildlife to humans and indirectly from wildlife to livestock to humans (Figure 3.6). There is increased risk of spillover of emerging pathogens from wildlife to humans for traders and at traditional markets that handle wildlife, particularly if they handle and slaughter live wild animals. An additional risk of transmission of emerging pathogens from wildlife to livestock and other animals comes from poor hygiene resulting in fomite transfer, i.e., the cross-contamination from crates, cages, and so on. Bats, rodents, and non-human primates are of the highest concern for emerging pathogens of pandemic potential (with other species potentially playing a role as intermediate hosts or amplifiers). For example, studies in North Sulawesi, Indonesia, have shown that pathogens are spread from wildlife to domesticated animals and on to humans (FAO 2017).

Wildlife farms have become more common in EAP, especially in China and Vietnam, and these pose a high risk of pathogen spillover. Wildlife farming is practiced for many species including rats, deer, foxes, bears, porcupines, civets, wild pigs, and assorted birds including waterfowl. Wildlife farming is considered a major transmission pathway for zoonoses, owing to the high contact rates between the farmed wildlife and humans, though there are little data to confirm this. Farming of wildlife often brings multiple species together, including species not typically overlapping in nature, and this provides novel opportunities for pathogens to adapt to new hosts. Farming wildlife also includes a significant share of animals sourced from the wild, and this provides a further pathway for pathogen introduction onto farms. There is little regulation of wildlife farming in the EAP region, though some registration of farms is now under way in China and Vietnam.

Long-distance movement of animals including of migratory wildlife, particularly wild birds, can cause the spillover of infection from one area to another. The actual situation is complex with varying levels of pathogenicity or asymptomatic carriage of pathogens in wild animal populations. It is noted that much of the spread of TADs is from human activities such as trade and swill feeding waste, and this can result in infection spreading to wildlife (e.g., FMD and PPR in Mongolia). Migratory birds are considered responsible for the long distance spread of HPAI H5N1 from Asia into Europe, and in North America HPAI H5N8 was spread by wild birds and then spilled over into poultry units with poor biosecurity. ASF has been spread from Europe to Asia with a combination of human transfer of pigs, swills, and pig products and also spread across borders by wild birds.

Climate change and ecosystem degradation increase the risk of disease spillover from wildlife. Wildlife populations are increasingly threatened as ecosystems degrade with greater encroachment into previously undeveloped areas, pollution and climate change, and aggressive harvesting of some species. This leaves the wildlife populations highly susceptible to sudden changes such as disease incursions, climate, or other disasters such as bushfires and floods. It is estimated that there is not only an increase in emergence of infectious diseases in humans but also now in wildlife and this has been supported by evidence from the ecological stressors that are occurring as a result of significant environmental change (Gibbs et al. 2020; Tompkins et al. 2014).

Long-term climate change also increases the risk of re-emergence of previously eliminated communicable diseases. The virulence of Escherichia coli, a bacterium that can cause severe gastroenteritis and other problems, has been shown to be positively correlated with increased temperature and rainfall. Escherichia coli has increasingly been transmitted via the food value chain in the developed world and through poor sanitation and hygiene practices in the developing world (Aiyar and Pingali 2020).

Paying Attention to Multiple Risk Transmission Points

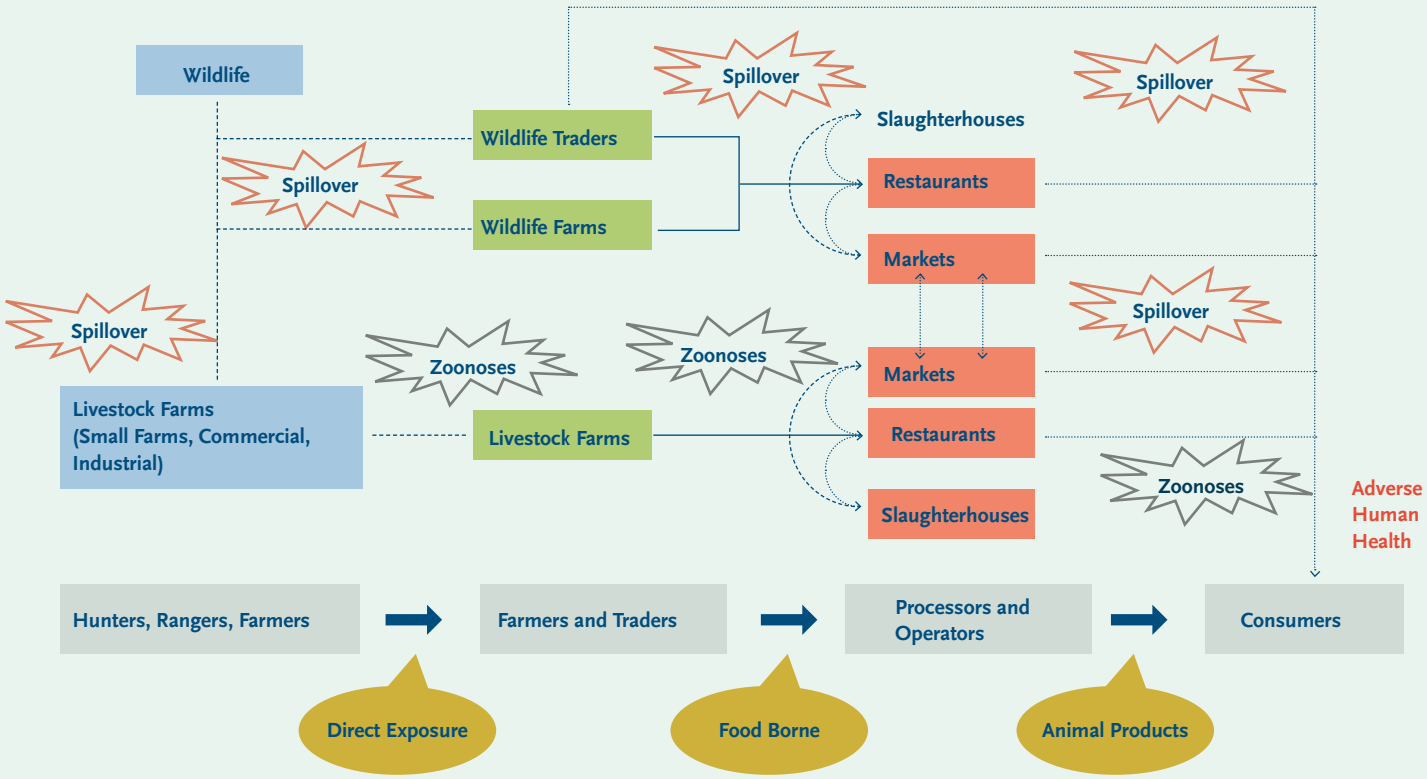


Figure 3.6: Livestock and wildlife supply chains showing transmission of zoonoses and spillover events *Source:* Authors' own elaboration.

Chicken farm
Photo credit: FAO/Jim Caro

Chapter 4. One Health Approach to Averting Disease Spillover and Spread

This chapter describes the One Health concept and the risk-based approach to animal disease management to effectively prevent and manage zoonoses and animal disease spillover and outbreaks.

Inter-disciplinarity is at the root of effective implementation and organization of the One Health approach. The role of animals (domestic and wildlife) in emerging pathogens and EIDs is not well understood. There is an over-reliance on hypothesis and modelling without conclusive or quantitative data on zoonoses and EIDs their epidemiology and origins. Until this gap is addressed, the relative significance of different sectors needs be taken with considerable caution to ensure that appropriate risk assessments are conducted, the correct critical control points are identified, and investments are applied appropriately to achieve the greatest effect.

Effective zoonoses and animal disease management must be risk-based and coordinated across sectors using a One Health approach. As with other disease risk management, zoonoses and animal diseases must be managed based on epidemiological knowledge, the identification of threats (spillovers and disease incursions), the likely frequency, and the potential impacts of the disease. This requires systems for identifying and assessing the threats and their probability, collecting, and analyzing relevant information and converting the findings into targeted policy, well-designed programs, and effective response planning. Because the origin and spread of animal diseases and zoonoses cuts across multiple sectors and involves multiple disciplines, animal health, environmental health, and human health must be coordinated using the One Health approach for effective disease prevention and control.

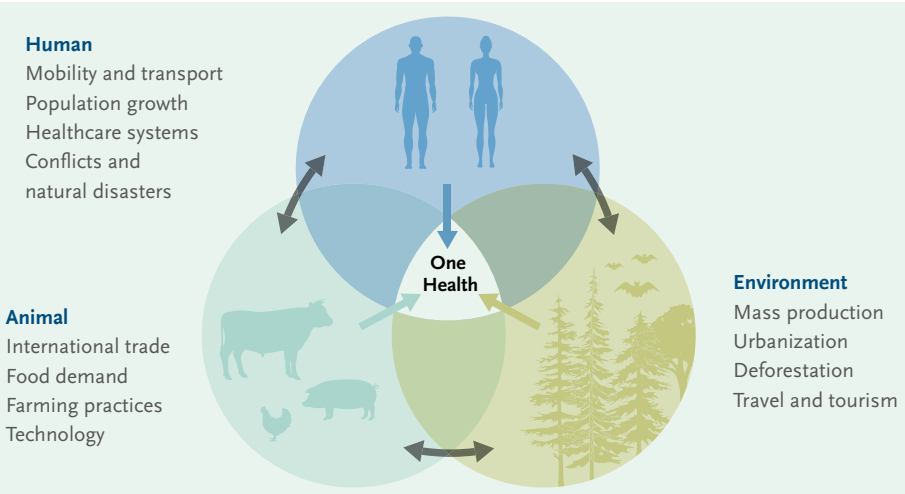


Figure 4.1: One Health for effective management of spillovers and zoonotic diseases *Source:* Adapted from Bedford et al. 2019.

One Health Approach for Improved Disease Control

Managing zoonoses and animal diseases must be based on epidemiological knowledge, threat identification, and their likely frequency and potential impacts

In order to effectively manage the risks of spillover, critical control points must be identified and then effectively controlled through a coordinated approach of institutions that cover human health, animal health, and environmental health, that is, the One Health approach. One Health is a framework for integrated cross-sectoral and inter-disciplinary approaches to improve the health of animals, people, and the environment and is rooted in a coordinated risk-based approach that considers points of interactions between humans, animals (domestic and wildlife), and the environment (Figure 4.1). A coordinated One Health approach has been advocated as pivotal in delivering effective and efficient prevention, detection, and control of zoonoses. Having identified the highest risk activities, cross-sectoral measures can be implemented to reduce these risks and to develop recovery approaches to mitigate their impact.

To successfully implement the One Health approach, well-coordinated institutional arrangements and governance are critical. Effective cross-sectoral coordination, collaboration, and communication require a clear policy mandate with the necessary legislation or formal agreements between the key institutions (human health, animal health and environment), with support from other ministries and agencies such as commerce and trade, finance, communications, research, and education. The respective roles and capacities of the various sectors must be clearly defined.

The One Health approach recognizes the need to take proactive steps including food-safety interventions to reduce the risks of EIDs. These steps include designing, promoting, and enforcing regulations and standards for animal health and production, wildlife management, and health and food safety as an urgent and proactive measure to protect against unintentional biosecurity threats (Aiyar and Pingali 2020).

Conundrum of Local Costs and Global Benefits

Investment in One Health to prevent and control zoonotic diseases offers very high benefits with much greater returns than many other public or private investments

World Bank economic analysis shows that investment in One Health systems for prevention and control of zoonotic diseases offers extraordinarily high expected benefits, with rates of return far above those of other public and private investments (World Bank 2012). Every year, an investment of USD 3.4 billion would produce an expected benefit of USD 30 billion for the international community. The annual expected rate of return would be between 44 percent and 71 percent (corresponding to, respectively, half or all mild pandemics being prevented). The above required investments in One Health systems are substantially below the average USD 6.7 billion per year in losses due to the six major zoonotic disease outbreaks in 1997– 2009, none of which developed into a pandemic.

Economic impact assessments and estimates of benefit cost ratio emphasize the huge benefit of being better prepared for EIDs and potential pandemics by investing in prevention and the ability to detect and respond rapidly to emerging problems. The potential economic benefit of averting a pandemic like COVID-19 would be much higher and deliver public goods to the whole world. One study focusing on preventive measures in wildlife, involving upstream investments in reducing deforestation, biodiversity conservation, monitoring wildlife trade, early detection and control, reduction of spillovers, including via livestock, estimated a cost of USD 18-27 billion annually. In June 2020, the IMF estimated that the global impact of COVID-19 would be in excess of USD 5 trillion and is still climbing (Dobson et al. 2020).

Early action limits the rising costs of control and prevents broader impact globally. Neglect of prevention, detection, and control actions in the early stage of disease transmission from wildlife or domestic animals may unwittingly put humans in the position of sentinels for animal diseases and environmental exposures, instead of the other way round. The high return on investment from epidemic and pandemic risk mitigation through animal and human health systems strengthening has been articulated in prior reports (World Bank 2012, 2017a). It is critical, as much as possible, to prevent the disease from reaching the point of spreading between humans, after which it may be difficult to slow or reverse, and the impact and cost of disease control would increase rapidly. Figure 4.2 illustrates the cost curve for disease prevention and control actions superimposed on a typical pattern of progressive transmission of infection that involves a pathogen originating in wildlife and its spillover to livestock and human populations.

Aligning incentives for local actions in wildlife and animal health with global public health benefits is a complex political economy issue in One Health. Most arguments for investments in One Health are rooted in the cost savings from preventing nationally and globally significant public health events. The returns from upstream preventive and surveillance measures related to One Health investments might not fully compensate local governments, private sector, and the communities unless additional value and revenue streams are created to increase the pool of local benefits and improve investment efficiency.

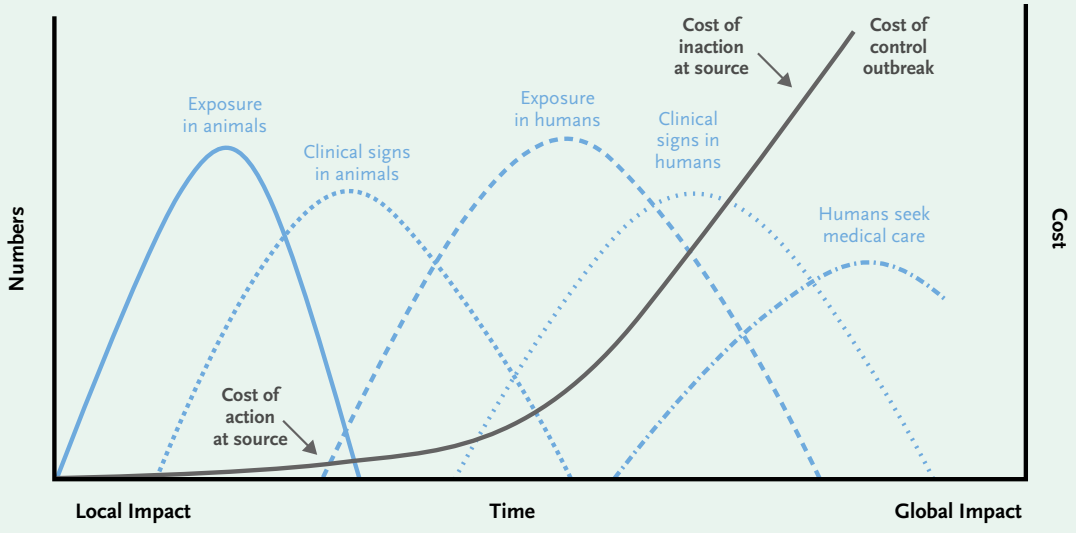


Figure 4.2: Cost of actions and inaction as the pandemic traverses from local to global proportions *Source:* World Bank 2012 adapted.

While transfers or ecological compensation mechanisms could be instituted for transmitting global benefits to local areas, taking a food systems approach for preventing zoonotic diseases, enhancing food safety, and reducing AMR could add to the significant local benefits. While more rigorous and context-specific cost-benefit/economic analysis would be necessary for any funding plan, Annex 1: Valuing One Health Investments illustrates why investing in One Health could be potentially cost-beneficial to the sectors.

High health status among farmed animals prevents the spread of animal diseases and reduces the risk of spillovers but poor health limits production

Animal disease prevention and control measures create large societal benefits even though veterinary service is considered primarily a private good. As many EIDs in people originate in animals and start as zoonoses, surveillance must take a One Health approach covering human and animal health (domestic animals and wildlife). Livestock productivity, food quality/safety, and market access can be enhanced by improving producer and trading organizations, addressing complex value chains, and implementing farm-level biosecurity, immunization, and disease control programs with improved animal welfare for animal health in livestock farms, wildlife farms, and wildlife hunting and trade. Achieving a high health status of farmed animals reduces the risk of spillovers and prevents animal diseases, while poor animal health compromises production and also generates significant negative externalities. Hence, animal health surveillance and infectious disease control should be a shared responsibility between public agencies and the private sector. The contribution of public schemes to animal disease surveillance funding in United Kingdom in 2011 was estimated to be about 90 percent. It also showed that animal health surveillance was heavily skewed toward regions with high cattle densities, particularly high-prevalence tuberculosis areas. The returns on investments in surveillance are thus likely to be at their greatest in areas where people gather and come into contact with animals. There is scope to better understand the benefits of surveillance, enhance data sharing, clarify costs, and identify who pays and who gains (Drewe et al. 2013). Table 4.1 presents a range of animal health services and the type of economic goods (private or public) produced and instances of externalities and moral hazards.

Table 4.1: Economic classification of animal health services *Source:* Umali et al. 1994.

Service	Type of economic good		Measures to correct for		Sectoral delivery	
	Public	Private	Externality	Moral hazard	Public	Private
Clinical intervention						
Diagnosis		X*				YY
Treatment		X**				YY
Preventive						
Vaccination		X*			Y	YY
Vaccine production		X				YY
Vector control						
Tick control		X*			Y	YY
Tse-tse control	X	X*			Y	YY
Veterinary surveillance						
Vet Epidemiology	X				YY	
Diagnostic support		X*			Y	YY
Quarantine			X		YY	
Drug quality control				X	YY	
Food hygiene/inspection				X	YY	
Veterinary research	X	X			YY	YY
Veterinary extension	X	X			YY	YY
Provision of veterinary supplies						
Production		X				YY
Distribution		X				YY

Note:*, private good with consumption externalities; **, private good with consumption externalities only for infectious disease; X, good classified as public or private; YY, economically justified; Y, economically justified under special circumstances.

Surveillance and the early detection of EIDs and novel pathogens with unknown disease epidemiology and transmission routes rely largely on passive surveillance, that is, systems for timely reporting of unusual disease outbreaks and unexpected health events. Low public awareness of the need to report and low animal health services capacity to investigate and report limit the sensitivity of passive surveillance, and this compromises the early detection of emerging issues and therefore the ability to mount a timely and cost-effective response. Inadequately sensitive surveillance and information failures are exacerbated by the lack of perceived benefits by the producers and the field staff. The lack of effective compensation and the threat of draconian disease control measures further discourage reporting. Policy must therefore calibrate producer responsibility and market-based incentives for reporting disease outbreaks with catastrophic financing instruments compensating for any economic losses. This approach will not only help in mitigating the moral hazard risks in financing local actions but also support transfer of the veterinary public health (and One Health) risks to global markets. Figure 4.3 could serve as a conceptual framework for resolving the dichotomy of local private good versus global public good for the prevention and detection of wildlife-livestock-human spillovers given the large positive externalities generated by local actions.

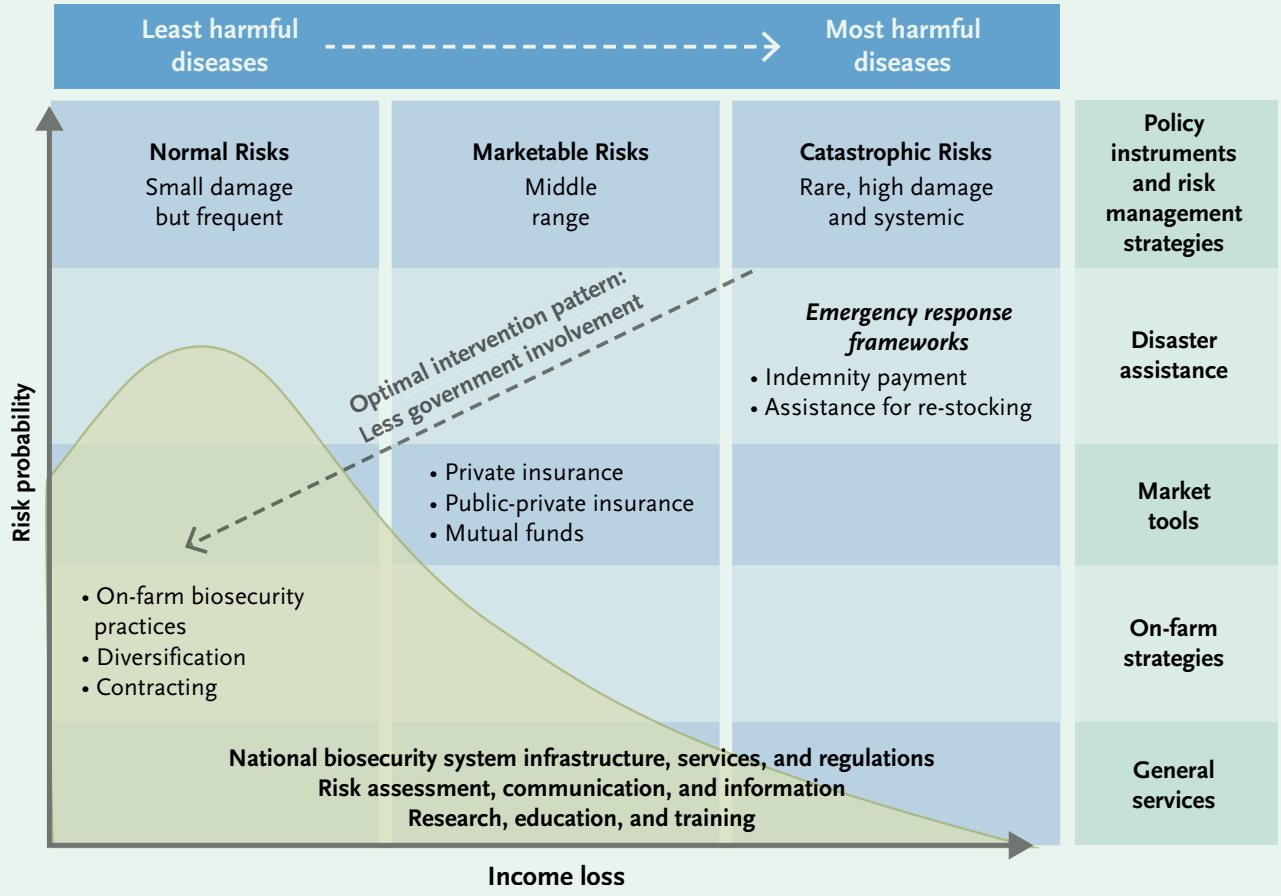


Figure 4.3: Risk management strategies and policies in management of animal diseases *Source:* Adapted from OECD 2011 by the authors.

Upgrading of scientific investigation infrastructure and capabilities is an important prerequisite for lowering the cost of action at source as delays resulting from mistaking a novel disease for a known one can be costly in terms of health and economic losses. In East Asia, this was seen with the first detections of Swine Acute Diarrhea Syndrome (SADS) coronavirus and Nipah virus. Greater knowledge of pathogens currently circulating in domestic animals and wildlife will help more rapid detection of disease spillover events. Capabilities for novel pathogen detection can serve two roles: first, infectious agents circulating in wildlife populations, with or without evidence of disease, can be identified and catalogued to help inform decision-makers about the possible source if outbreaks occur at a later date in humans or animals, and second, expanding diagnostic capabilities in sick people or animals allows rapid identification of causal agents using the advanced methods that may be required when routine pathogen testing fails.

Investing as little as USD 5 per person annually can help ensure the world is better prepared to deal with future pandemics

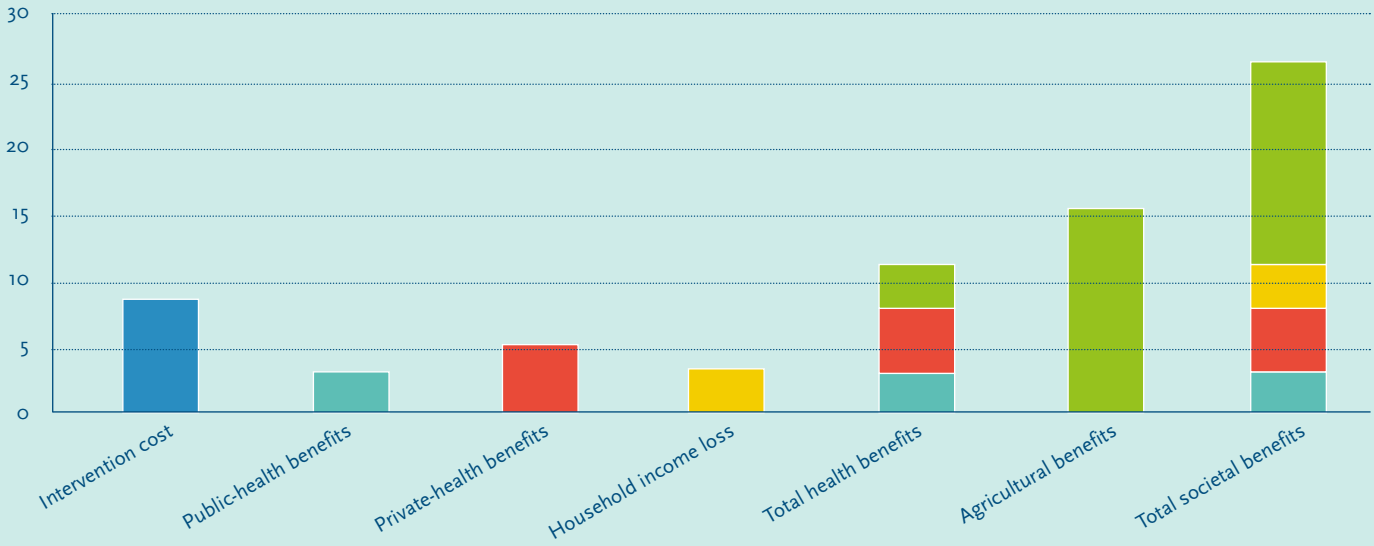
Smart investments of as little as USD 5 per person per year globally can help ensure far better preparation for future pandemics making a strong business case for strengthening the world's pandemic-response capacity at the global, national, and local levels. The recent report of the G20 High Level Independent Panel argued for an average annual investment of USD 34 billion for the next five years (including both global and country-level financing) to strengthen and coordinate pandemic prevention and preparedness by reinforcing operational systems for effective risk reduction and strengthening disease control in low- and middle-income countries. Similarly, McKinsey estimated that spending approximately USD 85 billion to USD 130 billion over the next two years and approximately USD 20 billion to USD 50 billion annually after that could substantially reduce the likelihood of future pandemics. Approximately 27 percent of this expenditure should take place at the global and regional levels, and about 73 percent should take place at the country level (McKinsey 2021).

The Mongolia case of controlling brucellosis at source offers an example of cost-effective financing of public services from a One Health perspective, contributing to the strengthening of health systems, and in a way that disciplinary medicine cannot offer alone.

The impact of One Health policies depends on whether governments and other decision-makers have adopted a cross-sectoral and inter-disciplinary approach to policy development and program design and implementation. Effective and sustainable change must include the development of One Health synergies that can be achieved at minimal cost and are offset by significant benefits. This requires that rather than building new structures, silos/barriers between sectors and disciplines need to be broken through a combination of enabling processes including appropriate governance, incentives, and compliance mechanisms and the development of a clear well-defined One Health coordination platform with effective chains of command. And these must be adapted to the regional, national, and sub-national contexts (Hitziger et al. 2018; Queenan 2017; Rüegg et al. 2017). Table 4.2 summarizes the key elements required for effective One Health collaboration taken from a high-level technical meeting organized by the WHO/FAO/WOAH Tripartite in 2011.

Box 4.1: Case of reducing human brucellosis risk though mass vaccination of livestock

In Mongolia, the mass brucellosis vaccination of livestock is estimated to have saved 49,207 DALYs with an investment of USD 8.3 million and to have generated USD 26.6 million in economic benefits. A cross-sector cost-benefit and cost-effectiveness analysis showed that whereas a 10-year mass vaccination of livestock is not profitable, if all the benefits, including private health cost, loss of income, and increase in agricultural production are included, the societal benefit-cost ratio is 3.1; if cost of intervention is shared proportionally to benefits, the public health sector would contribute 11 percent of the intervention cost, which would result in a cost-effectiveness of USD 19 per DALY averted (Zinsstag et al. 2005).



Distribution of benefits of mass brucellosis vaccination of livestock in Mongolia *Source:* Zinsstag et al. 2005.

Table 4.2: Key elements required for effective One Health collaboration *Source:* Adapted from FAO, OIE, and WHO 2011.

Key Supporting Elements	Key Operational Elements
1. Political will and high-level commitment	A. Joint cross-sectoral coordination mechanisms
2. Trust	B. Routine communication
3. Common objectives and priorities	C. Joint simulation exercises
4. Shared benefits	D. Data sharing
5. Strong governance structures, aligned legal frameworks, and recognition of existing international standards	E. Joint risk assessment
6. Adequate and equitably distributed resources	F. Active cooperation on disease control programs
7. Identification and involvement of all relevant partners	
8. Coordinated planning of activities	
9. Guidance on implementation of cross-sectoral collaborations	
10. Capacity development	
11. Strong and effective health systems within the individual sectors	

Theory of Change

The simple Theory of Change shows how establishing a One Health approach can deliver improved human health and well-being by reducing the risks from emerging pathogens and zoonoses from improvements in environment health and wildlife, animal health, and public health systems (Figure 4.4). To reach this goal, a series of outcomes must be achieved: reduced risks of pathogen spillover and zoonoses from animals (domestic and wildlife), improved food safety and security, and economic development and resilience and reduced environmental impact. It has been shown that for the last century, on average two new viruses per year have spilled over into humans (Aiyar and Pingali 2020). The MERS, SARS, 2009 H1N1, and HIV epidemics and the COVID-19 pandemic have had major impacts on human health and economies. The highest risk of zoonotic viruses infecting people directly is when they handle or slaughter live animals particularly primates, bats, and other wildlife or indirectly from livestock. Currently, there is very limited investment in preventing deforestation and regulating wildlife trade, despite their demonstrated high return in limiting emerging pathogens and zoonoses and the broader benefits. As public funding in response to COVID-19 continues to rise, analysis suggests that the associated costs of these preventive efforts are substantially less than the economic costs of responding to these pathogens once they have emerged.

The Theory of Change also identifies the need to establish standards for wildlife sources of food and to reduce the potential for zoonotic disease transmission. The risk of novel pathogens emerging from wildlife and being transmitted to humans remains low, but the potential impact can be very high. Risk reduction will be delivered through an array of activities producing outputs at multiple levels, including the development of effective policies and legislation, the establishment of robust well-resourced and monitored regional, national, and sub-national systems and programs, with coherent plans and guidelines including for contingencies and the capacity to address emergency disease situations. By addressing the intermediate outcomes this risk can be further reduced.

The Theory of Change shows how a One Health approach means better human health by reducing risks from emerging pathogens and zoonoses

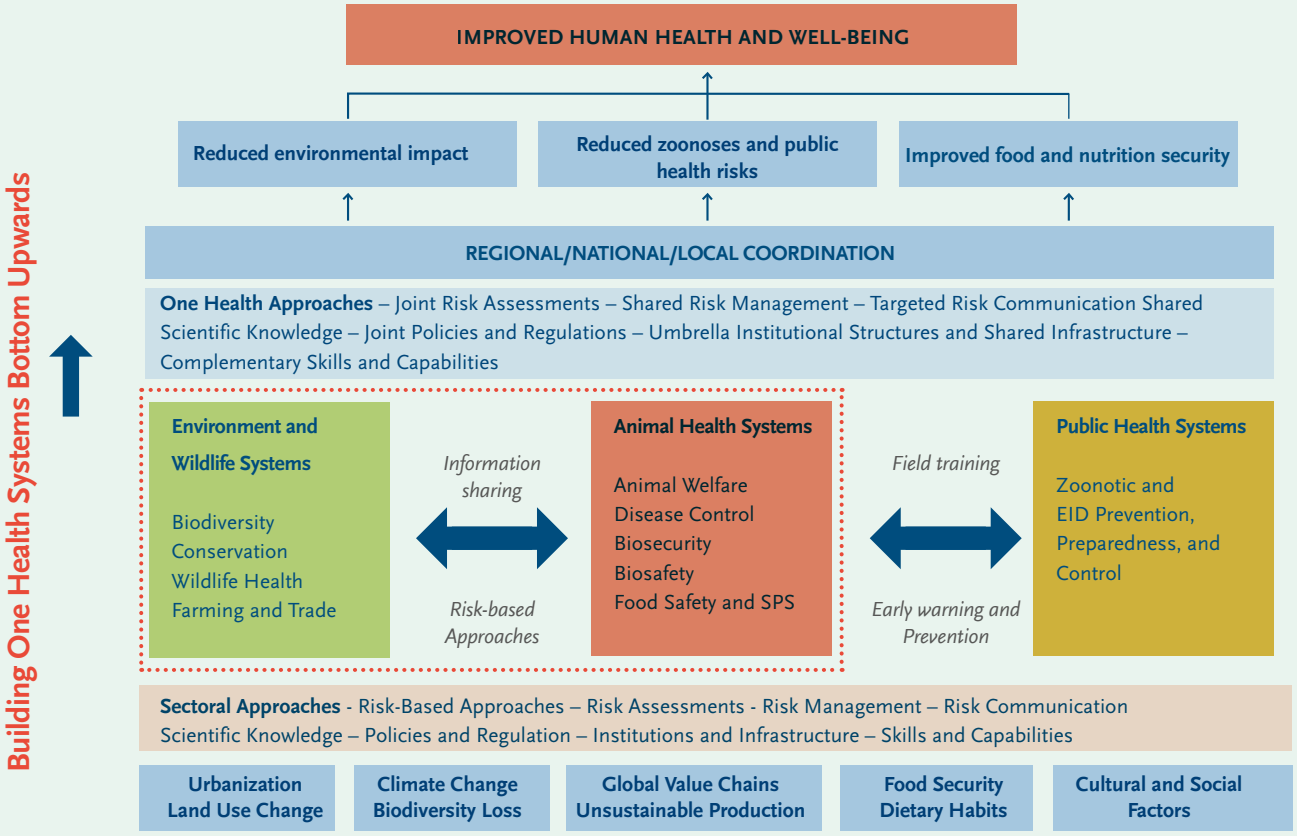


Figure 4.4: Theory of Change for building animal health and wildlife systems for One Health *Source:* Authors' own elaboration.

A disease outbreak can quickly become a pandemic through travel, international trade, and different eating habits arising from greater prosperity and changing lifestyles

a. Drivers for pathogen spillovers: The risks of spillover are increased by close associations between humans and animals, both domestic animal and wildlife, and are driven by population increases (human and animal), rapid urbanization, land-use change, climate change, and biodiversity loss. Local disease outbreaks can spread rapidly to become pandemics with increased travel and cross-border trade and food systems in response to changes in where, when, and what food people consume commensurate with their rising incomes and transforming lifestyles.

b. Strengthening the three pillars: The uneven capabilities of environment and wildlife, domestic animal health, and public health systems will limit the effectiveness of the One Health response to that of the weakest sector. Policy shifts will be necessary to develop stronger animal health and wildlife systems (the weaker sectors) to not only adopt risk-based approaches embedding science, transparency, and accountability in the surveillance, prevention, and control of zoonoses and emerging infectious diseases but also to harmonize with international protocols and standards. This would require improved regulations, enforcement, and incentivizing of private sector compliance for improved animal welfare, biosecurity and biosafety measures, responsible farm production, food safety, and sanitary protocols.

c. Coordinating One Health response: Implementation of the One Health approach begins with institutionalizing coordination mechanisms between the three primary sectors and developing joint risk assessments, identifying hot spots, and developing joint risk maps for priority zoonoses and EIDs, for animal health, wildlife health, and food safety including AMR. Beginning with sharing of disease information and developing joint risk maps, the sphere of collaboration should expand to joint policy actions, shared infrastructure, optimization of operational resources and development of complementary knowledge and skills, for a coherent One Health response combining the strengths of wildlife health, animal health, and public health systems.

d. Regional, national, and local One Health coordination: Pandemics do not respect administrative and political boundaries and the spread of EIDs and TADs is often caused by movements and trade of people, animals, and animal products across borders. Regional coordination is essential for improved border control, risk analysis of cross-border disease entry, establishment of health and trade standards, identification and certification of animals and animal products (both domestic and wildlife), and increased awareness and management of the informal movement to reduce the risk of international spread of animal diseases, including zoonoses. Furthermore, regional cooperation should support the development of One Health capacity through systematic sharing of risk and surveillance analytics, scientific investigation infrastructure, and knowledge and learning architecture and complementing HR capabilities of countries with weaker systems. Regional cooperation through collaborative research and provision of reference laboratory services would also help in standardizing and harmonizing protocols and Standard Operating Procedures (SOPs), especially on building shared data on pathogen mutation and spillover risks. It should also support collaborative research, communication, and awareness building in the region such as by the Southeast Asia One Health University Network (SEAOHUN).

Applying a Risk-Based Approach to Managing Animal Diseases and Zoonoses

A risk-based approach to disease identifies threats, considers the likelihood of an occurrence, and assesses its likely consequences

Adopting a risk-based approach allows the more effective utilization of finite financial and human resources to address the prioritized risks. A risk-based approach identifies the threats (hazard identification) and considers the likelihood of their occurrence (probability) and the likely consequences (impact). All actors in the sector, whether public or private, large or small, must be involved in managing the risks related to animal diseases. Disease prevention and control require strategic planning, strong awareness, and commitment from all stakeholders and the availability of sufficient resources for effective implementation. Planning for disease prevention and control should be risk-based, and prevention and control measures should be proportionate to the risk assessed. Resources will always be finite, and it is unrealistic to implement a costly program against a disease hazard that has only a low probability. Prevention and control measures should be proportionate to the risk faced by each stakeholder with consideration of public or private goods. Compensatory mechanisms may be needed to support compliance and equity.

The value of risk-based approaches is widely accepted, and although many countries now have some capacity to undertake simple risk assessments, there is little use of structured scientific risk assessments. Across the EAP region, considerable emphasis on training has been provided, mostly by international donors, on the use of structured scientific risk assessments in various aspects of policy development, program design, implementation, and resourcing. Areas promoted for the application of risk-based approaches include import risk analysis, risk-based surveillance, biosafety/biocontainment and the reduction in the risks from transporting diagnostic samples or in the diagnostic laboratories, livestock production and farm biosecurity, the reduction in antimicrobial use, assessment of disease epidemiology and reduction in risks, the management of supply chains including in animal/animal product movement, processing and trading including the use of HACCP, and promotion of food safety. A risk-based approach for operationalizing One Health interventions in animal health and wildlife systems is presented in Figure 4.5.

To mitigate risks efficiently and effectively, and 'working at the local, regional, national, and global levels, the goal should be achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment' (USCDC 2020). In 2018 the World Bank released an Operational Framework for Strengthening Human, Animal and Environmental Public Health Systems at their Interface ('One Health Operational Framework'), which provides guidance for donors and client countries to help optimize investments.

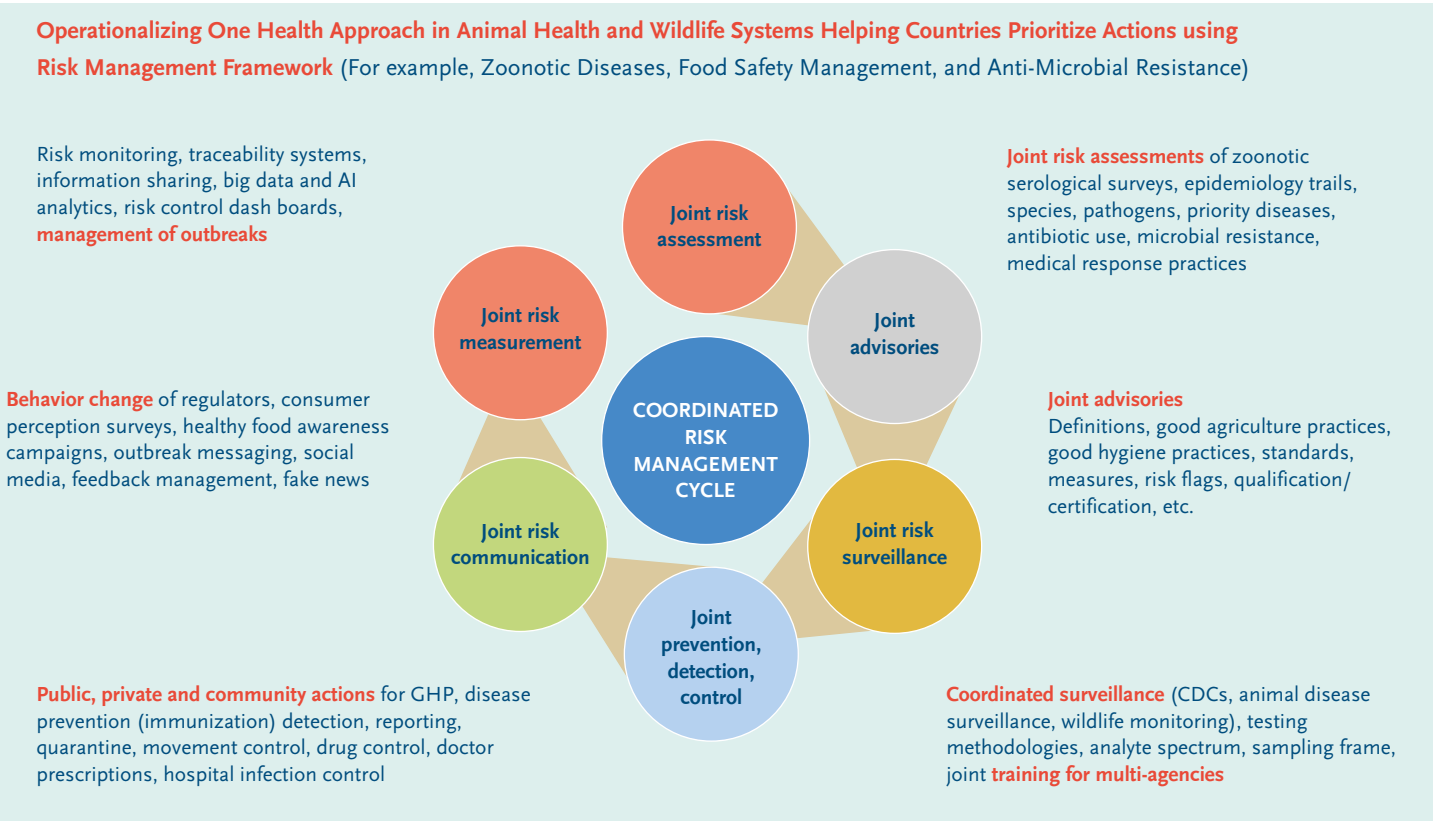


Figure 4.5: Operationalizing One Health approach in animal health and wildlife systems *Source:* Authors' own elaboration.

To reduce the risk, programs must be developed for the prevention of spillover from wildlife and from livestock. These programs will vary according to the likely disease epidemiology, that is, the relationship between the host, the pathogen, and the environment. Determining the preferred risk mitigation option requires an understanding of the biological aspects of the disease epidemiology (its host range, transmissibility, fatality, and recovery rates, etc.) and also the social, cultural, economic, political, and ethical factors influencing the effectiveness of control and prevention measures. State-of-the-art scientific knowledge and the ability to translate it into action are required.

Sound risk management policies use science-based platforms for advocacy with the collection and analysis of appropriate data and the preparation of evidence. To improve the delivery of animal health services and enhance livestock production practices, technical capacity and information management must be increased in quality and quantity through greater investment in staff, facilities, equipment, and operating systems and budgets with the development of the specialist skills and information systems that are currently limited such as for epidemiology, risk analysis, and food safety.

Key wildlife spillover mitigation steps must target hunting, trade, farming, habitat conversion alongside the cross-over risk from the livestock sector

Key risk mitigation measures that must be implemented include reducing the possibility of spillover of infection from the wildlife sector. Mitigation measures must target wildlife hunting and trade, wildlife farming, and habitat conversion but also address the cross-over risk with the livestock sector by improving the management of livestock supply chains, strengthening veterinary services, and improving livestock production practices to decrease the points for contact. A companion report focuses on wildlife and how to limit the risks of disease spillover (Reducing Emerging Infectious Disease Risks from Wildlife – Building Foundations for One Health in Asia and Pacific).

A risk assessment should consider the main drivers of EIDs, the types of threat, their probability, and likely impact using the prevention, detection, response, and recovery model to prioritize risk mitigation activities. Programs to improve animal health and reduce the risk of EIDs can be considered as having three elements: 1) animal health and livestock production; 2) wildlife trade, wildlife farming, and ecosystem management; and 3) food safety and food supply chains. In designing each of these programs structured scientific risk assessments should be undertaken. Table 4.3 shows an indicative assessment of the main drivers of EIDs and the risk of emerging zoonoses and identifies key areas to be addressed to achieve risk reduction.

Box 4.2: Regional example for risk-based approach

USAID's strategy for H7N9 is to attempt to disrupt its spread at the point of introduction, while human disease prevalence is low and the affected poultry population is limited (Forum on Microbial Threats, Board on Global Health, and Institute of Medicine, 2015). Since May 2013, the agency has partnered with FAO, WHO, and the CDC and eight countries in Asia to establish capacities for early detection of the virus in both poultry and humans and rapid control of the virus at the point of introduction. At the same time USAID established H7N9 surveillance activities in border provinces of China such as Guangxi and Yunnan.

Based primarily on knowledge of regional poultry trade dynamics, eight Asian countries were categorized in terms of the risk for H7N9 introduction–Lao People's Democratic Republic, Myanmar, and Vietnam–as having a 'high risk' for H7N9 introduction and five others–Bangladesh, Bhutan, Cambodia, Indonesia, and Nepal–as having a 'moderate risk'. In high-risk areas, USAID has supported surveillance of live bird markets and human populations. In all countries, the agency has supported the strengthening of clinical care practices for H7N9; disseminated communications to educate political leaders, market owners, traders, and consumers about the virus; and supported the development of a disease-control "tool kit" of interventions (live market closures, cleaning, depopulation, movement control) to contain the virus should it be detected.

In addition, a series of planning and review sessions brought together representatives from ministries of health and agriculture with technical experts, with the goal of educating ministries on H7N9, and how to use that knowledge to create preparedness plans and recognize needs; these functions continued at subsequent national planning sessions. The initiatives provided an example of infectious disease disruption through a combination of early detection and rapid control measures instituted during the 'introductory phase' of emergence and though risk-based *multi-sectoral efforts*.

Source: Authors' own elaboration.

Table 4.3: Animal health and wildlife systems contributing to One Health *Source:* Adapted by authors from Carlin et al. 2019, EcoHealth Alliance, and Berthe et al. 2018.

Main EID drivers	Prevent	Detect	Respond	Recover
Land use change and/ or habitat encroachment International trade in wildlife Wildlife farming systems and practices Livestock production systems and practices Poor hygiene and biosecurity of supply chain – wildlife Poor hygiene and biosecurity of supply chain – domestic animals Exposure to peri-domestic animals Livelihood activities and collecting foods from the forest	Identification of EID drivers Threat assessment Hazard profiling and risk assessment Screening and detection Risk reduction of EID drivers Prophylactic measures (vaccination, treatments) Separation and segregation Hygiene and sanitation Awareness of health risks	Surveillance systems: - environmental and sentinel detection - indicator-based surveillance (clinical/ syndromes) - event-based surveillance Sample movement and tracking Laboratory diagnostics Epidemiological investigation and case definition Multi-level and multi-sectoral reporting	Emergency systems established and operating Evidence-based control measures: - Quarantine or isolation - Treatment: pharmaceutical or non-pharmaceutical - culling/disposal - decontamination Epidemiological investigation and monitoring Multi-level and multi-sectoral reporting	Needs assessment Health impact management Economic and socio-cultural impact management Health system (re) establishment Remediation Alternative livelihood activities that are non-invasive to the ecosystem
Types of threat Emerging pathogens affect humans (direct) Emerging pathogens affect domestic animals Emerging pathogens from domestic animals affect humans (indirect) Introduction of diseases that affect native wildlife Alien species becoming invasive	**Cross cutting** **Governance:** leadership, policies, legislation, enforcement **Coordination:** Established One Health coordination and whole-of-government collaboration **Risk management:** Risk identification, communication, and education **Resources:** Resource allocation and coordination **Skills and human resources:** Workforce development and sustainability **Emergency response:** Developed emergency preparedness and response systems **Stakeholder engagement:** Community and private sector engagement, support, and resilience (compensation for losses) **Information sharing:** Data and information management and reporting **Research and development** **Donor coordination:** International organizations and NGOs			

CAMBODIA
Carcass surfaces are roasted with a gas burner in the wet market in Phnom Penh, Cambodia.
Photo credit: ILRI/David Aronson

Chapter 5. Overview of the Livestock and Wildlife Sectors in East Asia and Pacific Region

This chapter describes the development of the livestock and wildlife sectors in EAP, why the risk of disease spillover between animals and humans has increased in the region, and how antimicrobials are being overused for reducing disease with resulting high levels of AMR. The economic impacts of animal diseases are considerable and are only likely to increase unless managed more effectively.

Livestock Production in EAP is a Large Sector that is Growing Rapidly

All countries in EAP have large and growing livestock populations. China has by far the largest livestock population in the region. In all countries these numbers have been growing rapidly in recent years. The livestock data from various EAP countries are shown in Table 5.1. Annex 2 provides additional information on the trends in livestock numbers in the region. Though figures for the livestock economy are poor, it has been estimated that the total value of livestock is USD 40 billion in Indonesia and USD 11 billion in Vietnam. In China, the pig industry alone is estimated to be worth over USD 128 billion, and the industry is recognized as an essential component of the national economy and a critical source of livelihoods and food security for much of the population (Gale et al. 2019).

Table 5.1: Summary table of livestock populations in East and Southeast Asia, 2018 *Source:* Our World in Data, FAOSTAT 2018.

Country/Economy	Human population	Area (sq km)	GDP per capita	Cattle population	Sheep/goat population	Pig population	Poultry population (1000s)
Brunei Darussalam	437,479	5,265	31,628	681	10,724	1,236	16,352
Cambodia	16,718,965	176,515	1,510	2,855,353	-	2,215,641	22,087
China	1,439,323,776	9,326,410	9,771	63,417,928	302,462,222	447,175,334	6,065,250
Hong Kong SAR, China	7,496,981	1,104	48,676	1,583	716	153,458	1,540
Macau SAR, China	649,335	30	87,209	-	-	-	780
Democratic People's Republic of Korea	25,778,816	120,538	na	57,231	3,860,577	2,611,312	22,814
Indonesia	273,523,615	1,811,569	3,894	16,432,945	36,119,000	8,542,000	2,444,158
Lao People's Democratic Republic	7,275,560	236,800	2,542	2,040,907	616,325	3,824,663	42,783
Malaysia	32,365,999	329,613	11,373	752,547	581,844	1,654,801	331,786
Mongolia	3,278,290	1,553,556	4,121	4,380,879	57,679,507	27,819	878
Myanmar	54,409,800	653,508	1,326	17,418,364	5,926,112	12,934,454	327,941
Philippines	109,581,078	298,170	3,102	2,553,937	3,754,808	12,604,441	186,992
Papua New Guinea	8,947,024	452,860	2,730	93,249	10,365	2,152,024	4,637
Thailand	69,799,978	510,890	7,274	4,656,654	515,492	7,908,775	294,057
Vietnam	97,338,579	310,070	2,567	5,802,907	2,683,942	28,151,948	393,827

Table 5.2: Livestock value at the farmgate for selected countries, 2018 *Source:* Author's calculations.

Country	Producer price per tonne (USD)	Total liveweight (tonne)	Value (million USD)
Indonesia	3,299	11,903,610	39,228.85
Malaysia	3,203	372,812	1,197.32
Mongolia	738	3,911,928	2,885.42
Philippines	2,166	1,862,080	4,034.04
Thailand	2,591	1,990,742	5,158.09
Vietnam	2,896	3,960,414	11,467.82

5 Farmgate prices, shown as 'producer price per tonne', are used in the calculations and do not include any added value from along the value chain. It has been suggested that retail prices would be at least double the farmgate prices (personal communication Indonesia, Vietnam).

There is no robust method for estimating the value of livestock and their contribution to the economy. In part this is because the data on livestock numbers are often unreliable, but it is also the result of uncertain farmgate prices and costs of inputs along the value chain. The FAOSTAT combination of livestock numbers and farmgate prices provides an indication of the very significant investment in livestock (FAO 2020c). Table 5.2 shows the estimated 'capital value' of livestock at the farmgate for selected countries in the region for which livestock numbers and prices were available for 2018. More details of price per species are provided in Annex 3.[5] It can be seen that even taking these more limited estimates, there is significant investment in livestock in the selected countries for which data are available.

Livestock production has increased substantially to meet the rising demand for animal sourced foods in EAP. EAP has seen rapid economic development with increasing incomes, which – in line with global trends – has increased the demand for animal products and this has driven the dramatic increases in animal production – see Figure 5.1 and Figure 5.2. The 'Livestock Production Index' (Table 5.3) uses 2004-06 figures as a baseline with value of 100 and shows that all countries have seen a marked increase, with the exception of Cambodia.

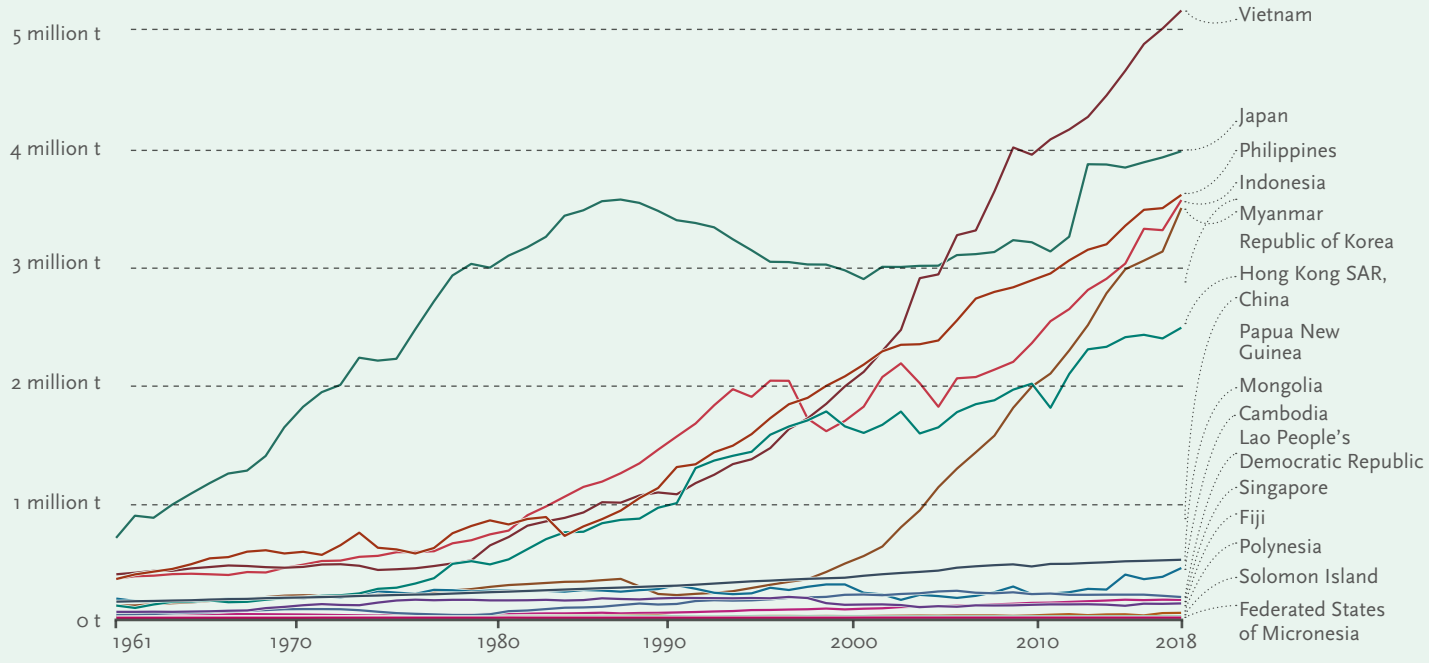


Figure 5.1: Meat production in EAP (excluding China), 1961-2018 (in million tonnes) *Source:* Our World in Data 2020.

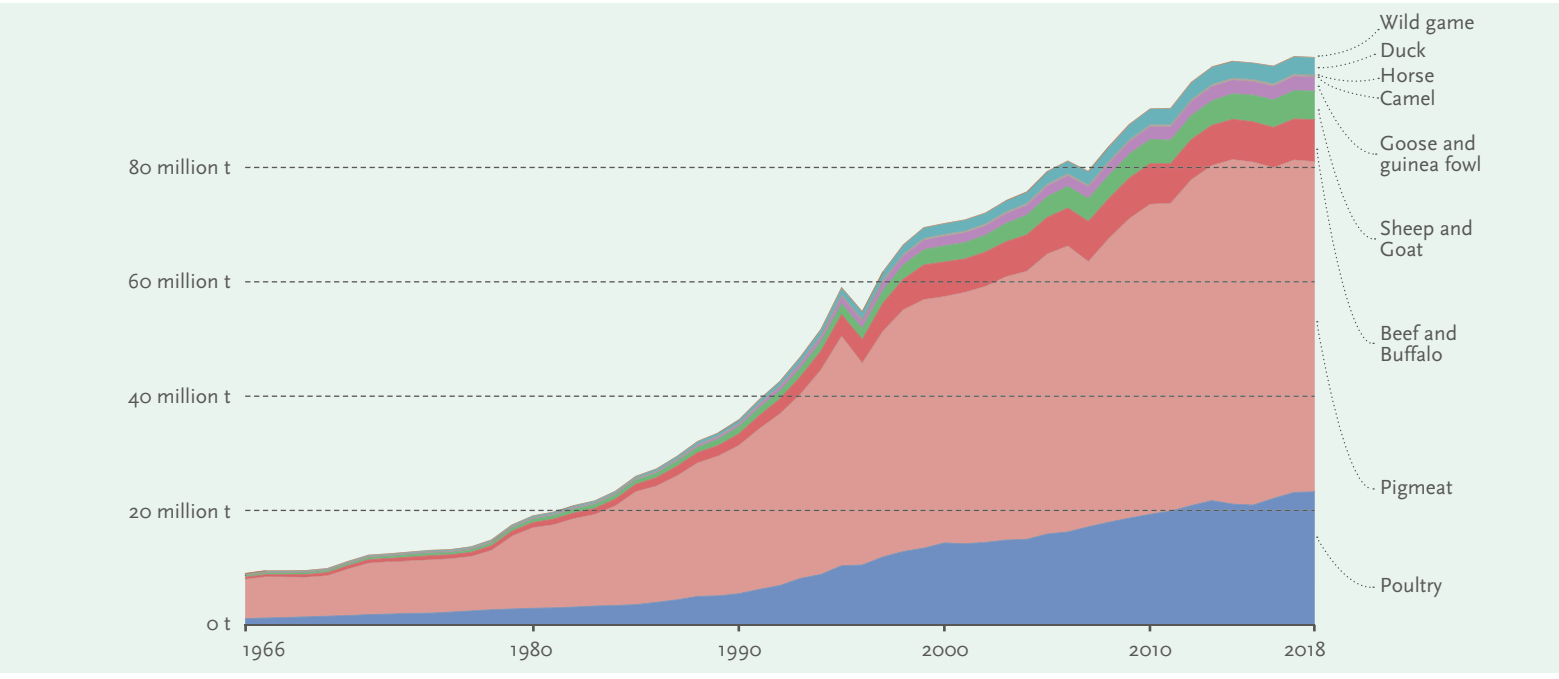


Figure 5.2: Growth in meat production by species in East Asia (1966-2018) *Source:* FAO.

Note: Total meat production includes both commercial and farm slaughter. Data are given in terms of dressed carcass weight, excluding offal and slaughter fats.

The numbers and density have increased for all livestock species, but improvements in animal husbandry and health practices, value chains, and food safety systems have been limited. Livestock numbers and density have increased in all production systems–large industrial, commercial, and backyard systems. Much of this growth has been the result of incremental increases in animal populations rather than any significant change in production systems or animal productivity. Policies have done little to drive change. A large share of production in the region remains as low input/output systems with limited investment; low profitability; and little resilience to market shocks, disasters, or climate change. In more developed countries, intensified animal production systems have increased more dramatically with greater investment in improved animal husbandry and better farm biosecurity. Overall farm hygiene, husbandry systems, and barriers to disease entry remain highly variable with limited development of coherent procedures and processes to minimize the risk of animal disease. The widespread risks to animal production have been demonstrated in recent years with the rapid spread of ASF across much of the region, resulting in catastrophic losses to producers, reduction in food security, and resilience to disasters and inflated prices of other meat products.

Smallholder production is often family based and poor rural people rely on it for their livelihood, food security, and employment

The sector is still dominated by smallholders and is an important source of employment, livelihoods, and nutrition. Backyard/smallholder livestock production characterizes many countries in EAP. Smallholder systems are largely based on low input/low output systems, often family based, and can be key to poor rural people's livelihoods, food security and employment creation as their livestock provide food for household consumption, products for income generation, and quick cash when emergencies and external shocks occur. Livestock also has an important cultural and spiritual value in many societies in EAP (e.g., buffaloes and pigs in weddings and other ceremonies, horse and bull racing, animal shows and competitions).

Table 5.3: Livestock Production Index, 2004-06 = 100 *Source:* World Bank 2016.

Sub Region/Countries	Livestock Production Index 2016	Sub Region/Countries	Livestock Production Index 2016
East Asia		**Pacific Island States**	
Cambodia	89.23	American Samoa	100.46
China	130.43	Fiji	109.67
Indonesia	144.98	French Polynesia	120.18
Lao People's Democratic Republic	125.57	Kiribati	118.94
Malaysia	144.66	Micronesia	102.05
Mongolia	149.57	Nauru	105.18
Myanmar	208.86	Samoa	111.64
Papua New Guinea	119.39	Solomon Islands	106.31
Philippines	126.91	Tonga	105.65
Thailand	131.25	Tuvalu	111.26
Timor Leste	113.83	Vanuatu	111.26
Vietnam	151.37		

Table 5.4: Distribution of backyard and commercial piggery farms in select countries in EAP *Source:* Authors' estimates based on FAOSTAT, data published by national ministries of Agriculture, Veterinary Services, etc.

Country	Number of pig farms			Total Farms	Pig Production (million pigs)	Production Value (million USD)	Size of Commercial Farms (pigs)
	Small Farms	Commercial Farms	Industrial Farms				
China (2017)	35,718,766	2,023,317	4,541	37,746,624	702.02	122,717.42	50-10,000
Indonesia (2018)	321,632	46,368	-	368,000	8.25	619.40	>20
Malaysia (2019)	-	455	160	615	1.95	1,066.97	50-3,000
Philiipines (2018)	160,000	4,700	376	165,076	12.60	5,885.61	50-10,000
Thailand (2010)	190,039	9,740	213	199,992	8.35	2,457.53	50-5,000
Vietnam (2019)	2,400,000	9,760	240	2,410,000	19.62	6,601.45	10-10,000

Gender roles vary, with poultry and small ruminants generally being managed by and providing more direct benefits to women. Table 5.4 shows the structure of the pig sector in selected countries and demonstrates the high proportion of pigs that continue to be produced on small farms.

Livestock production changes have contributed to unprecedented ecological and socio-cultural change, with dramatic reductions in natural ecosystems and biodiversity. The introduction of higher-productivity breeds and new feeding systems and rearing facilities, accompanied by the expansion of large intensive livestock systems, is playing a role in improving production efficiency but is also changing the structure of the sector, with impacts on the environment (Bingsheng K. 2010). These changes are particularly evident in East Asia and Southeast Asia, which are now globally significant pig and poultry producers. As the share of industrial-scale production has expanded relative to backyard production, increasing amounts of cereals are required by the livestock sector, which is contributing to significant environmental degradation around the region and globally. Livestock production requires much more water than crops, with milk and meat needing 10 to 50 times more water than crop production to produce the same nutritional output, especially when based on intensive grain feed and irrigated forage (Chacko et al. 2010). Furthermore, livestock production is a significant and growing source of nitrogen and phosphorus pollution, ecosystem degradation, and greenhouse gas emissions. The degradation of ecosystems leads to further loss of biodiversity and increased contacts between livestock production systems and wildlife.

The large increase in livestock production is mostly from smallholders without biosecurity or health support; their animals are often infected with endemic diseases

Despite the massive increase in livestock production, sub-optimal husbandry and hygiene conditions prevail. Smallholders, who still dominate the sector, vary in their adoption of improved husbandry practices and typically have no effective biosecurity and limited access to animal health programs. One consequence is that their livestock are commonly infected by endemic diseases and are at high risk from TADs. In contrast, industrial-scale producers generally have technical and veterinary services in-house and are generally used to assessing risks to the business, including the management of animal health. The more advanced large-scale producers operate at world's best practice standards with tight management of biosecurity, comprehensive disease prevention plans with extensive use of vaccinations and strategic use of antimicrobials and parasiticides, and close monitoring of production and health parameters. To better understand the pandemic risks faced by protein producers globally, the 2019 Coller FAIRR Protein Producer Index developed a Pandemic Ranking that combined six risk factors: deforestation and biodiversity loss, antibiotics, waste and pollution, working conditions, food safety, and animal welfare. The results showed that globally companies are doing far too little to measure and manage pandemic risk. Out of 60 international companies, 44, valued at USD 224 billion, were deemed high risk (worst performers) by the Pandemic Ranking. The remaining sixteen companies were rated as medium risk and significantly none of the companies were considered as low risk. Geographically, emerging market companies are categorized as high risk, particularly in Asia. Ninety-six percent (27) of Asian companies were deemed high risk (FAIRR 2020).

The use of antimicrobials is high in all production segments–from smallholders to industrial-scale producers–and it is insufficiently regulated, which has contributed to very high rates of AMR. Figure 5.3 shows the estimated use of antimicrobials in the livestock sector around the world. Throughout EAP, the sub-optimal husbandry and hygiene conditions have resulted in livestock producers using antimicrobials to prevent disease outbreaks rather than only to treat diseases when they occur. Moreover, in some countries, antimicrobials are still used as growth promoters, a use that is increasingly banned internationally. The risks to human health from AMR are further exacerbated by the widespread use of 'critically important antimicrobials', as designated by the WHO.

It has been estimated that nearly three-quarters of all antimicrobials used worldwide are used in livestock production and aquaculture, and EAP consumes more than 50 percent of the global total. In the pig and broiler sectors, EAP uses antimicrobials at five times the international average. China has the highest consumption of antimicrobials in the world, and it was estimated that approximately 97,000 tons were used in animal production in 2013, accounting for 54 percent of the country's total consumption.[6] The intensive use of antimicrobials in the livestock production in EAP has resulted in high rates of AMR and its spread beyond farming systems as a threat to human health (Box 5.1).

6 It can be noted that under new policies and controls, antimicrobial usage rates are likely to have subsequently declined.

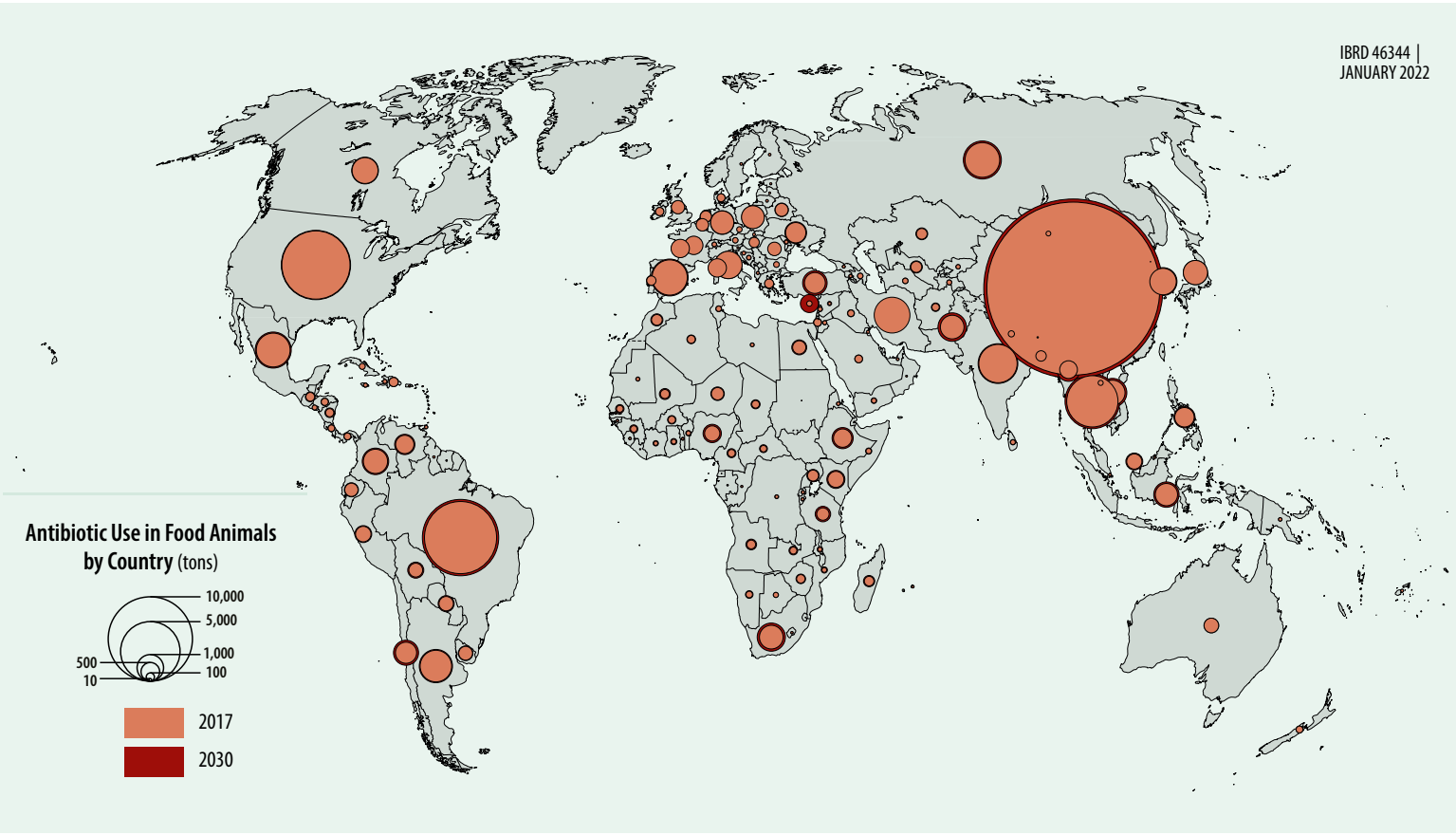


Figure 5.3: Estimates of the use of antimicrobials in the livestock sector in the world *Source:* Tiseo et al. 2020.

Box 5.1: Regional recognition of the urgency in reducing antimicrobial use

AMR is recognized globally as a major threat to human and animal health. In EAP, the threat from AMR is considered particularly severe with the high use of antimicrobials in humans and animals and increasingly in aquaculture. AMR includes resistance to 'critically important' human antimicrobial drugs as defined by WHO.

In recognition of this threat, national action plans to reduce the consumption of antimicrobials, including the banning of their use as growth promoters, are in place in many countries (e.g., China, Vietnam, Thailand, Indonesia, Myanmar, Cambodia, Papua New Guinea, Timor Leste) but high levels of consumption continue as the standard of animal husbandry and hygiene commonly remains poor. High levels of environmental contamination with antimicrobials have also been observed in many of the more intensive livestock producing areas in the region with high levels of antimicrobial-resistant bacteria and associated genes found in rivers and lakes in the region (e.g., China, Vietnam). This underscores the environmental health challenge of waste management in some parts of the region?

Source: Authors' own elaboration.

The Wildlife Sector in EAP

The demand for wildlife products has increased, resulting in increased local hunting and trade in wildlife with imports of exotic animals and products and the development of wildlife farms. The United Nations estimates that global illegal wildlife trade is worth between USD 7 billion and USD 23 billion a year, making it one of the most profitable criminal enterprises and the EAP is by far the greatest consumer of wildlife products in the world. Wildlife farming has become a significant industry in some countries in the region. For example, it is estimated to be a USD 20 billion industry in China, employing 15 million people. A survey in one region of Vietnam found that there were over 4,000 wildlife farms, farming 182 animal species. Wildlife farming in EAP includes rats, deer, foxes, bears, porcupines, civets, wild boars, and assorted birds including waterfowl. Typically, farming of wildlife often houses multiple species together, including species not typically overlapping in nature. Though data are limited, it is assumed that farmed wildlife includes a significant share of animals sourced from the wild.

Despite both the demand-driven growth and deliberate expansion of the wildlife sector, appropriate animal health and related food safety standards are not in place nor are adequate mechanisms or resources available for any compliance or monitoring activity. Some registration of wildlife farms is now taking place (e.g., in China, Vietnam) but there is minimal oversight of their animal health, hygiene, and welfare standards. The lack of health screening and largely uncontrolled distribution and retail result in increased risks of exposure of both domesticated animals and humans to both known and unknown pathogens from wildlife.

Livestock and Wildlife Supply Chains in EAP are Expanding

Supply chains for animals and animal products, both domestic and wildlife, in EAP are complex and intertwined, involving many actors across extensive distances. Local processing is often absent and live animals are traded over long distances and by multiple actors along complex value chains. Smallholders and hunters typically sell direct to traditional markets or through local traders; small commercial and some larger producers may also use local traders. These local traders may sell to retailers at a local market, or their consignments may be aggregated for supply to more distant urban markets, sometimes via a further aggregation/sorting point, and 'collection yards.'

Live animals are traded without local processing over long distances by various actors along complex, intertwined value chains, increasing exposure to various pathogens

Regional trade

Trade in livestock and livestock products is a significant activity for many countries in the region, with free trade being a key policy of the ASEAN. Trade in livestock and livestock products occurs between the Southeast Asian countries and into China and also between China, Mongolia, and the Democratic People's Republic of Korea. Studies of value chains and animal movements show that there is extensive international trade in livestock in mainland Southeast Asia, including from South Asia. In the Pacific Island countries, most animal trade is in the form of imported meat from Australia and New Zealand. Regulations intended to counter the spread of animal disease represented almost one-third (32 percent) of the specific trade concerns lodged with the WTO from 1995 to 2015. This large share reflects concerns about safe international meat trade and outbreaks of animal diseases such as foot-and-mouth disease (FMD) and bovine spongiform encephalopathy (BSE) and the concern that some regulations used to address these outbreaks are also functioning as non-tariff trade barriers. Table 5.5 provides an overview of the value of the official trade in live animals and animal products in the region.

Table 5.5: Value of live animal and animal products exports and imports for 2019 (USD, thousand) *Source:* ITC calculations based on UN COMTRADE and ITC statistics.

Countries	Live Animal Exports	Meat Products Export	Live Animal Imports	Meat Products Import
Cambodia	209	-	5,876	12,799
China	509,746	840,989	497,473	18,835,596
Indonesia	66,038	17,121	631,124	850,232
Lao People's Democratic Republic	229,8299	4,718	235,003	8,792
Malaysia	201,876	26,615	57,719	863,927
Mongolia	365	54,332	1,212	35,096
Myanmar	52,666	762	23,048	144,897
Papua New Guinea	-	43	1,051	121,945
Philippines	772	5,034	21,166	1,221,785
Thailand	381,456	1,028,431	91,800	139,347
Timor-Leste	-	-	314	13,710
Vietnam	23,836	90,344	596,383	2,630,089

The lack of local processing capacity at the national level also contributes to the very extensive internal movement of live animals. In countries such as China, Mongolia, Myanmar, and Indonesia, live animals travel widely across the country to markets and slaughterhouses. The actual management of wildlife transport varies widely, but not uncommonly there is a lack of separation of wildlife from domestic animals and people. Hygiene and welfare standards are also poor. In addition, the transport of livestock and wildlife animals may be mixed with multiple contact points and is often aggregated at collection points or in markets with high rates of contact (Figure 5.4).

Figure 5.4: Official and unofficial movement of cattle in Southeast Asia *Source:* FAO Regional Studies 2015.

Despite wildlife being a significant concern for emerging pathogens, only a fraction of animal-sourced products traded globally are from wild animals. Some 99.7 percent of the meat trade globally is from domestic animals. While there are no specific trade data for EAP, figures for the region are likely to be similar. Trade in wild animals is driven by high profits and continues informally even when it is officially banned. Wildlife is traded for food, pets, or luxury items (e.g., traditional medicine remedies and artifacts). Wild animals or their products may be traded and consumed locally; moved between rural and urban settings; or transported over countries, regions, and/or continents (Utermohlen 2019). The trade may be legal or illegal.

Traditional markets

Traditional markets[7] remain important in EAP for the sale of animal-sourced products and often of live animals. For consumers in most countries in the region, traditional markets are the main source of fresh produce and provide a price advantage over supermarkets for low-income households. Shopping at supermarkets is predominantly for processed and packaged foods – see Figure 5.5. The standards of the facilities, hygiene, and management in traditional markets are highly variable and commonly poor and result in a high risk of exposure to disease agents. Traditional markets often allow mixing of different species, the slaughter of live animals in close proximity to people, and sale of animal products in unhygienic conditions. In the EAP region, some good progress has been made in reducing the risk from mixed traditional markets, for example, in Hong Kong SAR, China, and parts of Thailand, but in most of the region these markets persist often with a high rate of consumer endorsement.

7 A number of different terms including 'traditional market,' 'wet market,' 'agriculture market,' 'farmers' market,' 'retail market', and 'open market' are commonly used to describe the markets that sell fresh agriculture products, including but not limited to fruits, vegetables, fresh meat, fish, live animals, birds, etc. In this report the term 'traditional markets' is used. Nevertheless, it should be noted that there is a wide diversity in these markets in terms of their size, facilities, and management, whether live animals are traded and/or slaughtered, and what products are sold. As such, the risk to human and animal health from markets varies widely.

Traditional markets provide an important social, cultural, and economic benefit for farmers, retailers, and consumers. Consumers prefer the convenience, perceived quality, lower prices, and social engagement of traditional markets. Animals such as poultry are commonly slaughtered and processed in the market to meet the cultural preference for purchasing 'warm meat' although also because of the lack of reliable cold chains and refrigeration logistics that do not allow for alternatives. Nevertheless, due to increasing concerns over food safety, preferences are starting to change. Many traditional markets no longer have live animals for sale.

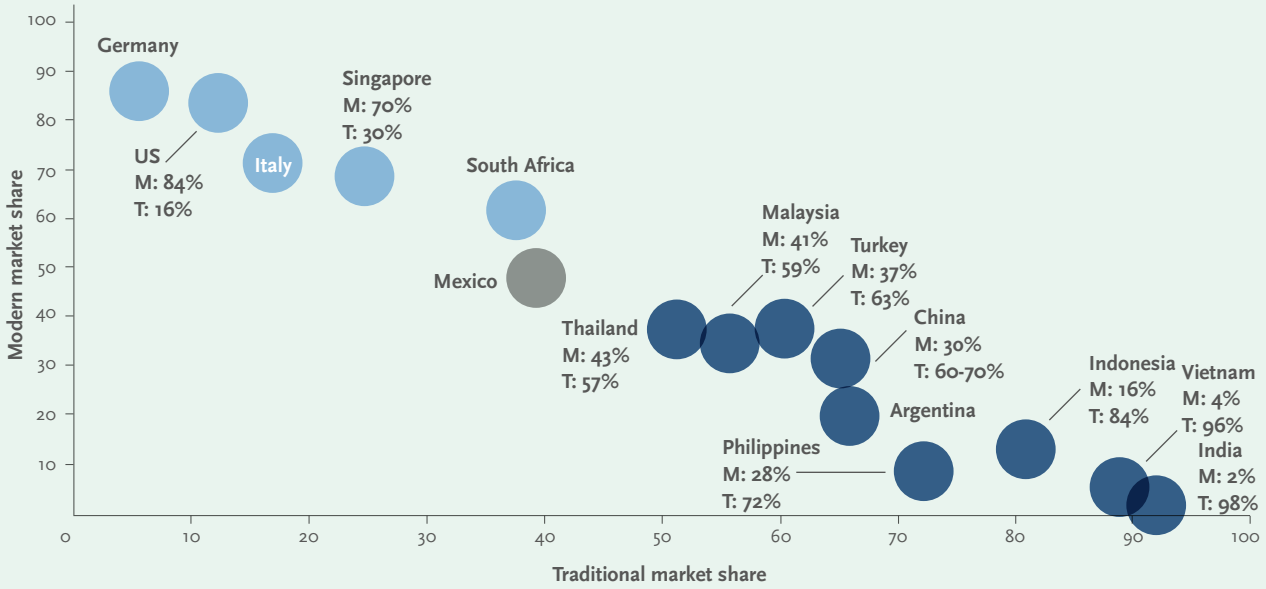


Figure 5.5: Comparison of modern market share with traditional markets *Source:* Tefft et al. 2017.

Significant problems can arise when traditional markets allow the sale and slaughter of animals. This is especially the case for wild animals, which cannot be easily assessed for potential risks before transport and slaughter/sale. When wild animals are kept in cages or pens and slaughtered and dressed in open market areas, these areas may become contaminated with body fluids, feces, and other waste, increasing the risk of transmission of pathogens to workers and customers and increasing the risk of spillover of pathogens to other animals and humans in the market. Some of the earliest outbreaks of EIDs have been linked to such traditional food markets, suggesting that traditional food markets provided an environment conducive for animal coronaviruses to be transmitted to new hosts, including humans. Mounts et al. (1999), while investigating the human outbreak of HPAI H5N1 in Hong Kong SAR, China, reported that a visit to a retail poultry stall or a market selling live poultry in the week before onset of illness was found to be significantly associated with the risk of becoming infected.

Consumers traditionally prefer local markets but these give rise to significant infection risks when wild or farmed animals are slaughtered and sold on the spot

There are many possible sources of wild animal-associated disease risk in food systems. These include exposure to live or freshly slaughtered high-risk wild animals in the handling, slaughter, and preparation; wildlife-livestock contamination through the livestock production and value chain with poor biosecurity; and food-borne illness linked to contamination and consumption. A significant volume of wild animal meat is harvested for subsistence or sold locally to populations with few affordable protein alternatives. Growing demand is also driven by urban, wealthier populations willing to pay a higher price for wildlife products as a luxury product. In Southeast Asia, 56 bat species, or 17 percent of those in the region, are known to be hunted, with bat hunting considered significant in Brunei Darussalam, Cambodia, East Timor, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand, and Vietnam. In addition, changes in food production systems may introduce risk to livestock and human populations owing to increased contact with wildlife. For example, expanding livestock and other agricultural activities near forested areas or other wildlife habitats or introducing poultry production along wild bird flyways creates opportunities for spillover, often in conditions favoring spread of disease. Certain food system practices also may attract wildlife to human settlements such as open sources of grains or animal feed leading to the presence of food-seeking wildlife pests and contamination of food supplies (World Bank and FAO 2022).

There are seven key aspects in assessing the risks to human health of traditional markets (i) the presence of higher disease-risk taxa; (ii) the presence of live animals; (iii) hygiene conditions; (iv) market size, (v) animal density and interspecies mixing, (vi) complexity of the supply chain; and (vii) sale of threatened species declining. These criteria provide the basis for building a risk framework to identify which types of traditional markets cumulatively engender the greatest threats to people and biodiversity. Lin et al. (2021) classified them into four broad types based on the following characteristics:

There is a precise framework that can identify the level of risk traditional markets pose to human health

a. Markets selling no live animals (excluding seafood) for consumption and only domesticated animal products, alongside other fresh fruits and vegetables
b. Markets selling live domesticated animals for consumption and slaughtered domesticated animal products, alongside fresh fruits and vegetables
c. Markets selling slaughtered wild animals (captive-reared or wild-caught) for consumption, besides selling live or slaughtered domesticated animals, alongside fresh fruits and vegetables
d. Markets selling live wild animals (captive reared or wild caught) for consumption, alongside live domesticated animals or slaughtered domesticated animal products and fresh fruits and vegetables.

Seven health and biodiversity factors were identified for qualitatively assigning risk levels (low, medium, and high) for each type of market to arrive at a risk assessment matrix in Table 5.6.

The cumulative risks of traditional markets to human health, animal health, and biodiversity are associated with the diversity of animals present, the market facilities and management, and their popularity. Most traditional agriculture markets pose little risk to One Health, but others pose disproportionately high risks. If the present or absence of live and wild animals is used to assess the risks from traditional markets to human health and biodiversity, the relatively small number of traditional markets that sell live wild animals can be seen to be disproportionately the source of many previous EID outbreaks.

Traditional food markets are often governed by complex administrative structures with multiple overlapping responsibilities between different regulatory and law enforcement agencies. Such markets are also characterized by poor facilities and inadequate funding. It is important for policy makers to prioritize regulating the traditional markets and taking steps to prevent resurgence of their highest-risk aspects. A coordinated approach is essential to improve hygiene standards and food safety in markets (Joint WHO, WOAH, UNEP Guidance, 2021).

Table 5.6: Taxonomy of EID and biodiversity risks across traditional market types[8] *Source:* Lin et al. 2021, adapted by the authors.

	Traditional market type			
	(1)	(2)	(3)	(4)
	Dead domesticated animals, excluding live seafood	**Live domesticated animals,** including any of **(1)**	**Dead wild animals,** including any of **(1)** or **(2)**	**Live wild animals,** including any of **(1)**, **(2)**, or **(3)**
High disease-risk taxa a present	**Low** No historical EID events have been linked to such markets	**Medium** Live domesticated animals in wet markets have been linked to past EID outbreaks such as avian influenza	**High** Wild animals in wet markets can comprise high disease-risk taxa for EIDs	**High** Same as (3)
Live animals present	**NA** No live animals sold in such markets	**Medium** Live animals facilitate viral shedding and zoonotic transmission; stress increases live animals' susceptibility to infection	**Medium** Same as (2)	**High** All of (2), and live wild animals can display greater stress responses to transport or market conditions than domesticated animals
Poor hygiene	**Low** Poor hygiene elevates the risk of foodborne illnesses	**High** Poor hygiene elevates the risk of zoonotic EID events	**High** Same as (2)	**High** All of (2), and the presence of live, wild animals elevates the risk of EID events
Large market size	**Low** No historical EID events have been linked to such markets	**Medium** Larger markets increase the pool of susceptible human and animal hosts to EID spillovers	**High** All of (2), and the presence of high disease-risk taxa elevates the risk of EID events along the supply chain	**High** All of (3), and the presence of live, wild animals elevates the risk of EID events
High animal density and interspecies mixing	**Medium** The tight confinement of live, domesticated animals along the supply chain can pose health risks.	**High** Interspecies contact facilitates viral spillover and amplification along the supply chain and at markets	**High** All of (2), and the presence of high disease-risk taxa elevates the risk of EID events along the supply chain	**High** All of (3), and the presence of high disease-risk taxa elevates the risk of EID events along the supply chain
Long length and breadth of supply chain	**Medium** Lengthy supply chains can exacerbate hygiene issues and interspecies mixing; multiorigin sourcing can facilitate viral spillover	**Medium** Same as (1)	**High** All of (1), and wildlife supply chains can be lengthier or more irregular than those of domesticated animals and elevate the risk of EID events	**High** Same as (3)
Threatened or declining species sold	**N/A** No threatened or declining animal species sold in such markets	**N/A** No threatened or declining animal species sold in such markets	**High** Wild animals in wet markets can be of threatened or declining species	**High** Same as (3)

8 Disease-risk taxa would cover those animal species that are important hosts, carriers or vectors of pathogens.

CHINA
White raccoon in cages on a farm.
Photo credit: chinahbzyg/Shutterstock

Chapter 6. Assessing EAP's Readiness to Avert Spillover and Disease Spread

This chapter assesses the systems, institutional capacity, and performance of the animal health services (domestic and wildlife) in the region and their contribution to One Health. The assessment considers the wide range of policies, legislation, governance structures, systems of delivery, programs, resources, communications and consultations, etc, related to animal health, veterinary public health, and animal welfare. The chapter also discusses existing regional institutions and some opportunities for effective regional coordination on animal disease prevention and control.

Animal Health Policies and Institutional Mandates in EAP

To minimize the impact of pathogen spillover, emerging infectious animal diseases, and zoonoses, a country requires effective animal health and wildlife services with the adoption of a One Health approach for prevention, detection, and emergency preparedness and response. Achieving a high national emergency preparedness and response capability requires 1) a strong policy commitment to disease prevention and emergency response from political leaders, senior managers, and animal health and wildlife staff; 2) enabling legislation that provides the legal mandate for action; 3) a well-defined and functional 'chain of command' from central to province/district levels and to the field, with reporting back; 4) developed and tested operational systems to carry out the necessary risk analysis, prevention, disease surveillance, disease control, and eradication measures with supporting communications and consultations; 5) documented plans with guidelines and standard operating procedures on what and how activities will be undertaken; and 6) the resources to carry out the activities for communication, prevention, surveillance, control, and eradication, including specifically sufficient and timely funding for the payment of compensation, staff trained for all the required tasks, and the necessary equipment and materials. Critical to the effective management of an emergency response to an animal disease or zoonosis incursion is the need for strong leadership and effective management of the animal health and wildlife services and close liaison with the human health services with strong collaboration and support from across government, with non-governmental and community service organizations (NGOs and CSOs), the private sector, and international agencies.

Livestock health and disease management policies

Economic development and food security drive EAP livestock policies more than food safety or controlling zoonoses

Livestock policies in EAP have been driven by economic development and food security with less emphasis on food safety and the control of zoonoses. The rapid increase in demand for livestock products in the region has seen dramatic growth in production with little attention or policy development on environmental impact, biosecurity, and disease control or sustainability. The opportunity for significant production and productivity gains in the EAP region is recognized, but countries also face constraints with limited rural infrastructure, complex land tenure issues, and often low agricultural productivity and competitiveness of agri-food products. Most countries have documented multi-year agricultural development strategies, some with corresponding investment plans. Three priority outcomes are commonly identified:

1) Enhanced governance and capacity of institutions responsible for agricultural/livestock development
2) Improved productivity, increased farmer incomes, and enhanced resilience to threats from animal disease and climate change, specifically
   - Transition from low-input/low-output, subsistence production to more efficient commercial farming systems;
   - Improved food security and food safety;
   - Increased income generation and improved resilience; and
   - Access to rural finance and improved delivery of services including technical and extension services with greater emphasis on research and development.
3) Better supply chain management with enhanced market linkages and improved competitiveness.

The systems for the prevention, detection, and response to EIDs linked to animals, zoonoses, and food-borne infections in many EAP countries are not commensurate with the level of risk. Figure 6.1 shows that country risks (using INFORM Epidemic Risk)[9] and their capacity (as indicated by the size of the bubbles) to prevent, detect, and respond to EIDs, zoonoses, and food-borne infections vary markedly and correlate closely with a country's GDP per capita. Countries with low GDP per capita typically have higher risks, but the lowest capacity to manage these risks, for example, Timor Leste, Myanmar, Cambodia. Countries with higher GDP per capita may still have high risks but have a greater capacity to respond, for example, Thailand and to a lesser extent Indonesia. Singapore, with the highest GDP per capita in EAP, has the lowest risk and the greatest capacity to manage risk.

9 The INFORM Epidemic Risk Index developed by the Joint Research Center of the European Commission in collaboration with the WHO assesses the risk of countries to epidemic outbreak, which would exceed the national capacity to respond to the crisis. The risk score ranges from 0 to 10, where 10 is the highest risk. In its original version it is covering four groups of infectious diseases on the base of the mode of transmission and the epidemiological triad addressing agent, host and environment: (i) zoonoses, (ii) vector-borne, (iii) person-to-person (P2P), and (iv) food-borne and waterborne.

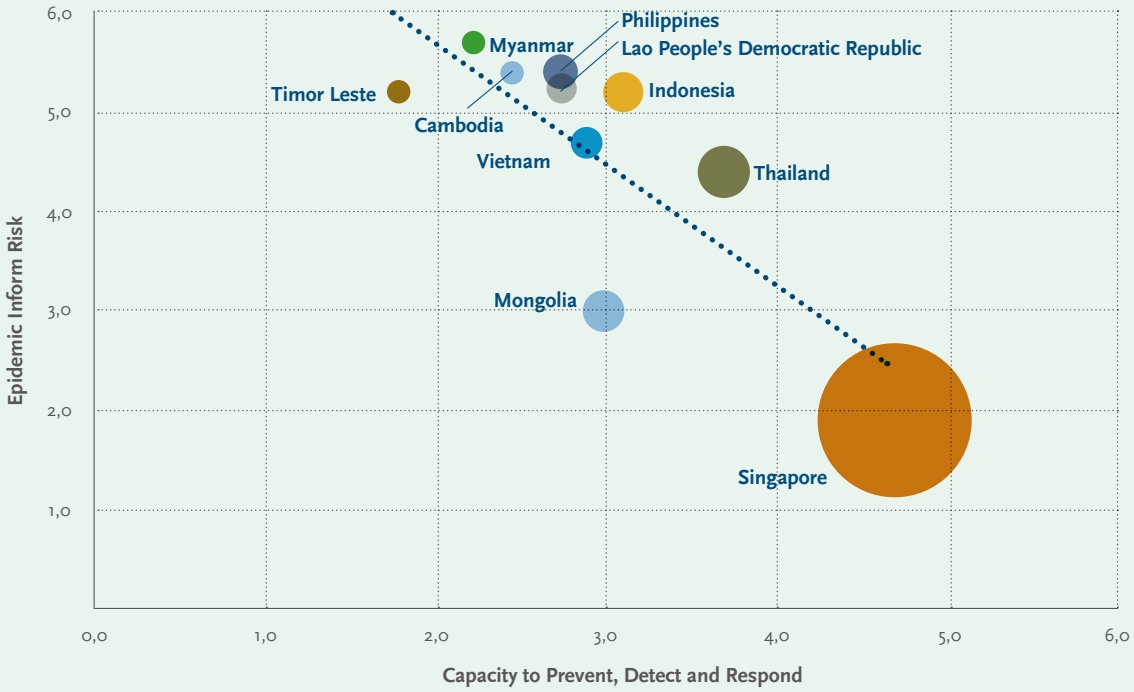


Figure 6.1: Institutional capacities for managing EIDs linked to livestock, zoonoses, and food-borne infections *Source:* Authors' own elaboration.

Many countries have made considerable updates to their legislation on animal health, zoonoses, and food safety, but considerable gaps in the mandate, implementation, and funding remain and a risk-based approach to animal disease management policy is largely absent. Countries that have updated their legislation include Mongolia, China, Vietnam, Myanmar, Indonesia, Papua New Guinea, and Timor Leste, though much remains in progress in other countries. Notwithstanding this, the legal mandate is often weak or absent for disease prevention, detection, control, and recovery, or significant important gaps remain, e.g., lack of clear funding mechanisms for emergency response and the use of compensation. There is also limited use of risk assessments to formulate policies, design programs, and prioritize the use of resources. In some countries the integrity of the legislation is compromised by new laws conflicting with older unrepealed laws and regulations. Both WOAH and FAO have had programs to support reviews of legislation, but it is still a 'work in progress' in most countries.

Many EAP countries have an emergency response plan for animal disease outbreaks but few have a strategy to prepare for such emergencies

All the countries in the EAP region have policies for emergency response to incursions of animal disease, but there has been limited development of systems for emergency preparedness. Emergency preparedness and response systems in animal and human health were boosted in response to the epidemic of H5N1 HPAI that swept much of the region in 2003 and the following years and more recently in response to H7N9 avian influenza. This led to the establishment of One Health platforms in many countries (e.g., Cambodia, China, Indonesia, Thailand, Vietnam), but progress in developing and implementing programs has been often slow. Over the initial period of the avian influenza epidemic, pandemic preparedness plans were developed with increased collaboration and coordination between animal and human health services but with limited engagement with the wildlife sector. Since that time, progress in the development of One Health capacity has varied considerably and many countries have languished with attention diverted to other priorities.

Animal health and food safety policies for the value chain of animals and animal products are generally inadequate or absent. There is typically no ability to identify or trace animals and animal products, either domesticated or wildlife, though a few pilot projects are now under way (e.g., Mongolia, Thailand, Vietnam). For smallholders, the input suppliers of feed, technical, animal health, and other services often face uncertainty, as producers are highly susceptible to market shocks and disease outbreaks. Consequently, smallholders have often invested little in improving their biosecurity, their buildings, or other infrastructure because of the production risks and uncertainty. Commercial producers have greater commitment than backyard producers, but at a smaller scale remain highly susceptible to disease and

market pressures. The large integrated livestock producers have a stronger commitment to improving production efficiency and product quality with improved returns; nevertheless, these large producers also have a high risk of disease incursions as biosecurity often remains inadequate. Modern technologies such as 'blockchain' and the use of distributed ledger technologies provide a unique opportunity to bring greater efficiency, transparency, and traceability to product exchange and information in the livestock sector. However, they are not yet broadly adopted in the region.

Science-policy interface is weak and animal health policies are not evidence-based

The science-policy interface for developing evidence-based policies and programs is weak and countries have made limited use of risk assessments to identify priority activities to protect human and animal health (both domestic and wildlife). This has typically resulted in poorly prepared policies, limited strategic planning and inadequate program resourcing, and inefficient implementation. All countries in the EAP region have developed policies for increasing livestock production, improving animal health, and promoting food safety and the control of zoonoses. By contrast, EAP countries have limited policies or programs for wildlife. Though variable, overall, there is insufficient critical review and assessment of the effectiveness of disease control policies and programs.

One Health and effective risk management require solid scientific evidence but very few countries have set up strong, independent scientific institutions to deliver this

The effectiveness of the science-policy interface varies across the region but with no countries having established strong independent scientific advisory institutions – such as Chief Scientists or high-level Advisory Committees. Central to One Health and to effective risk management is that policies are informed by sound scientific evidence as well as consideration of social, cultural, economic, and political factors (Aitsi-Selmi et al. 2015; Aitsi-Selmi, Blanchard, and Murray 2016; Gluckman and Wilsdon 2016; National Research Council 2012; OECD 2015; Parkhurst 2016). COVID-19 has demonstrated the importance of governments having access to timely and state-of-the-art scientific research and advice and for countries to develop policies and programs on the basis of such sound advice and understanding, some countries in the region demonstrate better integration of scientific data into the policies (e.g. China, Republic of Korea, and Vietnam). Of the countries considered in this review, China has the strongest relationship between its large scientific community and government through the China Center for Disease Control (CDC), China Animal Health and Epidemiology Center (CAHEC), and the Chinese Academy of Agriculture Sciences (CAAS). It is recognized that international organizations such as FAO and WOAH have a key role in facilitating access to scientific advice to governments of the lower-middle income countries in the region (Li et al. 2016).

Several wildlife disease and pathogen surveillance research projects have been conducted in the region over the past decade, but most countries lack functional national systems, and as a consequence, information on emerging issues and diseases in wildlife is lacking. Even though these projects have identified areas considered to be at high risk of emerging pathogen spillover, operational national systems in most countries have not been developed, apart from for some selected diseases such as HPAI (for example, China, Vietnam, Indonesia). The very limited existing systems for wildlife diseases/pathogen surveillance result in the lack of information on which to base policy development and to design and implement programs for risk mitigation.

In recent years, the research community has become more active in identifying changes in factors that affect the emergence of infectious diseases from wildlife, but these have not been adequately utilized by the wildlife health system. Some progress has been made in domestic animal surveillance; however, the wildlife health systems are not yet developed sufficiently to utilize the research findings. Thus, there is little integration of the findings into policy development, and as a result the real risk from wildlife is poorly understood. Such risk factors include the identification of novel zoonotic pathogens, environmental changes, wildlife population distribution, and human behaviors. Despite several occurrences of pathogen spillover in the past, risky species (such as bats and rodents) and pathogens do not seem to be prioritized in the surveillance strategies. Similarly, response systems have not been prioritized accordingly.

Wildlife policies and programs are poorly linked to other animal health policies and programs

Across the region, dedicated institutional mandates for wildlife health and emerging disease prevention, detection and response are lacking, and there is a lack of clear responsibility for the different wildlife sectors – free-ranging, captive, and farmed wildlife. Countries vary in their approach to environmental change and wildlife, with differences in scope and distinctions of wildlife management, wildlife disease, and environmental health. In most countries there is a patchwork of coverage for specific species and/or sites (e.g., free-ranging wildlife, active commercial wildlife farms, non-active wildlife farms, markets), which makes coordination and collaboration problematic. There are some notable exceptions, such as the Republic of Korea's legislated requirement to report relevant findings to other ministries.

The lack of capacity in monitoring wildlife health changes is exacerbated by complex institutional arrangements. By default, EIDs often come under the responsibility of the human or the veterinary services as the first detection is often in the human or domestic animal populations in the absence of effective wildlife disease monitoring systems. WOAH Wildlife Focal Points, the designated national point of liaison for wildlife health, have been designated in various institutions across the region, including Ministries of Agriculture or Environment or sometimes at an academic institution. This arrangement is cumbersome as all reports to the WOAH must go through the WOAH delegate; most often this is the Chief Veterinary Officer at a Ministry of Agriculture. Reporting to WOAH is also voluntary which further limits the transparency and effectiveness of sharing data on wildlife health. The WOAH Wildlife Focal Points are commonly not involved directly in wildlife health and merely act as a focal point for information. The consequence is that capacity remains low in identifying and addressing emerging issues in wildlife at both national and regional levels.

The capability of funding, veterinary services, and science-policy interface in EAP animal health services ranges from adequate to poor

Institutional Assessment: Animal Health Institutions, Systems, and Programs

The systems, institutional capacity, and performance of the animal health services in the EAP region were assessed using the available WOAH Performance of Veterinary Services (PVS), WHO Joint External Evaluation (JEE), and the 'State Party Self-Assessment Annual Reporting' (SPAR) tool reports (Box 6.1). Additional information was provided by the authors, from their regional networks and with reference to a range of regional and country reports.[10] It should be noted that PVS and JEE are not mandatory, and that the information could not be verified due to COVID travel restrictions and also that the assessments were undertaken at various times (from 2007 to 2019). Furthermore there is currently no established system to assess the wildlife system or application of One Health.

The systems, institutional capacity, and performance of the animal health services in the EAP region vary from reasonable levels of capability to being very weak. The assessment of the capacity and capabilities of the national veterinary services considered the wide range of policies, legislation, governance structures, systems of delivery, programs resources, communications, and consultations and covered animal health, veterinary public health, and animal welfare. The institutional assessment, based on the reports from 16 countries in the region, drew the following overall conclusions:

- Funding for animal health services was difficult to assess in many countries but was low compared to the contribution of the sector.
- The capabilities and capacity of veterinary services were closely aligned with the level of development in the country; countries with the lowest GDP per capita had the weakest veterinary services even though the investment in livestock in the country was very significant.
- The governance of veterinary services across the region varied with some countries having national policy and direct management of field service delivery, whereas other countries had decentralized government structures with the loss of direct lines of communication, funding and program delivery.
- The science-policy interface as required for effective policies and programs to reduce the risk from EIDs and to promote One Health was weak across the region. No government had established strong independent scientific advisory institutions, such as a Chief Scientist or a High-Level Advisory Committee.

10 It should be noted that no country visits were undertaken to validate or update the available assessments owing to the COVID-19 situation.

Box 6.1: Background information on the assessment tools

WOAH-PVS Pathway

WOAH-PVS pathway is voluntary and is designed to assess the authority and capability of the veterinary services to comply with WOAH international standards. The PVS pathway utilizes a series of tools for the evaluation of the performance of veterinary services, the identification of gaps and the development of a strategic plan for improvement. The baseline PVS Evaluations are undertaken by independent certified WOAH experts who benchmark performance against the established WOAH international standards through a combination of document review, interview, and site visits. The PVS pathway missions are voluntary (https://www.woah.org/app/uploads/2021/03/2019-pvs-tool-final.pdf).

WHO-JEE assessment

A WHO-JEE is a 'voluntary, collaborative, multi-sectoral process' to assess a country's capacity to prevent, detect, and rapidly respond to public health risks. The purpose of the external evaluation is to assess the country status and its progress in achieving the targets set under the International Health Regulations (IHR) and to recommend priority actions to be taken. The external evaluation is a desk top review and validation of the country's own assessment of its performance (https://www.who.int/publications/i/item/WHO-WHE-CPI-2017.62).

SPAR assessment

SPAR, the 'State Party Self-Assessment Annual Reporting' tool, has been available to support countries report on the status of their national core capacities to the World Health Assembly. The mechanism was developed as only three JEEs had been undertaken in Pacific Island countries.

Under the PVS process, a number of critical competencies assess institutional arrangements and the stability of policies and programs. The JEE evaluations assess the broad context of health delivery, with some indicators having specific relevance to animal health and application of a One Health approach, and other indicators also reference the development of systems and synergies with animal health services, e.g., in legislation, coordination and information sharing, biosafety of laboratories, human resources, and control of points of entry. In the following assessment the PVS and JEE Evaluations are widely used with cross-referencing of other materials, particularly when considering countries with no recent PVS Evaluation or no JEE evaluation.

Source: Authors' own elaboration.

WOAH-PVS Evaluations have been undertaken in all ASEAN countries except Singapore, as well as in Mongolia, the Democratic People's Republic of Korea, Papua New Guinea, Fiji, New Caledonia, and Vanuatu. The PVS Evaluation missions took place between 2007 and 2019 and therefore some information is quite dated, although some countries have now had a PVS Follow-up Evaluation. WOAH recommends that a further evaluation should take place every five to ten years at the discretion of the country. PVS reports may be kept confidential and so are not all available for public review. Several countries in the region have also participated in the WHO-JEE evaluation program and these reports are all available online.[11]

Numerous assessments have taken place to evaluate countries' health regulations, human and animal health, agriculture, and public safety levels

Assessment methodology: The institutional assessments were based on relevant reports of PVS, JEE, and other country-level evaluations relevant for One Health outcomes. The WOAH Performance of Veterinary Services (PVS) pathway is designed to evaluate a country's ability to meet WOAH international standards as well as provide a continuous process aimed at maintaining sustainable, long-term strengthening of animal health systems. The WHO JEE entails systematic, multi-sectoral evaluation of the technical areas of International Health Regulations (IHR) such as human and animal health, food safety, agriculture, defense, and public safety that helps countries to identify the most urgent needs within national health systems; prioritize efforts; and enhanced preparedness, response, and action, for targeting resources in the most effective way. Considering the confidentiality of the PVS and JEE reports the data compiled by the authors were anonymized and detailed scores have been presented in Tables A2.1 and A2.2. The maximum possible score is 5; full compliance with international standards and the intermediate scores denoted are (1) for no capacity; (2) limited capacity; (3) basic capacity; (4) partly functional; and (5) fully functional and best practice.

11 https://www.who.int/ihr/procedures/mission-reports/en/

The indicators considered for the assessments broadly covered (i) governance aspects with respect to One Health, animal health services 'chain of command,' wildlife services and coordination, and related legislative and policy frameworks; (ii) institutional capacity and the application of risk management approaches, delivery of animal health and wildlife services, specialist skills, food safety, antimicrobial resistance stewardship and programing and included financial resources and budgets; (iii) the implementation of livestock programs and risk mitigation including prevention (border controls, animal disease control, supply chains and marketing), detection (surveillance systems, laboratories, data and information management systems), response (contingency planning, building surge capacity, emergency response systems), and recovery function (contingency planning, compensation support, private sector engagement); and (iv) some assessment of the wildlife services though only limited information was available (risk of exposure, wildlife trade and farming, and detection/surveillance, laboratories and data management). JEE/PVS scores were averaged for the relevant indicators and then updated using authors' and expert opinion where appropriate as some country assessments were dated (from 2007). Similarly, the wildlife related aspects were assessed by expert opinions as they are not scored in either the PVS evaluations or JEE.

Countries were grouped into three categories according to the World Bank's classification: low-income, lower-middle-income, and upper-middle-income. The countries included in the assessment are (i) low-income countries: Cambodia, Democratic People's Republic of Korea, Lao People's Democratic Republic, Myanmar, Papua New Guinea, and Timor Leste; (ii) lower-middle-income countries: Indonesia, Mongolia, Philippines, and Vietnam; and (iii) upper-middle-income countries: China, Thailand, Malaysia. The Pacific Island countries were not included in this assessment.

Animal health and veterinary public health programs are weak in the region. There is considerable variation in the delivery of programs to promote animal health, food safety, and the control of AMR. Less developed countries have a poorer record of program implementation and this is particularly the situation with food safety and efforts to address AMR. Figure 6.2 shows the variation in program delivery across the region.

The region's animal and veterinary public health programs are weak with considerable variation in promoting animal health, food safety, and AMR control

The overall conclusion is that the capabilities and capacity of veterinary services in the region are closely aligned with the level of development in the country (Figure 6.3). Unsurprisingly, countries with the lowest GDP per capita have the weakest veterinary services even though the investment in livestock in the country can be very significant. Countries such as Cambodia, Lao People's Democratic Republic, Myanmar, Papua New Guinea, and Timor Leste have multiple weaknesses, whereas the more developed livestock dependent countries have stronger veterinary services, e.g., Malaysia, Mongolia, Thailand, and Vietnam, with better developed veterinary services performing at a higher level on many of the assessment parameters when compared with international standards and best practices. In supporting the development of animal health and wildlife systems in the region, the stage of national development indicates the countries facing the greatest challenges and ones that can be recommended for additional support from donors and investment programs.

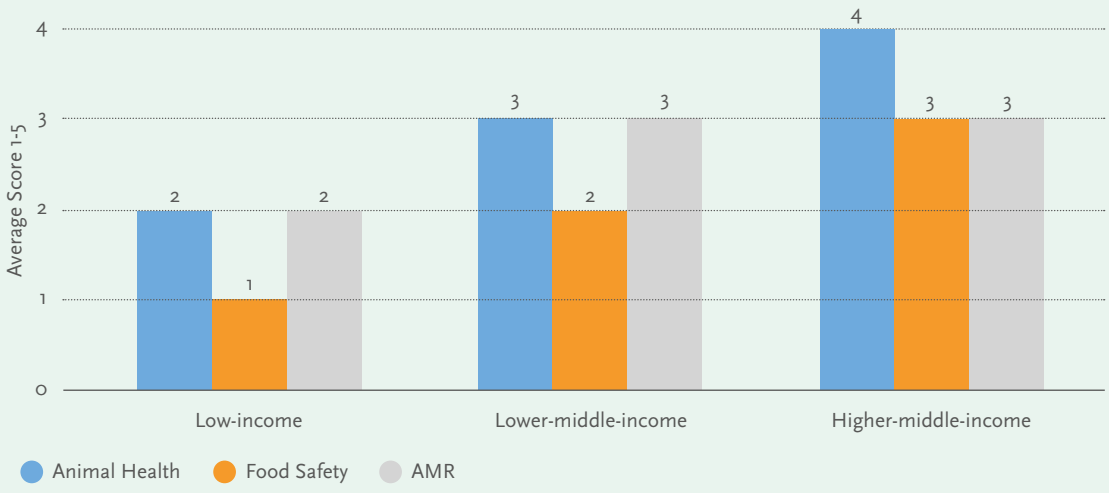


Figure 6.2: Assessment of animal health, food safety, and AMR programs *Source:* Authors' own elaboration based on the assessment of PVS and JEE reports detailed scores in Tables A2.1 and A2.2.

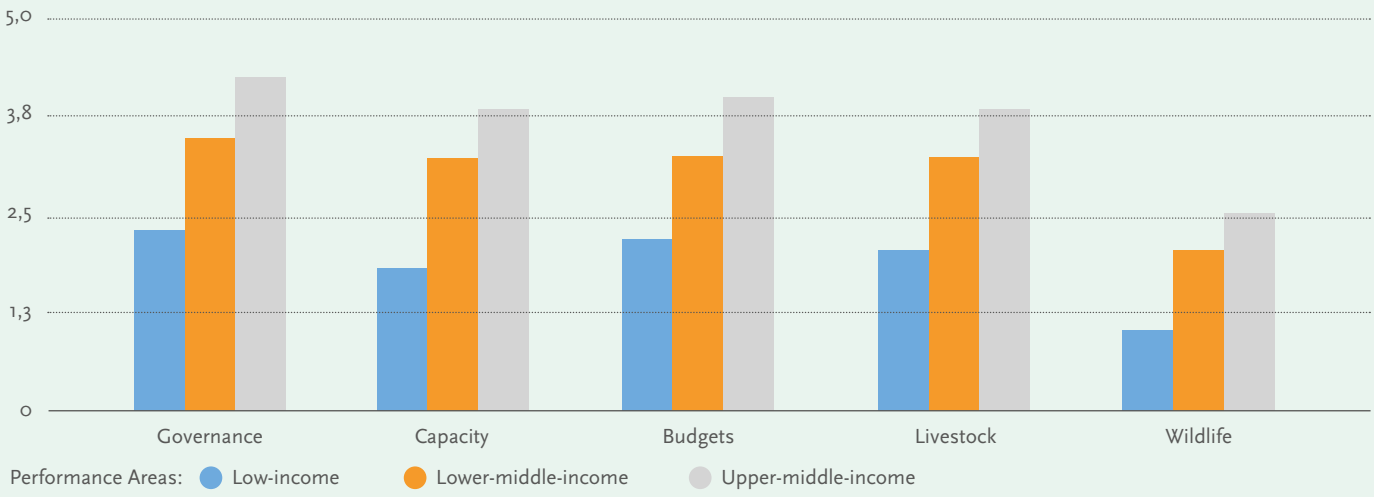


Figure 6.3: Assessment country performance capacities *Source:* Authors' assessment based on PVS, JEE, and other reports.

Governance structures for veterinary services vary considerably across countries in EAP. Some countries have national policy setting and direct management of service delivery at the field level, while other countries have decentralized their veterinary services. For example, China, Vietnam, Myanmar, Cambodia, Indonesia, and the Philippines have decentralized government structures intended to improve service delivery, resulting in matrix management. Typically, technical policies are set nationally, but programs are delivered by states/provinces or other sub-national entities. This is the case in China, Vietnam, Indonesia, and many others; however, the technical chain of command in disease prevention and control should not be compromised by the decentralization.

Decentralized service delivery of national policies results in broken lines of communication, inadequate funding, and partial delivery

A consequence of the decentralized service delivery is a weakening of the 'chain of command' with a loss of direct lines of communication, funding, and program delivery. Typically, policies are set nationally but programs are delivered by states/provinces or other sub-national entities without having direct lines of communication and with fragmentation of funding and program delivery. Importantly, this loss of command structure reduces coordination and consistency between the sub-national entities and contributes to ineffective and inefficient program delivery. Some countries have retained or even reintroduced direct control. For example, Mongolia has re-established a centralized governance structure and a strong 'chain of command' with simple lines of reporting. Others are managing decentralization which would need strengthening communication and improved reporting, e.g., Myanmar. This applies specifically to services such as livestock production and animal health/veterinary services.

Most of the countries in the region do not have consolidated budgets for their animal health services, so it is difficult to get a comprehensive overview of total funding nor is it possible to make country comparisons. In many countries, funds are provided for livestock services that variously cover livestock breeding, feeding, husbandry, product development, extension, and veterinary services. In addition, as most countries have adopted a decentralized system for the delivery of field services with animal health services being funded both from central and decentralized budgets, it is difficult to determine the actual total level of funding of the animal health services. Staff salaries and other fixed costs (buildings, etc.) are also sometimes not included in operational budgets. Figure 6.4 shows operating budgets for animal health services, primarily the veterinary services based on PVS reports.[12] Notably, the operating budgets for livestock services increase as the level of the country's economic development increases.

12 Scores were developed by using relevant criteria from the Performance of Veterinary Services (PVS) of WOAH by more recent information provided by the authors and their networks. The maximum possible score is 5, that is, full compliance with international standards.

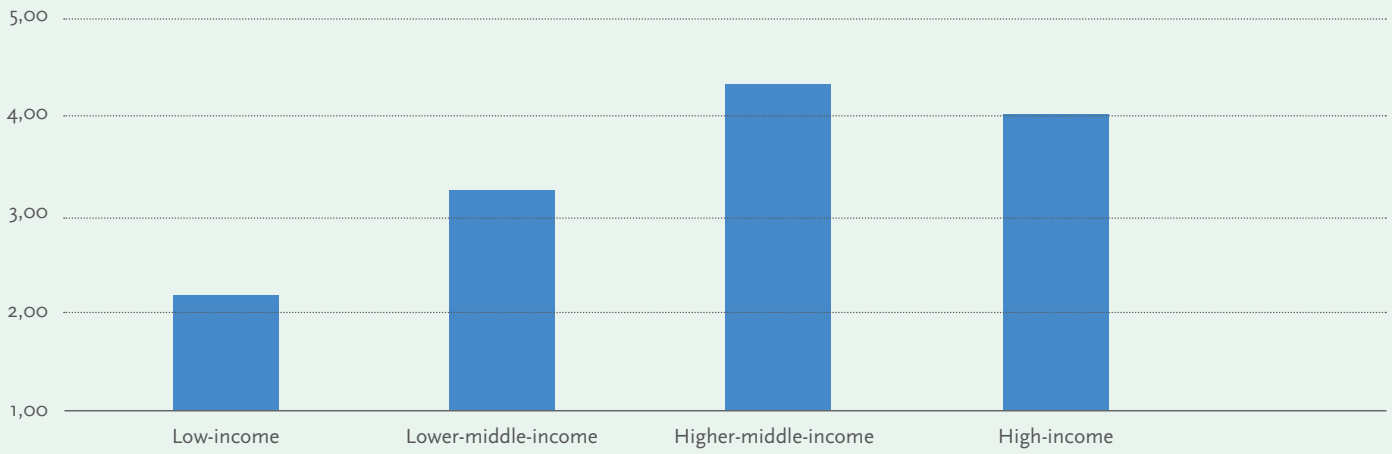


Figure 6.4: Operating budget for veterinary services *Source:* Authors' assessment based on PVS reports.

Based on the data available, budgets for livestock and animal health services are low in the region. Table 6.1 compiles the available data for Cambodia, Indonesia, Mongolia, and Myanmar. The animal health expenditures for Indonesia are national expenditures and do not take into account expenditures at the sub-national level. Hence, the actual animal health budget will actually be substantially greater.

Governments infrequently engage directly with the private sector and few joint programs for mutual benefit have been developed in most countries in the region. The concept of PPPs is little understood; however, there may be some recognition of opportunities. Only limited consultation has taken place for the development of policies, the design and implementation of programs, and the sub-contracting of activities. In many of the countries in the region, the growth of more intensive and vertical production systems has resulted in greater control of production and marketing systems by large-scale private businesses that operate independently of government veterinary services (e.g., Vietnam, Cambodia, Indonesia). While there is a significant opportunity to develop PPPs in all countries, governments currently do not work in partnership with the private sector in a coordinated approach that would result in mutual benefits. Figure 6.5 shows that as the national-level economic development increases, the capacity of both the public and private sectors increases in parallel.

Table 6.1: The available annual budgets (2019) for livestock and animal health services

Country	Livestock budget (USD)	Animal health budget (USD)	Farmgate value as calculated from FAOSTAT (USD)	Comments
Cambodia	4,560,000	3,140,000	Not available	
Indonesia	138,200,000	14,350,000 + 3,340,000 (Animal product safety)	39,228,000,000	Excludes sub-national contribution
Mongolia	-	17,800,000	2,885,000,000	No livestock budget available
Myanmar	30,000,000	12,000,000	Not available	

Source: Authors' calculation based on compilation of data from different sources/countries.

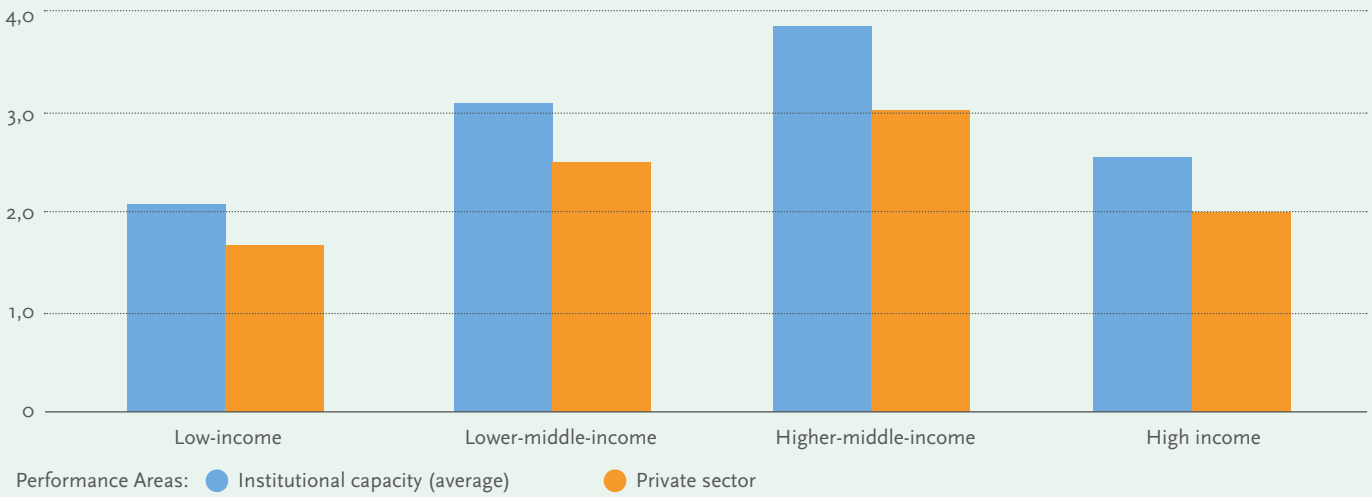


Figure 6.5: Comparison between public and private sector capacities *Source:* Authors' own elaboration, based on PVS and JEE reports.

Veterinary staffing varies in capacity and capabilities across EAP

The size and competencies of veterinary staffing vary significantly in correlation with the size and development of countries (Table 6.2). The larger countries generally have thousands of veterinarians, medium-size countries significantly fewer, and the smaller countries few or none at all. Good progress has been made in strengthening veterinary schools in all countries with reviews and updating of veterinary courses. Across the region, the increasing numbers of veterinary schools are now well aligned with WOAH Day 1 competency standards. In many countries the delivery of veterinary clinical services remains in the public sector, though with increasing private sector engagement from veterinarians and less qualified veterinary paraprofessionals.

Table 6.2: National veterinary staff numbers and veterinary livestock units (VLUs) *Source:* Authors' calculations.

Country/Economy	Total VLU	Veterinarians	Veterinary para-professionals
Brunei Darussalam	165,644	na	na
Cambodia	3,740,915	928	11,280
China	288,469,250	461,000	645,000
Macao SAR, China	63,092	na	na
Hong Kong SAR, China	7,800	na	na
Democratic People's Republic of Korea	1,454,822	na	na
Indonesia	47,049,025	4,746	5,140
Lao People's Democratic Republic	3,677,768	158	5,534
Malaysia	4,625,032	na	na
Mongolia	10,165,955	2,028	838
Myanmar	25,170,721	7,522	12,311
Philippines	8,580,670	na	na
Papua New Guinea	786,263	13	75
Thailand	10,021,406	8,790	1,340
Vietnam	18,455,156	7,300	2,250

Note: VLUs are calculated as cattle/buffalo = 1, sheep/goats = 0.1, pigs = 0.3, poultry = 0.01. "n. a" is no data available.

Animal health field services are often provided by poorly qualified staff with insufficient veterinary supervision. Many countries rely on large numbers of animal health officers with limited training, variously classified as 'veterinary paraprofessionals,' also known as 'paravets,' and lesser qualified village animal health workers (sometimes referred to as commune or community animal health workers). The WOAH has defined a number of competencies for veterinary paraprofessionals, and they are expected to be a science graduate, to have a high level of training, and be able to undertake specific duties such as in clinical services, meat inspection, and laboratory support. All countries employ some number of veterinary paraprofessionals though they are not usually trained to the levels required by the WOAH. Less qualified village animal health workers are private providers and are typically drawn from the local community and have only a few days or weeks of training. Veterinary paraprofessionals and village animal health workers form the bulk of the animal health field service in a number of countries and often operate with little veterinary supervision and have limited skills in diagnostics and treatment but are freely able to dispense antimicrobials and other medicines. The use of large numbers of minimally trained animal health workers and/or poorly qualified veterinary paraprofessionals results in poor delivery of animal health services with compromised detection of emerging problems, limited diagnostic skills, and sub-optimal treatments with overuse of antimicrobials. This problem is exacerbated by inadequate supervision by qualified veterinarians.

Unqualified staff, paravets and animal health workers with limited diagnostic skills often provide animal field services without supervision and they over-prescribe antimicrobials

Few or no veterinarians are employed to monitor wildlife health. In the few countries where veterinarians are employed in the wildlife services, it is usually only at the central level, occasionally at a sub-national level, and then only limited in numbers. Countries rarely have veterinarians working on wildlife health in the field. Wildlife services, including wildlife disease management, are typically under the Ministry of Environment, or equivalent, with little or no veterinary oversight or understanding of disease epidemiology and risk management. The wildlife sector has technical expertise in environmental management and ecology though the actual capacity varies widely by country.

Although the competencies of veterinarians have improved steadily, there remains a regionwide gap in higher-level leadership, management, and communication skills. Diagnostic competencies have improved with better clinical skills and improved laboratory capacities and capabilities. Veterinary staff generally have limited skills in leadership, strategic planning, program delivery, and management, and there has been only limited emphasis on improving communication and advocacy skills. The imperative of understanding the economics and optimizing resource utilization is largely absent.

Lack of specialist veterinary skills

Capacity for epidemiology[13] in government and other institutions is limited across the region. Epidemiology is an important discipline to support policy and program development for the prevention, early detection, rapid response, and the control of EIDs including zoonoses and TADs. Experience with managing the H5N1 HPAI, H7N9 avian influenza, Nipah, ASF, SARS, and COVID-19, have highlighted the need to strengthen epidemiology capacity at the regional, national, and sub-national levels in the region. Epidemiology involves a range of specific skills that are required to support an effective animal health service. Outbreak investigation with immediate assessment of risk factors and the possibility of spread requires skills in field epidemiology, with good communication and engagement skills, the application of 'participatory epidemiology' with the community, the recognition of cultural and ethnic differences, and the different roles undertaken by men and women. An understanding of epidemiology is required to ensure adequate data capture and first level analysis from the field, laboratories, and other sources. More advanced epidemiology skills are required for higher level analysis of complex systems including the use of geospatial, genome/micro-array analysis, and other advanced techniques.

13 Epidemiology studies the causes, distribution, and control of diseases in populations and involves the application of a variety of epidemiological tools and approaches for outbreak investigation, surveillance, information management and analysis, and risk analysis and supports the improved understanding of animal production and health economics. Social engagement and participatory approaches have been used successfully in less developed countries where resources are scarce. Epidemiology assesses the characteristics and risk factors for disease and provides insights into how best to mitigate disease risk. Epidemiology provides information from which economic assessments and optimizing resource utilization can be based.

Epidemiology development programs are in place in many countries but are yet to deliver the critical numbers of epidemiologists required. Many countries now have some epidemiology capacity developed under various donor programs, either with the country or under a regional program. Some countries (e.g., China, Philippines, Thailand, Vietnam) have also been integrating their human health Field Epidemiology Training Program (FETP) and animal health Field Epidemiology Training Program for Veterinarians (FETPV) to promote One Health coordination on infectious disease threats. There is significant potential to build on this and conduct formal and informal joint training on zoonotic diseases and public health from a One Health perspective. The 'FETP Frontline' program is piloting One Health approaches to field epidemiology at the local government levels. Enhancing institutional capacity will need ongoing support for program implementation, evaluation, and ensuring quality, strengthening networks of epidemiologists, and ensuring their integration into systems for disease prevention, outbreak detection, and emergency response and control.

Veterinary services infrastructure, equipment, and laboratories

With the exception of the lower scoring countries in the assessment,[14] infrastructure and equipment at the national headquarters and in the main, national, and regional laboratories have improved in recent years, though budgets for maintenance are often limited. Budgets for capital investment are still limited and there remains a high dependency on donor support. Operating and maintenance budgets are also limited and so basic repairs and maintenance including calibration of equipment is often lacking. Purchase of consumables such as laboratory reagents are often a problem. Sub-national infrastructure is more variable. Good facilities and equipment in the field are often lacking. Countries facing the greatest challenges (Lao People's Democratic Republic, Cambodia, Myanmar, Timor Leste, Papua New Guinea) have limited infrastructure and equipment at all levels. In more developed, better resourced countries, information technology (IT) systems, internet access, and smart phones are generally available, lending themselves to improved communications, data capture, and lines of reporting.

Veterinary laboratories in the region vary greatly but many have improved and now operate to a high standard

The veterinary laboratories in the region vary considerably but many are now operating at high standards with good reliability. The FAO conducted an assessment of the national and main regional veterinary laboratories in the EAP region using its Laboratory Mapping Tool (LMT), see Table 6.3. The major weaknesses identified were the lack of a Laboratory Information Management System (LIMS) and bioinformatics capabilities and, in some laboratories, the need to develop quality management systems and to improve collaboration and networking. The national laboratories in Papua New Guinea and Timor Leste face the greatest challenges and require ongoing international support and domestic investment. There is very limited laboratory capacity in the Pacific Island countries with testing support being provided by Australia and New Zealand. The USAID PREDICT project[15] was implemented to strengthen the global capacity for detection of viruses with pandemic potential and was implemented in China and many countries in Southeast Asia. PREDICT supported surveillance and laboratory diagnostic capabilities for both previously known and newly discovered viruses, targeting five virus families – filoviruses, flaviviruses, influenza viruses, paramyxoviruses, and coronaviruses. An outcome from PREDICT was the development of laboratory testing protocols for novel pathogens and these have now been established in most countries in the region though they are not being used extensively.

Livestock disease surveillance, prevention, and control

All countries in the region have at least basic capacity to detect and respond to EIDs and emerging issues, but capacity to prevent disease is very limited. There is also limited development of policies and programs to support recovery and minimize the impact on food security, livelihoods, and economic development. Across the region, though to varying degrees, the emphasis has been on outbreak detection and response with little development of policies and programs for effective prevention. Threat identification and risk management is rarely undertaken. Figure 6.6 shows a comparison of capacity by country-income grouping to prevention, detection response, and recovery.

14 See in Tables A2.1 and A2.2.

15 PREDICT was an epidemiological research program funded by a United States Agency for International Development (USAID) grant.

Table 6.3: Assessment of main national laboratories in the EAP *Source:* FAO LMT assessment.

	Overall FAO LMT SCORE	Location, budget and organization	Infrastructure, equip't, supplies	Staff skills and sample accession	Quality Assur', Biosafety	Collaboration & networking	Real-time PCR (Y/N)	ISO Accred'n (Full/Part/ None)	Highest BSL level (1-4)	LiMS system installed (Y/N)	Bio-informatic [Yes/ Ltd/ No]
Brunei	3	3	3	3	3	2	N	P	2	N	N
Cambodia	3	3	3	2	3	2	Y	N	2	N	N
Indonesia	4	4	4	4	4	5	Y	P	2	Y	Y
Lao PDR	3	3	3	2	3	2	Y	N	3	N	N
Malaysia	3	4	4	4	3	3	Y	P	3	Y	L
Mongolia	3	4	3	3	3	2	Y	N	2	N	N
Myanmar	3	4	3	3	4	3	Y	N	2	N	N
Papua New Guinea	2	3	2	3	2	2	N	N	2	N	N
Philippines	3	3	3	3	2	2	Y	P	2	N	L
Thailand	5	5	4	5	5	5	Y	F	3	Y	Y
Timor Leste	1	2	1	2	1	1	N	N	2	N	N
Vietnam	3	4	3	3	3	3	Y	P	2	N	Y

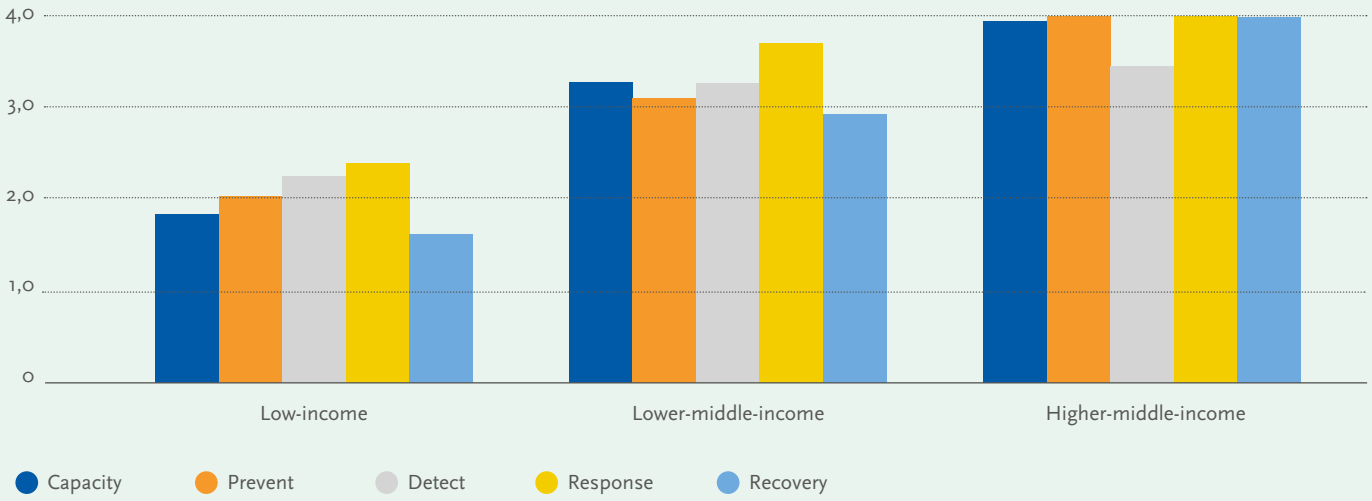


Figure 6.6: Capacity of animal disease control management by country-income groups *Source:* Authors' assessments based on PVS, JEE, and other reports.

Even though border controls are the first barrier to the entry of disease into a country, border security and quarantine infrastructure is weak in many countries in the region. There is extensive formal trade and considerable informal illegal movement of livestock across the long land borders of mainland Southeast Asian countries and also extensive trade among the island countries. Movement across borders includes the trade in wildlife and wildlife products and, although much smaller than livestock trade, it is significant for some species (e.g., waterfowl and other birds, deer, bats, pangolins). The Pacific Island countries have generally managed to avoid outbreaks of major animal diseases, although the recent incursion of ASF into PNG is a concern for the whole Pacific region.

Despite extensive trade and illegal international livestock movements, border security and quarantine infrastructure are weak in many EAP countries

Improved farm biosecurity and animal husbandry help create barriers for the introduction of diseases. Many countries have developed programs to improve livestock production standards based on the concept of 'Good Animal Husbandry Practices.' Larger commercial production systems are investing in improved facilities and better biosecurity, but this is not typically the situation in smallholder systems, in large part due to their lack of financial resources and lack of demand drivers. Major problems remain, as was seen with the rapid recent spread of diseases such as ASF and ongoing problems with other major diseases such as FMD and HPAI.

All countries in the region have some surveillance capability but with varying levels of reliability and timeliness. Surveillance is critical for early detection of outbreaks and emerging issues, to monitor changes in the prevalence of disease and also the use of antimicrobials and prevalence of AMR. Effective disease surveillance requires an established system with high levels of public awareness, field services to investigate outbreaks, laboratories to confirm field diagnoses, and systems of data capture, analysis, and reporting. Epidemiology skills are required to design and run an effective surveillance system. Across the region, field services, as indicated above, vary according to the availability of well-trained staff and so the timeliness and quality of the field investigation vary. The national and main regional laboratories in most countries are now generally reliable and operating well but there are some exceptions where further international support is required.

Many countries are developing national integrated 'animal health information systems' (Mongolia, Vietnam) and in some countries they are already operating well (Indonesia). Countries with embryonic systems need much greater commitment and investment to achieve fully functional systems. The less developed countries (Lao People's Democratic Republic, Cambodia, Timor Leste, Papua New Guinea) have no integrated systems and rely on paper records or standalone spreadsheets or databases. In the better developed countries, investment is required to improve timely and representative data capture, functionality, and reporting.

There is widespread reluctance to report a serious disease outbreak as it affects the livestock owner, leading to movement restrictions and often culling

A major challenge with current disease surveillance in the region is the lack of transparency in the reporting by livestock owners and also timely reporting by the animal health services. This is because reporting a serious disease tends to have a negative impact on the livestock owner and their community due to movement controls, animal culling, etc. Currently, the socioeconomic context of animal health and the impact of disease reporting are not adequately considered in the promotion of timely field reporting. The reporting by the animal health services is often delayed or prevented by hierarchical and political sensitivities.

Countries in the region have frequently failed to control emergency disease outbreaks. All countries in East and Southeast Asia have had emergency disease incursions and have responded variously in the last few years, most commonly to HPAI, ASF, and rabies and more recently to Lumpy Skin Disease in cattle. Countries have struggled to effectively combat disease incursions with many countries now endemically infected with these diseases. Failure to respond effectively has been exacerbated by late detection, a lack of transparency of the changing disease situation, ineffective communication and collaboration with stakeholders, and the inability to implement rigorous control measures. Some countries have been successful in eradicating HPAI (Thailand, Philippines), others less so, and the disease is now endemic in a number of major poultry producing countries in East and Southeast Asia with various mitigation practices being adopted – mostly reliant on extensive vaccination. In response to the threat from H7N9 influenza in 2013, preparedness plans and surveillance systems were strengthened in the Greater Mekong countries.

All countries in the region have ongoing control programs for animal diseases and zoonoses but the programs face constraints in their implementation. Effective disease control requires long-term control programs with the intention of reducing or ideally eliminating a disease. The region's prioritized diseases vary but often include major TADs such as FMD, ASF, and HPAI; additional control programs for zoonoses commonly include rabies, anthrax, and brucellosis. Across the region, these long-term disease control programs have faced multiple challenges and there has been very limited progress though with some local successes. The challenges include poor development of coherent strategies with a lack of input from epidemiologists and economists, inadequate planning, and insufficient funding. There has also been a tendency to focus on major animal diseases and zoonoses, though the greater impact on livestock production and the benefit to owners is often from controlling endemic diseases such as hemorrhagic septicemia, Newcastle disease, and parasitism. These endemic diseases are generally controllable by livestock producers by improving hygiene and management practices with strategic vaccination or treatments and are considered to be of individual or private benefit. Programs for controlling TADs and EIDs are often funded by government and donors due to their potential for public health benefits. In many cases, there has been limited review and revision of these control programs, in spite of their limited progress and ongoing drain on resources. There is a need in almost all countries for a review of all disease control programs and a refocus on priorities and sustainability.

Wildlife health systems[16]

There is often no defined government authority/ministry responsible for wildlife health in a country. The institutional mandates covering wildlife health, wildlife surveillance, control of wildlife trade, health of wildlife for food and products, captive wildlife, farmed wildlife, and other wildlife aspects vary by country and may involve a range of agencies serving a mix of functions. In some countries, oversight for zoonotic diseases may have its own specialized institutional arrangements. Wildlife protection and management are usually under a Ministry of Environment or its equivalent. Surveillance activities may be split across multiple agencies: for example, surveillance and management activities for avian influenza surveillance are frequently under a Ministry of Agriculture and not the Ministry of Environment. This is reported as giving synergies for sampling collection and diagnostic testing, with the benefit of risk reduction to livestock from wild birds, but coordination and flow of information are not always well established.

In many countries, a range of state agencies are involved in monitoring wildlife health, leading to disjointed sharing of information and data

There are few wildlife disease surveillance programs in EAP. The lack of a clearly defined mandate for wildlife health results in a lack of ownership with no or few programs that monitor wildlife health and changes in health status which could provide early warning of increased threats to wildlife and of potential spillover to humans and domestic animals. Though the WOAH encourages its member countries to establish wildlife disease surveillance and reporting systems in their PVS program, they have no specific assessment of wildlife in its evaluation of surveillance and risk management. It is recognized that some key operational distinctions exist for wild and domestic animal programs. For example, apart from WOAH-listed diseases, wildlife disease reporting does not include international trade implications, specialized protocols, and/or training that may be needed (e.g., for safe handling practices of wild animals), and specific diagnostic tests may need to be developed. The importance of wildlife health monitoring is demonstrated by the mass die-off of waterfowl in Qinghai Lake, China caused by HPAI H5N1, which subsequently resulted in disease outbreaks in Europe from long-distance bird migrations.

A key challenge for the systematic strengthening of national wildlife health programs is the lack of a dedicated tool to assess a country's ability to assess and manage wildlife and wider environmental functions and to prioritize areas of investment. There is no parallel instrument for wildlife to the WHO-JEE and WOAH-PVS assessments. In the Republic of Korea and in Thailand, a needs assessment was conducted in partnership with the United States of America Geological Survey National Wildlife Health Center (via the WOAH Twinning Program for Thailand), and this approach is currently being reviewed. As referenced in the World Bank One Health Operational Framework, a draft Country Assessment for Environmental Health Services has also been developed (World Bank 2010).

Efforts to date in the region have largely focused on specific diseases and/or species rather than building wildlife health systems. Wildlife is not always included in programs designed to implement One Health approaches and it is noted that wildlife expertise is often not included in teams for the investigation and response to wildlife origin and domestic animal and zoonotic diseases. Many countries report limited animal health surveillance, particularly in terms of transparency and timeliness, and they cover only selected diseases. Wildlife-specific diseases and pathogen surveillance in such countries is also poor, and this is further compounded by challenges with the diversity of species, limited training on wildlife handling and sampling, narrow testing panels that are not designed to detect novel or rare pathogens, and limited understanding of disease epidemiology. These weaknesses limit the development of robust risk assessment and effective risk management strategies.

There are several current or recent projects in the region that address emerging disease risks from wildlife; however, implementation is poor, and activities are rarely maintained after project closure. Challenges such as fragmentation of responsibility, lack of coordination and comprehensive mandates, and – in some cases – competition due to the lack of coherent program development have resulted in ineffective implementation. Furthermore, the sustainability of any activities is often poor due to funding constraints, turnover of personnel, and inadequate facilities. In some cases, national program activities are being performed by nongovernmental stakeholders which further complicates program design and

16 A companion review to this report has been prepared with a focus on wildlife. A summary of the wildlife report is provided here. For more details, the reader is referred to the wildlife report.

coordination. There is often only limited collaboration or coordination in program design or delivery or sufficient integration of outputs into One Health policy development, decision-making, and operations. Data sharing agreements, data management, activity coordination, and leadership were also recognized as key shortcomings.

Investment in wildlife services is limited across EAP. Only 5 percent of total wildlife investments globally goes to support wildlife health (World Bank 2012). This is emblematic of the systematic under-investment in environmental health services, which results in operational gaps and limited capacity to assess and manage zoonotic disease and other risks at the wildlife source. The lack of a dedicated budget for wildlife heath programs and activities for many countries in the region challenges sustainability of personnel and the development of other capacities (laboratory testing, monitoring programs, etc.) and impedes longitudinal surveillance and improved management. Operationally, this means that even when wildlife health is part of domestic animal health and health security projects, it is unlikely to be integrated into planning or into routine operations. The high return on investment from epidemic and pandemic risk mitigation through animal and human health systems strengthening has been articulated in prior reports (e.g., World Bank 2012, 2017) and requires the inclusion of wildlife to maximize global public good through enhanced prevention and preparedness. EAP's wildlife workforce and institutional capacity are insufficient to adequately surveil and manage wildlife diseases.

In the EAP region, the most pragmatic approach to support wildlife health and risk mitigation is to consider a minimum system that can conduct the basic functions aligned with a country's situation, its goals in wildlife health, and conservation and recognizes the regional context. This can be scalable to a country's needs, and from a regional perspective, additional roles could be supported by international support (e.g., workforce training, advanced laboratory diagnostic testing). In addition, wildlife programs are expected to (i) provide science-based threat detection for public safety, trade, and conservation; (ii) focus on prevention and protection; and (iii) foster collaboration across agencies, sectors, and disciplines (especially for climate change and public health).

Five key attributes, functions, and goals are needed to deliver a comprehensive wildlife health program and these require an expanded wildlife workforce

Five core attributes of national wildlife health programs, with associated functions and goals have been proposed (Stephen et al. 2018) (Table 6.4). By undertaking the core attributes, the associated functions will be delivered; for example, developing a knowledge and science-based program would identify and assess hazards, and this would investigate disease etiologies and be used to prioritize threats and risk reduction.

The wildlife workforce is inadequate in the region. In some countries, there is advanced capacity for research into wildlife diseases and emerging pathogens, but no workforce is in place to translate findings into applied use. Many countries in the region have low overall veterinary capacity and face workforce shortages and/or high turnover in the public sector that hinder animal health operations and long-term institutional knowledge. Where wildlife veterinary capacity is in place, it is often focused on specific activities that are not readily scalable for a broader system oriented to tracking emerging pathogen or zoonotic disease risks. For example, veterinary capacity may be targeted to anti-poaching and forensic investigations. As not all functions require veterinary capacity, some programs have trained additional personnel (park rangers, hunters, tourist guides) to serve as frontline eyes, feeding into the reporting system. To date, this approach is underutilized in the region.

Wildlife disease surveillance information is limited and usually not shared with other sectors

Information, such as disease incidence and risks, environmental factors, and populations at risk, is not routinely shared between the human health, animal health, and the environmental health sectors. There are exceptions, such as in Indonesia where a One Health database, 'SIZE,' under the management of the coordinating Ministry of People's Welfare (Kemenko PMK) is being developed for the integration of domestic animal, human, and wildlife data. Nevertheless, the lack of integrated information in most countries makes it challenging to assess wildlife disease surveillance and gaps in the detection, monitoring, and understanding of risks. Additionally, reporting mechanisms are often not in place for the efficient reporting of targeted information to centralized government systems to support the risk analysis undertaken by governments nor is it available for coordinated public-private responses.

Table 6.4: Five key attributes and associated functions and goals of national wildlife health programs *Source:* Stephen et al. 2018.

Attributes	Functions	Goals
Knowledge- and science-based program	Hazard recognition and assessment	Detect aetiologies and threats of concern in a timely fashion Establish national wildlife disease status Support claims of disease freedom Assess success of disease management programmes
	Risk assessment, risk communication, decision support, and trend analysis	Provide specialist knowledge to inform risk assessments Provide decision-makers with actionable information Help with risk communication
	Health information management	Maintain a historic database to document national disease status Support evidence-based action and advice Support retrospective research and investigations
	Research and development	Understand the ecology of wildlife disease by independent or partnered research Provide special expertise or capacity to support research
	Disease control and management and emergency response planning	Provide information and capacity to support actions to protect human and animal health
	Provide expert advice and expertise	Provide a recognized focal point for coordination of wildlife health expertise
Cross-nation equivalence and harmonisation	Development of and/or expert input into standard operating procedures, policy, and practices	Coordinate wildlife health interests to enable a consistent, coordinated, and harmonized response across a nation Compare available health data over time and space
	Provide, facilitate, and/or augment diagnostic and epidemiological capabilities	Provide equivalent access to modern capabilities to characterize wildlife disease events
Partnerships and national coordination	Develop and maintain a partner network	Enable robust information sharing and nationwide coverage Establish and maintain communication frameworks Access to and centralization of samples and data
	Program coordination	Coordinate wildlife health interests to enable consistent, coordinated, and harmonized information-sharing
	Communication and outreach	Inform stakeholders, including the public and risk managers, of options to reduce risk, prevent/control disease, and maintain ecosystem health
Leadership and administration	Advocacy	Inform policy
	Planning and strategy development administration	Strategic and adaptive management transparent program management
Capacity development	Workforce training	Success planning Maintain and develop consistent expertise
	Operate and/or provide access to appropriate facilities	Ensure adaptive and modernized infrastructure to cope with current and emerging issues

Reporting to the WOAH is not comprehensive and the risk of spillover in the region is not clear. Because of poor detection of infection and/or disease in wildlife, the risk of pathogen spillover and spread of animal diseases and zoonoses is unclear. Access to diagnostic tests in veterinary laboratories for wildlife samples is highly variable and, in addition, many laboratory tests are not validated for wild animals. Moreover, apart from wildlife cases of WOAH-listed diseases and EIDs, wildlife disease reporting to the WOAH or other international agencies is not internationally mandated. Between 2014 and 2018, in the EAP region, only Singapore submitted regular reports to the WOAH's World Animal Health Information System (WAHIS-Wild), a voluntary information system that serves as the only global reporting system for wildlife diseases. In the region occasional reports have only been received from Mongolia, Lao People's Democratic Republic, and Thailand.

Most EAP countries need to make a greater commitment to applying One Health approaches with better coordination between different ministries

Adopting One Health approaches in EAP has been slow

The adoption of One Health approaches to policy development is making slow progress in most countries across the region. In most countries, there is a lack of effective commitment and application of One Health approaches to disease prevention and control. All countries in the EAP region have developed policies for improving animal health, promoting food safety, and controlling zoonoses. However, in many countries, the One Health cross-sectoral, inter-disciplinary, multi-institutional approach to policy development has been slow to be adopted and these policies have not been developed into coherent strategies for prevention and control. There has been some engagement in inter-disciplinary research in the region (e.g., China, Indonesia, Vietnam), but it is generally a marginal activity for most academics and researchers, because scientific publication, evaluation, and career progression are still optimized for disciplinary research. Only limited research funding has been available.

Cross-government coordination to deliver One Health has been initiated in most EAP countries, though not in the Pacific Island countries, with the formation of high-level steering committees. These are variously effective with some developing strong coherent One Health programs (Thailand, the Philippines, and Malaysia), while others have had long-established coordination mechanisms in place, but these are inadequately resourced and at risk of being disbanded (Indonesia, Vietnam). In other countries the coordinating committees were more recently established and are yet to achieve any policy change or improvement in program delivery (Papua New Guinea, Myanmar).

An important challenge for countries in establishing effective One Health coordination with improved policies and programs is the different priorities set for the different ministries. Across the region, the Ministries of Health tend to be focused on individual human health, for example, high reliance on post-bite prophylaxis for rabies control rather than on preventing the disease in the reservoir animals, whereas the Ministries of Agriculture priorities are in delivering food security and economic development and animal health is a lower priority. Regionally, the One Health situation becomes more uncertain if the agency responsible for wildlife health and the environment is included, with wildlife health having an even lower profile and priority in the sector. Overall, the development and engagement of wildlife authorities in One Health is very limited across the EAP region. If other activities such as food safety systems for domestic and international trade are included, then other One Health stakeholders also have a role in managing and monitoring commercial activities such as Ministries of Commerce and Foreign Affairs, but they are rarely engaged.

These reporting systems are highly inefficient in terms of disease control as it can take considerable time for the information to be used to provide insights on disease trends and outbreaks (Madder et al. 2012) and this contributes to delays in event response times. In many countries, laboratory data and animal health event reporting from the field are recorded in stand-alone databases, submitted separately, and then summarized. In more resource-abundant settings where internet access is available, multiple sources of epidemiological data may be collected but are often recorded in separate systems. Information management systems in the region are generally very weak and fragmented. Addressing these issues requires integrated multi-sectoral approaches and the application of new technologies.

Regional Institutions and Programs in EAP

Cross-regional coordination is limited as no single entity covers the whole East Asia and Pacific region, with ASEAN[17] and the Pacific Community[18] being the main regional organizations. Ten Southeast Asian countries are members of ASEAN and the Pacific Community covers 22 states. There is no formal

association of countries in East Asia. ASEAN has a policy of promoting the free flow of regional trade with reduced tariff and non-tariff barriers and this includes trade in animals and animal products. To support this goal, ASEAN countries have been variously developing policies and programs to increase livestock production and product quality, improve value chain management, develop mutual recognition of professional services, and reduce the risk of animal diseases and zoonoses including promoting food safety and reducing AMR. The Pacific Community countries have no core policies on livestock production and trade but have identified climate change as a key risk factor that will compromise their sustainability, including the economic and social benefits from livestock production.

A Tripartite Regional One Health Coordination Group has been established in the EAP region covering the FAO, WHO, and WOAH and their regional and sub-regional offices. The secretariat for the Asia Pacific Tripartite is currently hosted by the WOAH, Bangkok. The tripartite collaboration between the FAO, WOAH, and WHO aims to use a One Health approach to address the threats to human, animal (domestic and wildlife), and ecosystem health and advocates for effective multi-sectoral, interdisciplinary, and transnational collaboration at the local, national, regional, and global levels. The 'Tripartite Guide to Addressing Zoonotic Diseases in Countries' (FAO, OIE, and WHO 2019) has been developed to support the adoption of more coherent and effective One Health systems. It is expected that operational tools will shortly be developed to support the guide. Despite the tripartite coordination in EAP, the inclusion of wildlife and environment has been very limited and there has been only marginal strengthening of institutions and capacity building.

The FAO, WOAH, and WHO collaboration aims to use a One Health approach to address a variety of threats to human, animal and ecosystem health

The FAO and WOAH have active regional and sub-regional programs covering a range of issues. These include improved advocacy and evidence-based policy development, increased capacity and capabilities (staff development, investment in laboratories and other infrastructure), strengthened systems of risk assessment, disease prevention, surveillance and information management, disease detection and response, and improved regional coordination and transparency. The FAO and WOAH work with national governments to develop and deliver their programs and activities and coordinate closely with regional entities such as ASEAN and SPC. The WOAH programs in Asia are addressing ASF, FMD, and neglected zoonoses and facilitate the Southeast Asia and China Foot-and-Mouth Disease (SEACFMD) campaign, a regional program that seeks to address FMD, primarily through policy support.

The FAO Emergency Centre for Transboundary Animal Diseases (ECTAD), with a regional office in Bangkok, has been supporting ASEAN and its member states in animal health and zoonoses using the One Health approach. ECTAD develops plans and provides assistance to ASEAN and ASEAN Member States to mitigate the transboundary animal health and zoonotic disease threats. Since 2005, it has worked in Cambodia, Indonesia, Lao People's Democratic Republic, Myanmar, the Philippines, Thailand, and Vietnam in the EAP region as well as in Bangladesh, China, and Nepal. ECTAD teams have delivered the Global Health Security Program (GHSP) and Emerging Pandemic Threats (EPT) programs, funded by USAID. In the EAP region, the teams delivered several important One Health and Animal Health deliverables. Some highlighted examples are the development of multi-sectoral (human health, animal health, environment) coordination mechanisms; enhancement of laboratory capacity; preparation of national strategies, policies, and action; plans for disease surveillance, forecasting, and early warning; and training of over 1,600 professionals on epidemiological skills. Annex 5 gives a brief description of the country-level engagement strategies of ECTAD.

The FAO has designated Mahidol University in Thailand as the FAO Reference Centre for Zoonotic and Wildlife diseases in the region. An Asia and Pacific review is being undertaken to assess the current knowledge and gaps at the 'Health-Environment-Wildlife-Livelihoods' (HEWILI) interfaces including 1) sustainable wildlife management; 2) wildlife as a source of sustainable livelihoods; 3) wildlife as a source of food and nutritional security; and 4) preventing of disease spillover from wildlife. (http://www.fao.org/3/cb1490en/cb1490en.pdf).

17 ASEAN: Association of Southeast Asian Nations, is an economic union comprising 10 member states in Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Myanmar, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.

18 The Pacific Community or South Pacific Commission (SPC) is the principal scientific and technical organization in the Pacific region, with 26 country and territory members: the American Samoa, Australia, the Cook Islands, Fiji, France, French Polynesia, Guam, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, New Caledonia, New Zealand, Niue, the Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, the Solomon Islands, Tokelau, Tonga, Tuvalu, United States of America, Vanuatu, the Wallis and Futuna Islands.

In addition, the WOAH, FAO, and the International Atomic Energy Agency (IAEA) are supporting the development of laboratory capacity in the region. The WOAH and FAO have designated international reference laboratories/centers in China for FMD (WOAH in Lanzhou), avian influenza (WOAH and FAO in Harbin), and epidemiology (WOAH and FAO at CAHEC in Qingdao). Similarly, the IAEA, through its Animal Production and Health Laboratory, supports Member States to build laboratory capacity for the early detection and diagnosis of animal and zoonotic diseases. In response to the COVID-19 pandemic, the Zoonotic Disease Integrated Action (ZODIAC) has been launched with the IAEA to take the lead in tackling emerging zoonotic diseases (IAEA 2020).

ASEAN has established the ASEAN Coordinating Centre for Animal Health and Zoonoses (ACCAHZ), which aims at facilitating and providing the framework of cooperation and coordination among ASEAN Member States, their dialogue partners, development partners, and other stakeholders in the prevention, control, and elimination of TADs and zoonoses in the ASEAN region.

Rabies is endemic in the dog population of most ASEAN countries; controlling the disease in dogs is the best way to prevent rabies in humans

The ASEAN Rabies Elimination Strategy (ARES)[19] has been developed as a strategic framework for the reduction and ultimately the eradication of rabies in the ASEAN countries. Rabies continues to be endemic in the dog population in the majority of ASEAN countries and nearly all human rabies cases are due to bites from rabid dogs. The disease causes a significant social and economic burden with the majority of rabies cases occurring in children. Controlling the disease in dogs is the most cost-effective way to prevent rabies in humans. The ARES utilizes an integrated One Health approach considering the socio-cultural, technical, organizational, and political constraints to control. In 2008, an ASEAN 'Call for Action' was made requiring countries to implement control plans for the elimination of rabies in the ASEAN+3 countries, that is, ASEAN Member States plus China, Japan, and the Republic of Korea by 2020. This is now being revised to 2030. The ARES was endorsed by health and agricultural ministers of ASEAN countries in 2014, with Vietnam and Indonesia to be the co-lead countries. A regional review meeting was held in 2018 at which countries were recommended to increase dog vaccination rates and improve dog population management, develop regional capacity building activities, promote human health with 'integrated bite case management', and regularly share information on their implementation of rabies control programs.

The ASEAN regional laboratory capacity building is being developed through the 'Regional Strategic Framework for Laboratory Capacity Building and Networking,' but laboratories do not yet have the capacity to fulfill their regional mandates. This framework has been officially endorsed at the ministerial level by the ASEAN Ministers of Agriculture Forum. The aim is to promote sustainable development of national veterinary diagnostic laboratories to enhance the laboratory capacity for detecting and responding to emerging infectious diseases and promote laboratory quality systems and networking among the laboratories. It is also intended to improve linkages with regional and global initiatives, such as the WOAH/FAO Network of Expertise on Animal Influenza (OFFLU), the Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs), and the One Health approach. These laboratories need further support to fulfil their regional mandates as regional reference labs, to develop regional SOPs; validate and confirm test samples from other countries; implement regional proficiency testing; and provide training, regional networking, and data sharing. There is also a new proposal to designate further capabilities in the region for bioinformatics, bio-risk management, and quality assurance. Leading regional laboratories have been designated, as follows:

- Avian influenza: Veterinary Research Institute, Ipoh, Malaysia;
- FMD: Regional Reference Laboratory, Pakchong, Thailand;
- Brucellosis: National Institute for Animal Health, Bangkok, Thailand;
- Rabies: National Centre for Veterinary Diagnosis. Hanoi, Vietnam, and Changchun, China (WOAH reference laboratory);
- Swine diseases: Regional Animal Health Office Number 6, Ho Chi Minh City, Vietnam; and
- AMR: Singapore.

The SEAOHUN, in Chiang Mai, Thailand, has been established to build regional coordination and capacity development in delivering One Health. To reduce the risk from pathogen spillover and the impact of future pandemics, SEAOHUN was established to develop the next generation of a skillful and competent One Health workforce. Since its establishment in 2011, SEAOHUN has expanded its

network membership from ten universities in four countries – Indonesia, Malaysia, Thailand, and Vietnam, to 81 universities including Cambodia, Philippines, and Lao People's Democratic Republic. The expansion was made possible with the support of United States of America and the Republic of Korea. The university members are multi-sectoral, coming from disciplines connected to the health of humans, animals, and the environment. SEAOHUN is funded by USAID. **A number of regional programs have been developed for diseases such as FMD, PPR, and ASF, but though these programs have received considerable support, they have yet to deliver successful prevention or sustainable control of these prioritized animal diseases.** The losses from endemic animal diseases, zoonoses, and the recent epidemics of transboundary animal diseases have highlighted the ongoing weaknesses in the animal health systems across the region.

Regional and international agencies and development partners are implementing a number of livestock production and trade projects in the region. Most of these projects are country focused. The World Bank-financed China Emerging Infectious Diseases Prevention, Preparedness and Response Project, China Food Safety Improvement Project, and the Mongolia Livestock Commercialization Project follow One Health approaches to livestock production and trade. ADB is implementing a regional project in Cambodia, Lao People's Democratic Republic, and Myanmar to promote cross-border trade across the Mekong region and with China. The South-South Cooperation project is a three-way partnership between the FAO, China, and the five other Greater Mekong Sub-regions (GMS)[20] countries, intended to limit the spread of TADs through policy support and also some capacity building activities. China is implementing bilateral projects (South-South Cooperation) with its Mekong neighbors. Other donors active in the region include the United States of America, Australia, the European Union, the Republic of Korea, Japan, New Zealand, Canada, and Switzerland. In addition, international agricultural research groups are active such as Australian Centre for International Agriculture Research (ACIAR), International Livestock Research Institute (ILRI), and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD).

To control transboundary animal diseases, it is imperative that a regional approach is taken to ensure that progress made in one jurisdiction is not compromised by weaknesses in another. The FAO supports the development of regional capacity through emergency Technical Cooperation Programs (TCP) under which up to USD 500,000 of the FAO's own funds can be mobilized rapidly and serve as catalyst for greater funding by bringing stakeholders/countries together, identifying their urgent needs, strengthening capacities and surveillance often as first entry points, etc. Recent TCPs include responses to HPAI, ASF, and COVID-19 and addressing livestock production and health issues in the Pacific. The WOAH also supports regional capacity building and emergency response and has recently been active in addressing regional cooperation and resource building to reduce the threat of various transboundary animal diseases and zoonoses including FMD, PPR, ASF, and emerging infectious diseases in the region.

Monitoring transboundary animal diseases demands an EAP regional approach so that progress in one country is not undermined by weakness in another

International Health Regulations – Performance of Veterinary Services (IHR-PVS) Bridging workshops, a joint WHO-WOAH initiative, provide a basis for improved delivery of One Health. IHR-PVS Bridging workshops aim to analyze and improve the collaboration between the human health and animal health sectors in the prevention, detection, and response to zoonotic diseases and other health events at the animal-human interface (food safety, food security, AMR). These workshops do not usually engage with the wildlife sector. The concept is that the One Health coordination and collaboration is reviewed and a plan developed to address the limitations identified. The reports break activities into key areas: One Health coordination, education, surveillance, laboratories, emergency preparedness, response, and communications. From the EAP region, only IHR-PVS Bridging workshop reports were available for Thailand, Myanmar, and Indonesia. Key issues identified were the need for (i) coherent policies with the necessary legislation; (ii) well-trained human resources in professional skills and epidemiology; (iii) improved surveillance systems and sharing of data and information; (iv) improved laboratory capacities and biosafety; (v) planning, funding, and resourcing for emergency preparedness and response; and (vi) integrated communication strategies, and mechanisms at national and sub-national levels.

19 https://asean.org/storage/2017/02/ASEAN-Rabies-Elimination-Strategy.pdf

20 The GMS countries are Cambodia, the People's Republic of China, Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam.

MONGOLIA
Little boy feeding the goat kid, Mongolia.
Photo credit: Gonchig Gan-Ulzii

Chapter 7. Building Animal Health and Wildlife Systems for One Health in EAP

Based on the assessment of policies, practices, and institutional capacities, this chapter outlines general recommendations for countries in EAP to implement One Health and manage threats through a risk-based approach to animal and wildlife health. Some examples are provided of experience from inside and outside the region. This chapter also provides recommendations on strengthening regional institutions and coordination and for improved animal disease prevention and management.

Need for Strong Political Commitment to One Health

Political leadership and commitment are critical for effective One Health systems. Cross-sectoral coordination and institutional capacity are essential to operationalize One Health. Implementation requires the support from all levels of government – national, sub-national, and in the field. Local champions drawn from the government, non-government organizations, or academic institutions are necessary to support One Health implementation. The veterinary services for livestock and wildlife are responsible for the control of transboundary and endemic animal diseases and zoonoses at their animal source and to support food safety. Many zoonotic diseases such as avian influenza, brucellosis, anthrax, and salmonellosis have a major impact on public health arising from poor food safety and reduced food security of livestock products. In contrast zoonoses such rabies, plague, and leptospirosis are of public health concern but have little impact on livestock production or animal health. Thus, it is important to understand disease epidemiology and the threats posed, so as to define the priority diseases for One Health collaboration. Zoonoses, food safety, and AMR are priority areas for cooperation between the animal health, wildlife, and human health and environmental sectors.

Each of the three pillars of One Health has its own mandate, responsibility, priority, and constraints. Factors such as organizational and funding modalities, disciplinary and professional silos, conflicting interpretations of the meaning of integration, and complex power relations impose limitations for institutionalizing a robust One Health System. Most investments have emphasized human health impacts rather than long-term, unknown, potential emergence of disease. The reason seems to be that funding flows have prioritized interventions with easily definable metrics, thereby marginalizing more complex drivers of disease such as ecosystem change and socio-political dynamics. Funding flows have instead followed the standard approach of technological solutions and emergency response. However, there has also been a growing emphasis on research and action geared to understanding the drivers of disease emergence, placing greater emphasis on ecosystems and other endemic and neglected diseases. These are relatively marginal in terms of funding and organizational support and are at an early stage, but they offer the potential for more integration and moving beyond an epidemic outbreak narrative. It is recognized that the animal health and wildlife sectors are weak in terms of surveillance and response for emerging and high-impact diseases and therefore more investment will be required for strengthening these sectors in developing countries. Indeed, the veterinary public health service is rudimentary and wildlife health almost non-existent in most developing countries. Table 7.1 captures the challenges and solutions for designing and systematically implementing the One Health approach based on global experiences.

Table 7.1: Challenges in designing and implementing One Health programs *Source:* dos S. Ribeiro, van de Burgwal, and Regeer 2019, adapted by the authors

Thematic area	Key Challenges	Possible Solutions
Policy and institutions	- Institutional fragmentation affecting both hardware (legal frameworks, policy guidelines, and bureaucracy) and software (knowledge and analytical resources) jurisdictions that challenge One Health practice - Lack of coordinating body able to promote collaboration and integration of structures and strategies	- Engage with political leaders and high-level decision-makers on the imperative need to adopt a One Health approach - Develop One Health 'champions' at a political/senior level - Adopt a grounded national perspective, building One Health systems based on shared visions, evidence-based policies, and regulations - Build capacity to improve integration, coordination, and collaboration at institutional, scientific, and geographic level

Financing	- Lack of adequate financing and incentives for prevention, surveillance, and response - Weak incentives for country and local reporting	- Establish sustainable funding strategies including developing PPPs - Create an audit and rating framework for monitoring surveillance and response systems - Create a unified funding structure that can be used in coordinated One Health initiatives to improve the health of local communities
Multi-actor collaborations	- Establishing One Health collaborations and trust can be complex and time-consuming - Unequal power/representation of actors - Hard to engage the private sector due to either significant regulatory overlaps or regulatory arbitrage	- Develop a collegiate approach to address differences in status and power between stakeholders - Develop knowledge platforms and decision-making in a familiar and neutral environment (for example, convergence of private sector interests with public health outcomes) - Develop common terminology, framework, goals and interests, and transparency
Multi-domain collaborations	- Lack of cross-sectoral leadership in One Health - Lack of trained personnel - Hard to sustain the engagement of stakeholders within One Health teams	- Develop a collegiate approach to address differences in status and power between stakeholders - Develop knowledge platforms and decision-making in a familiar and neutral environment (for example, convergence of private sector interests with public health outcomes) - Develop common terminology, framework, goals and interests, and transparency
Joint surveillance systems	- Lack of legal basis for integrated surveillance across different sectors - Uneven laboratory capacities, HR capabilities, and infrastructure challenges across sectors	- Develop joint One Health surveillance activities for endemic zoonoses - Establish coordinated cross-sectoral early detection for emerging infectious diseases with information sharing - Mandate both public and private diagnostic laboratories as a source of surveillance data - Improve information management to support surveillance and response activities - Build human resources capacity to support surveillance and response

Information and data sharing mechanism	- Problems with access to quality, reliability, and timeliness of One Health data and information	- Improve sectoral data reporting and informational management systems - Develop data standards, guidelines, and agreements for data sharing - Develop systems for sharing data and information such as interoperability - Use additional data sources (for example social media, local media) to support big data analysis
Monitoring and Evaluation	- Lack of qualitative and quantitative indicators for One Health outcomes - Lack of One Health evaluation studies and reporting of outcomes	- Develop standardized framework for systematic evaluation and reporting of One Health outcomes - Use examples from other disciplines to improve monitoring and evaluation (for example, epidemiology, socioeconomics) - Undertake economic analyses to develop a business case for One Health
Regional collaboration	- Weak regional leadership to improve surveillance and response capabilities	- Strengthen systems for coordinating regional One Health surveillance and response - Harmonize country systems with international standards - Identify priority risks and mitigate threats from regional wildlife and trade - Increase engagement of public and private sector stakeholders

This review assessed the strengths and limitations of the animal health and wildlife systems in East Asia and Pacific and the implications for One Health in preventing and responding to pandemic threats. Critical constraints in the animal health and wildlife services were identified that must be addressed to deliver improved human health and well-being, improve animal health and production, and reduce the risks of emerging pathogens and EIDs. The key outcomes required to strengthen animal health and wildlife systems were

- Improved leadership and commitment to develop the necessary policies, address the identified threats, and develop coordinated and sustainable systems;
- Fully functional integrated cross-sectoral, inter-disciplinary One Health systems for coordination, collaboration, and delivery of effective and efficient disease prevention, detection, and control programs;
- Reduced risk of EIDs from wildlife/livestock/human and wildlife/human interactions through increased capability of countries to manage animal, human, and environmental health risks;
- Prevention of national and international spread of animal diseases and zoonoses; and
- Minimized economic consequences of animal and zoonotic diseases, including of EIDs and endemic diseases.

The findings of this report also highlight the imperative of adopting risk-based policies that are coordinated and delivered across sectors using a One Health approach to strengthen animal health and wildlife systems and to reduce the risk from emerging pathogens and from animal and zoonotic diseases in EAP. Risk assessments should map the complex interactions between humans, livestock, and wildlife in the supply chains of animal products and also from the changing interactions with wildlife through trade, farming, and ecosystem alteration. Having identified the highest risks, mitigation measures can be implemented. Ideally these risks would be eliminated, and the risk of pathogen spillover prevented, but this can never be

guaranteed. So, there is a need to also develop coordinated One Health cross-sectoral systems to rapidly detect spillover events and to be able to respond quickly and effectively. Using One Health, coordination and leadership recovery mechanisms must also be developed to reduce the impact on human health and on animal health and the environment. Table 7.1 provides an overview of national and regional approaches that should be considered to promote One Health in individual sectors and across sectors.

Developing Effective One Health Systems

Harmonizing legislations, policies, institutions of animal health for One Health

Strengthened leadership with improved policies – It is critical for policy makers in the EAP region to devote more attention to the threat to health from pathogen spillover, EIDs, and zoonoses, due to their considerable adverse impact on the health and well-being of their communities, their economies, and their ability to address poverty and to increase their resilience to other disasters such as climate change. To reduce the risk of EIDs and zoonoses, effective policies need to be developed, based on sound science and functional science-policy dialogue. Programs should be informed by the scientific evidence in addition to consideration of social, cultural, economic, and political factors. Currently there are no strong independent scientific advisory institutions within governments in the EAP region. There is also a need for good data/information on populations, budgets, and economics to support decision-making. Currently data are inadequate, not available in real time, and not shared sufficiently between the sectors.

Box 7.1: Setting up One Health in China

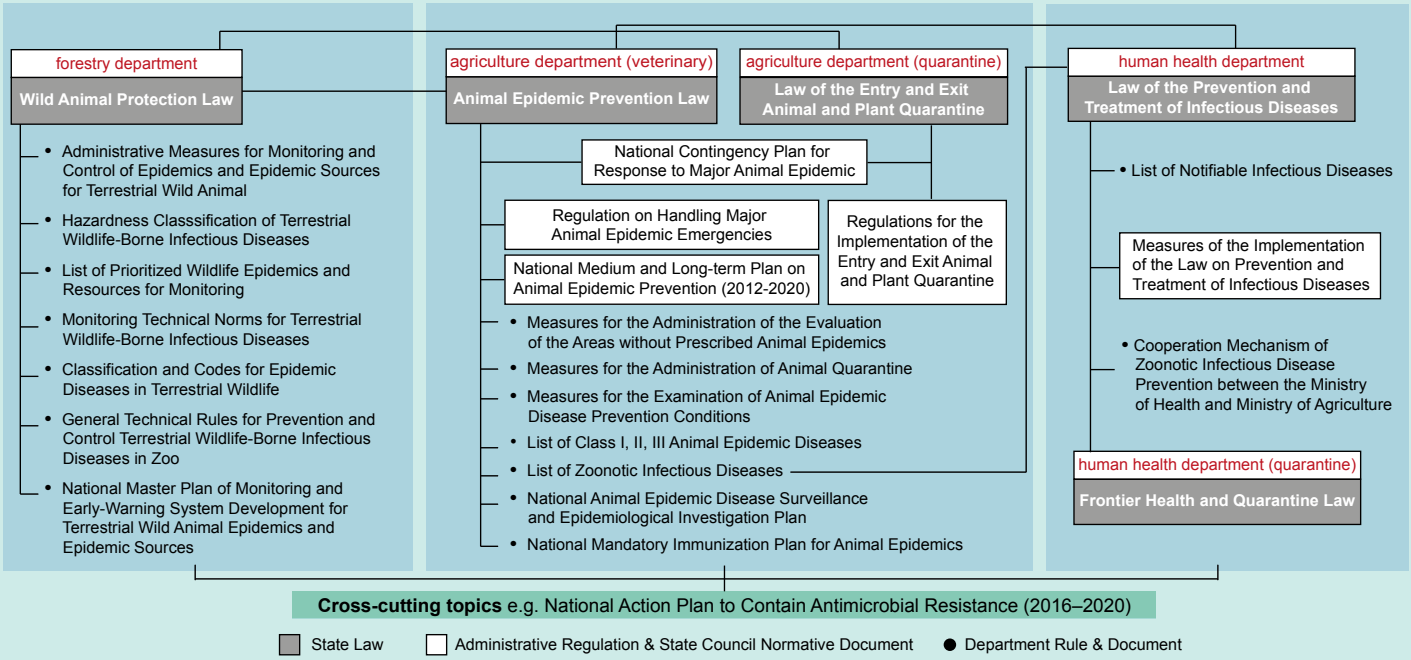
In China there is a growing awareness of the importance of One Health and cross-sectoral and inter- disciplinary cooperation in the control of zoonotic diseases and EIDs at the national level and this is being supported by planning, action, and training by multiple stakeholders. China is using One Health approaches in the control of zoonotic diseases and to prevent and respond to emergencies and pandemics such as SARS, highly pathogenic influenzas, H7N9 influenza, and COVID-19.

The Animal Epidemic Prevention Law of the People's Republic of China was first introduced in 2008 and this led to the establishment of the National Animal Disease Monitoring and Surveillance Plan, issued annually by the Ministry of Agriculture and Rural Affairs, covering major animal diseases including ASF, FMD, and HPAI, and also zoonotic diseases including brucellosis, schistosomiasis, echinococcosis, bovine tuberculosis, and rabies. The law was revised in 2020 along with other legislations fast-tracked to boost the One Health legal framework. The revisions support a strategic shift beyond prevention and control to the eradication of priority zoonotic and epidemic diseases, stressing the role of community-based enforcement of good practices and greater responsibilities cast on relevant businesses and government departments along the whole value chain. Likewise, the changes in the Law of Quality and Safety of Agriculture Products 2006 were initiated to enforce stricter control of agricultural inputs (particularly pesticides, veterinary drugs, antimicrobials as growth promoters [AGP]), prevention of pollution of the agricultural environment, and stronger penalties for violations of the law and related regulations. The National Biosecurity and Biosafety Law was introduced for the prevention and control of major emerging infectious diseases and animal and plant disease outbreaks and for promoting laboratory biosafety, research and development, and applications of biotechnologies. Improvements were also made to the Law on Infectious Disease Prevention and Control Law of Prevention and Control and Wildlife Protection Laws. Much greater emphasis is now placed on the coordination, facility, and data sharing between different agencies responsible for One Health.

The departments overseeing forestry (including wildlife), animal health, and public health systems are required to undertake joint efforts to monitor and manage zoonotic diseases in China. Disease surveillance and monitoring are conducted among free-ranging wild animals and in the farming production of wild and domestic animals, which are required to quarantine prior to entering the market for consumption. The shared scope of work and existing collaboration among different departments provides entry points to operationalize One Health interventions for risk reduction of zoonotic diseases. For example, the close connection between animal health in farm production and food safety controls requires One Health action from animal, human, and environmental health systems to address a variety of issues in zoonotic disease monitoring and management, AMR, market regulation, and consumption behaviors. Some topics are cross-cutting; for example, the National Action Plan on AMR includes all three agencies. At the same time, fragmented authority can result in gaps in mandates and coordination, including in the scope of priority disease lists, relevant settings (for example forest, farm, market, ports of entry), and relevant disease prevention, detection, and control responsibilities between domestic animal and wildlife health.

Various donors and international organizations have been contributing to the development of One Health work in China. The United Nations Theme Group on Health established a Working Group on Diseases at the Animal-Human Interface in 2011 (FAO 2014). This group along with international agencies (including WHO, FAO) and donors (including European Union, USAID) have been working to facilitate

One Health approaches and have convened workshops and joint training programs and participated in One Health responses to H7N9 and through its technical group on rabies published a review on rabies control in China (Yin el al. 2013). In 2019, China conducted CDC One Health Zoonotic Disease Prioritization (OHZDP) workshops and identified zoonotic (avian) influenza viruses, echinococcus, rabies, plague, and brucellosis as zoonotic diseases of major concern in the country. Joint training on One Health and zoonotic disease control between China FETP and China FETPV has been a feature of field epidemiology training since 2013. Joint training has also been carried out at provincial and sub-provincial levels and this is expected to increase.



Source: Zoonotic disease monitoring and management in China (under review) Li H et al. 2021.

Impact

The effectiveness of the response to H7N9 and the COVID-19 emergency has been limited by sector-specific approaches particularly where joint investigations and control should have been undertaken and directed at the interface for transmission between animals and humans. However, the recent developments have shown greater commitment to make the coordinated One Health approach work. The main challenge is to build the cross-sectoral and inter-disciplinary systems required at all levels to ensure that the synergies and the most efficient and cost-effective outcomes are achieved.

Lessons learned

The diversity and scale of the Chinese livestock and wildlife economy represent a unique challenge calling for tailormade risk governance and management solutions suiting the Chinese context and in cultural and socioeconomic terms.

Source: Authors' own elaboration.

Effective legislation – Legislation should be developed that mandates One Health and the cross-sectoral cooperation and collaboration to deliver effective programs. Legislation covering animal health services and the management of wildlife and emergency preparedness and response should be reviewed and revised, including the authority to take the necessary rigorous surveillance and control measures, provisions for emergency response including funding, and the development of systems and staff resources. Compensation or other protection mechanisms are recognized as a key factor in mitigating the impact of emergency control measures and its provision should be included in legislation. Protocols for declaring a sanitary emergency should be defined in legislation with a definition of the process and who has the authority to declare an emergency.

Functional institutions, governance, and coordination – Governance structures and institutions for One Health need to be strengthened at the national and sub-national levels to meet the challenges from emerging pathogens, EIDs, and zoonoses to human and animal health. This requires a clear mandate with well-defined institutional roles and responsibilities and how coordination and collaboration are

to take place between the relevant ministries and agencies. Institutions, their systems, staffing, and budgets will need to be developed to provide the necessary capabilities in risk reduction.

Special attention is needed to link wildlife health with other sectors to ensure information and expertise supports surveillance, prevention, and detection of emerging diseases. Improved coordination and resource utilization between the sectors would strengthen wildlife surveillance systems and the identification and management of the risks of wildlife disease and pathogen spillover and more broadly of ecosystem health and population ecology. Coordination is a challenge across the region and reinforces the importance of the need for full involvement of wildlife health. Wildlife expertise is included in some partnerships against emerging diseases, but wildlife components need to be better specified in program objectives. There should be greater definition, benchmarks, and processes to formalize involvement of the wildlife sector in One Health.

In many cases, wildlife disease control efforts can leverage existing human and animal health infrastructure and capacity enhancements; however, in some cases special considerations are required for pathogen surveillance and wildlife disease investigations. Strengthening the control of diseases in wildlife should consider a number of issues including

- The implications of novel pathogen discovery and determining potential risk to other species and populations and appropriate management strategies;
- Epidemiological investigation for the source of pathogen spillover events, in terms of distinguishing reservoir and/or potential intermediate hosts;
- Epidemiological study of the value chains to identify, analyze the risks and prioritize the pathways, and identify critical points for minimization of transmission;
- Interface, species, and sample type selection for efficient detection of specific agents;
- Safe sampling, in some cases requiring capture and immobilization of wildlife and proper protocols for human biosafety and conservation;
- Validated laboratory tests for wildlife pathogens;
- Community sensitization, particularly for populations that have had limited contact with formal health systems but may be highly dependent on wildlife and ecosystems (such as some indigenous populations).

Box 7.2: Collaborative strategic planning for One Health in Vietnam

Vietnam has a large wildlife farming industry. A survey of more than 4,000 active wildlife farms in southern Vietnam was undertaken in 2014 (FAO 2014) with 182 farmed species being identified. Most (95 percent) of the surveyed farms reported only keeping one or two wild animal species and the majority (70 percent) also reported having domestic animals. Some farms reported wild harvest of animals, including 29 percent of the primate farms. Behavioral risk surveillance has recently been conducted at wildlife farms and this identified priorities for risk reduction. In addition, the scale of the wildlife trade in the Vietnam presents a challenge for enforcement: in 2010, 13,000 illegally trafficked animals were confiscated. Though regulations are in place, violations are common on farms, in markets, and in animals for sale in restaurants.

In Vietnam, the authority to address wildlife risk factors for emerging diseases is split between several agencies including the Ministry of Industry and Trade (markets) and the Ministry of Agriculture and Rural Development (farms, food quality) and their respective laboratories oversee safety testing of animal products. Several decrees, circulars, and directives cover the farming, trading, and utilization of wildlife. Wildlife farming is a growing industry in the country.

In 2016 the national five-year One Health Strategic Plan for zoonotic diseases was updated with a focus area being the prevention of infectious disease emergence and specifically 1) to identify the risk factors or interfaces associated with spillover, amplification, and/or spread and 2) to implement risk reduction strategies based on identified risk factors. The table below provides an extract from the One Health Strategic Plan with a focus on wildlife.

Wildlife extract from One Health Strategic Plan, Vietnam (2016)

What	How	Who
Complete planned work on the identification of zoonotic and potential pandemic agents in animals prior to their emergence	Undertake testing of a range of animals for viruses with pandemic potential	MARD and provincial authorities WCS, livestock farmers, and traders Wildlife farmers and traders International partners (USAID-PREDICT)
Improve capacity for early detection of spillover to humans of potential pandemic infectious agents	Undertake testing of humans working in association with animals, especially clinical cases	MoH plus above
Implement measures to reduce the risk of emergence of novel agents for specific industries	Develop and introduce industry/ sector specific guidance on preventive measures	MARD, MOH, MONRE* International partners (FAO, USAID-PREDICT)

* MONRE - Ministry of Natural Resources and Environment

Impact

Emphasis was made on the need for greater engagement with the wildlife sector with increased research on disease drivers, the development of policies and guidelines, and resource allocation to support One Health capacity building. The One Health Strategic Plan identified a number of risk reduction activities focusing on emerging zoonoses that involved a range of governmental and non-governmental partners. On the ground, impact in mitigating the risks of disease spillovers has yet to be delivered.

Lessons learned

Though Vietnam provides a good example of progress being made in establishing coordination mechanisms, it remains at high risk from emerging zoonoses. Developing effective coordination mechanisms should provide better understanding of the risks from the wildlife trade and wildlife farming and allow improved targeting of risk reduction strategies. Risk reduction also needs to recognize the socio-cultural, political, and economic constraints on changing existing demand for wildlife to mitigate risk most effectively.

Source: Authors' assessments based on FAO (2014).

Development of human resources – Leadership, strategic planning, management, and technical skills of the animal health and wildlife service's staff need to be improved. Improving their skills in epidemiology (including joint training with human and wildlife sectors), risk analysis, and food safety management is needed to enable the better understanding of animal and wildlife pathogens and diseases and how they can most effectively be prevented or controlled. There is also a need to develop skills in leadership with improved independence to make technical decisions; understanding of socioeconomics; and strengthening of skills in communications, social intelligence, and cultural awareness. This will enable effective communications and advocacy, which can be substantiated by economic impact and other studies on animal health and production, wildlife health and management, the control of emerging pathogens, EIDs and zoonoses, and the optimal use of resources.

Fixing the Weak Links in Animal Health and Wildlife Systems

Implementing effective risk-based approaches in animal health

Stronger animal health services are required. The veterinary services need to be strengthened with greater emphasis on regional, national, and sub-national disease monitoring and prevention systems; strengthened disease intelligence with improved analysis and reporting (greater use of epidemiology and economics); improved detection and response mechanisms; and clearly defined communication channels. Emergency risk communication systems with full transparency should be established between countries to increase early warning and the effectiveness of prevention and control measures.

Box 7.3: Risk-based approaches to animal disease prevention and control

The implementation of effective global, regional, and national programs for the prevention and control of EIDs, zoonoses, and food-borne infections requires strong commitment to One Health with the development of well-resourced, coherent policies, and programs to support risk-based approaches. Such One Health policies and programs need to be developed based on sound science-based risk assessments.

Rinderpest was the second disease to be successfully eradicated globally after smallpox and the first animal disease to be eradicated. The global eradication of rinderpest in 2011 demonstrated that risk-based approaches for disease control can be used to control and eradicate priority animal diseases at global, regional, national, and sub-national levels. A number of global strategies are in place to prevent and control major animal diseases such as the Global Alliance for Rabies Control, Global Foot-and-Mouth Disease (FMD) Control Strategy, the Global Strategy for the Control and Eradication of PPR (peste de petits ruminants), and a number of other diseases such as brucellosis and African Swine Fever (ASF).

Specific disease programs have been implemented in the EAP region, including the Southeast Asia and China Program for Foot-and-Mouth Disease (SEACFMD). The declaration of the Philippines as a free zone for FMD without vaccination in 2011 is a demonstration of an effective control program in a developing country where a national authority worked successfully with the regional SEACFMD Program and the international donor community. In this program the main elements of success included a national team that planned and implemented a well-coordinated and resourced program of risk management which included progressive zoning, preventing of reinfection, movement control, and intensive surveillance for early detection and demonstration of progress, rapid response, disease control, and information management all supported by a strong community awareness program.

Impact

It is noted that implementing risk-based approaches for disease-specific control programs has the effect of improving capacity to prevent, respond, and control other animal disease threats and zoonoses and also the improved control of endemic disease at no additional cost and these generic benefits need to be appropriately attributed. More rigorous economic analyses of the burden of disease and the cost-benefit of its control and/or eradication would provide a strong platform for improved advocacy. It is noted that for disease-specific programs, investment needs to be maintained to ensure sustainability in the form of 'peace time' preparation, when there is little disease present and even after the stated disease control objective has been met.

Lessons learned

Disease-specific risk-based approaches can provide a clear, logical, and long-term vision and framework and can be successful, when they have the appropriate tools (diagnostic tests, vaccines, etc.) and long-term government and public support. However, for most disease-specific programs progress is slow and uneven due to lack of sustainable commitment by stakeholders and donors, lack of technical skills and capacity, and inadequate resources. Also, such programs can take away resources that are being used for the control of other diseases with reduced capability to control EIDs, zoonoses, and food-borne infections.

Source: Authors' own elaboration.

Investments are required to strengthen the veterinary services' capacity for service delivery including for emergency preparedness and response. Greater coordination and collaboration should be established between the veterinary, wildlife, and health services.

Robust systems for animal health information management are required. The economics of the use of resources is seen as an important driver of animal production, including reducing the impact of diseases and of marketing systems. But, to date, livestock and animal health data remain very poor. Data collection and reporting on livestock populations, animal and wildlife health, and production and value chains should be improved to support risk assessments and policy making. Data on wildlife hunting, farming, and trade are particularly limited. Integrated information management systems using modern digital systems for data collection, analysis, and rapid reporting should be developed/enhanced in all countries and this should include the integration of early warning, surveillance, and laboratory data and mechanisms to convey the results to the various stakeholders. Improving the databases will also allow robust economic analysis of costs and benefits, including estimating the 'burden of disease,' which can then form the basis for risk analysis to address the highest risk activities and support decision-making in terms of budget and resource allocation. Better understanding of the economics and socio-cultural context of the livestock value chain and of wildlife trade and farming would also strengthen the understanding and ability to adopt risk-reduction practices.

Implementing effective wildlife policies

Risk reduction at wildlife-human and wildlife-domestic animal interfaces is critical to reducing the risk from EIDs. Information on the relative effectiveness of interventions to prevent pathogen spillover and/or pathogen amplification is limited, in part because of the many factors affecting the uptake of possible interventions. As with livestock policies and programs, there is a need to integrate a risk-based approach into wildlife disease detection and management and to develop evidence-based policies. Changes in trade practices and demand must be taken into account when assessing disease risks from the wildlife trade and designing proactive regulations.

Wildlife health programs should be designed to contribute to existing conservation, animal health, and health security obligations and for sustainable development. Biodiversity management and protection, wildlife health monitoring, and disease detection provide critical information to inform management decisions for populations and species, including in assessing changing threats, extinction risks, and the risk of pathogen spillover. Similar to the spillover of emerging pathogens to humans, EIDs are also a threat to other wild species, both via direct inter-species transmission and through the movement of wild animals across different populations, countries, and continents (Daszak, Cunningham, and Hyatt 2000). The risks posed by the increasing encroachment into wildlife areas from activities such as farming, logging, mining, and tourism and the threats from climate change should be assessed, options for reducing the risks identified, and a program of risk reduction implemented.

The wildlife services should be strengthened with close coordination and integration with the human and animal health services. Greater definition, benchmarks, and processes to formalize involvement of the wildlife sector, where inadequate, is needed. In many cases, wildlife disease control efforts can leverage existing human and animal health infrastructure and capacity enhancements; however, in some cases special considerations are required for pathogen surveillance and wildlife disease investigation.

Better understanding of the wildlife trade and stronger wildlife services, coordinating with human and animal health services, will lead to more effective wildlife policies

Greater understanding of the legal and illegal wildlife trade (including free-ranging wildlife, wildlife hunting, captive wildlife, and wildlife farming), considering the socio-cultural drivers of demand and the economics of supply, should be developed to identify the priority high-risk pathways that require urgent attention. Improved understanding and management of the trade in wildlife and wildlife products should be developed in alignment with WOAH international standards for the safe trade in animal products. The extensive wildlife trade should be regulated including reducing the risk from informal and illegal trade. Improved border control, risk analysis of cross-border disease entry, identification, and certification of animals and their products and increased awareness and management of informal movement will reduce the risk of international spread of animal diseases, including zoonoses.

Strengthening disease surveillance systems in animal health and wildlife systems

Minimizing the impact of EIDs, zoonoses, and food-borne infections requires the early detection of emerging issues. This requires the effective integration of animal health surveillance systems (domestic and wildlife) with the human health systems, that is, the One Health approach. Achieving a reliable and sensitive surveillance program countries requires 1) enabling legislation that provides the legal mandate for action; 2) capacity for field investigations with well-defined and functional lines of reporting; and 3) functional information management systems for data capture, analysis, and reporting by skilled epidemiologists.

Surveillance is critical for early detection, to monitor changes in the prevalence of EIDs, zoonoses, and the use of antimicrobials and AMR. Effective disease surveillance programs should be developed in coordination with public health authorities with high levels of public awareness; competent field services to investigate outbreaks; laboratories to confirm field diagnoses; and systems of data capture, analysis, and reporting. Countries should have epidemiology skills to design and run an effective surveillance system. All countries in the region have elements of a surveillance system but with varying levels of competence. A major challenge is the lack of transparency in reporting by livestock owners and by the animal health services as reporting a serious disease tends to have a negative impact on the livestock owner and their community due to movement controls, animal culling, etc. Field services in many countries remain weak.

Efficient and effective surveillance programs need to be supported by structured scientific risk assessment to identify and priorities risks. National information management systems should be developed to ensure timely and reliable information is available to develop targeted risk-based surveillance programs to address the prioritized risks for EIDs, zoonoses, and food-borne infections.

Building emergency preparedness and response capabilities in animal health and wildlife systems

Emergency preparedness, detection, rapid response, and recovery with epidemiological and risk assessments are central to adopting a One Health strategy

Emergency preparedness and response systems should be developed, with defined roles of all ministries, agencies, the private sector, NGOs, and other stakeholders. The availability of funding, trained staff, and resources must be known and the sources and mechanisms of obtaining additional funds, staffing, and materials need to be predetermined. Systems for emergency preparedness, detection, rapid response, and recovery need to be developed and tested during "peace time" and crucially strengthened by the adoption of epidemiological and risk assessment methods and the application of a One Health approach.

Successful contingency plans should be developed focusing on identified risks and be based on the legal authority for emergency preparedness and so provide the mandate for prevention, detection, response, and recovery activities. Contingency plans should be prepared and tested for specific diseases that are a known threat and for unknown 'generic' diseases. Staff should be trained in the various roles required and simulation exercises undertaken to test the emergency systems and to further develop staff capabilities. Contingency planning requires the setting of clear policies and the development of emergency systems with well-formed plans and supporting guidelines and SOPs. Contingency plans will be implemented effectively only if resources are made available including funds for operations, appropriately trained staff, and the necessary equipment and materials. For most effective risk mitigation, a multi-sectoral, inter-disciplinary One Health approach must be developed across government and with the private sector.

Box 7.4: Preparing for ASF incursions in China

The MARA first released the 'ASF Epidemic Emergency Implementation Plan' emphasizing the contingency approach in January 2019, which was revised in February 2020. In this contingency plan, ASF outbreaks in China were to be classified into four categories according to the severity and potential impact of the outbreaks. The plan set out specific response levels, the command structures to be set up, and the measures to be taken.

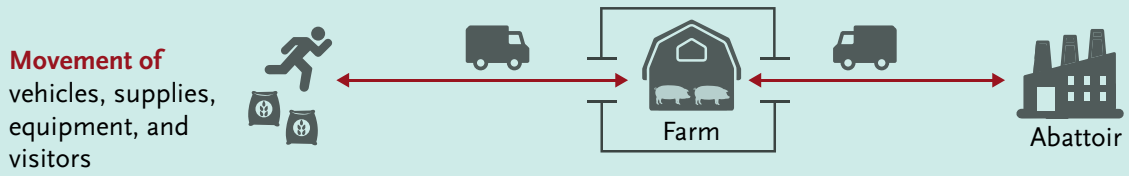
Summary of the four ASF response categories and the required coordination and response

Category	Definition	Response Plan
Category I Significant major outbreak	Number of new outbreaks increases and spreads rapidly to most provinces within a 21-day period Serious threat to the pig industry, economy, and social welfare	MARA reports a Class I emergency response to the State Council and activates the national emergency command agency, or The State Council authorizes MARA to initiate a Class I emergency response and to establish an emergency command agency composed of multiple departments. Provincial, municipal, and county-level governments establish EOCs and start operations. All relevant departments jointly carry out epidemic prevention and control as per their responsibilities.

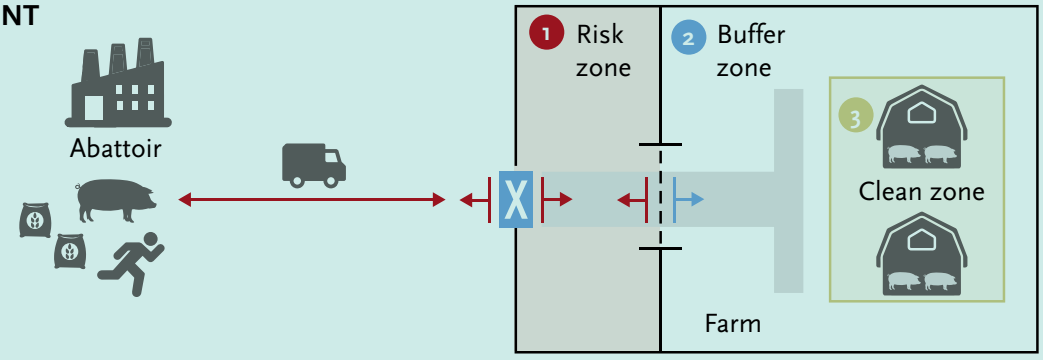
Category II Major outbreak	ASF outbreaks in more than 5 provinces within a 21-day period Outbreak likely to spread further	MARA, with the affected and at-risk provincial, municipal, and county-level governments, initiate a Level II emergency response and establish EOCs. All relevant departments jointly carry out epidemic prevention and control as per their responsibilities.
Category III Large outbreak	Outbreaks occur in more than 2 provinces, but fewer than 5 provinces in a 21-day period	Provincial, municipal, and county-level people's governments in the affected provinces initiate a Level III emergency response and establish an EOC. All relevant departments jointly carry out epidemic prevention and control as per their responsibilities. MARA strengthens supervision of the emergency response work.
Category IV General outbreak	Outbreaks occur in 1 province only within a 21-day period	The governments at the affected city and county initiate a Level IV emergency response and establish an EOC. All relevant departments jointly carry out epidemic prevention and control as per their responsibilities.

MARA is to determine the category of the ASF outbreak. In general, movement of live pigs and their products from high-risk areas to low-risk areas would be strictly restricted. The specific transport supervision plan to be formulated separately and released by MARA. The ASF contingency plan also included an after-action review (AAR) component.

THE PAST



AT PRESENT



1. Restricting the movement of vehicles, supplies, equipment, and visitors at the entry zone X
2. Implementing quarantine measures in the buffer zone
3. Creating the clean zone 1 Risk zone 2 Buffer zone 3 Clean zone
4. Enhancing hygiene and awareness of the farm workers

Impact

ASF was first reported in China in 2018 but despite the contingency planning, risk analysis, and diagnostic capacity building, ASF spread across the country and in the region very rapidly. One reason cited for the failure of the contingency plan was that it focused only on the animal health system and did not provide details on the communications and the authority of other ministries and agencies involved in the emergency response. For example, the transport and commerce ministries had strong business incentives to continue to move pigs and the municipal authorities failed to regulate swill feeding.

Lessons learned

Though the risk of an ASF incursion into China was recognized and contingency plans developed, the disease was still able to spread rapidly across the country and to neighboring countries. The contingency plan and actions taken were insufficiently robust to prevent the spread of ASF. The limitations of only using the animal health services were identified as an important trasparency in communication and regional collaboration and coordination.

Source: Authors' own elaboration (FAO 2020a; MARA 2019; Image sourced from Woonwong, Yonlayong, and Duy Do Tien. 2020. *The Future of the Pig Industry after the Introduction of African Swine Fever into Asia*).

Practicing One Health during Peace Time Building Capabilities for Future Crisis

Food systems offers several entry points for One Health approaches

Enhanced disease prevention and control programs in food production. Entry points for One Health interventions in food systems are shown in Figure 7.1. These programs should be supported to improve the understanding and management of supply chains for animals and animal products both within and between countries. Greater emphasis should be placed on quality assured production practices with improved farm biosecurity and strengthened border control for both the legal and illegal trade in live animals, livestock products, and wildlife. Countries should also develop programs to address the priority neglected animal diseases, including production limiting endemic diseases, and neglected zoonoses, recognizing the impact these also cause. Including these priority diseases will both benefit human health, and increase support and commitment for disease control programs by producers, as their control will promote efficient and more profitable livestock production.

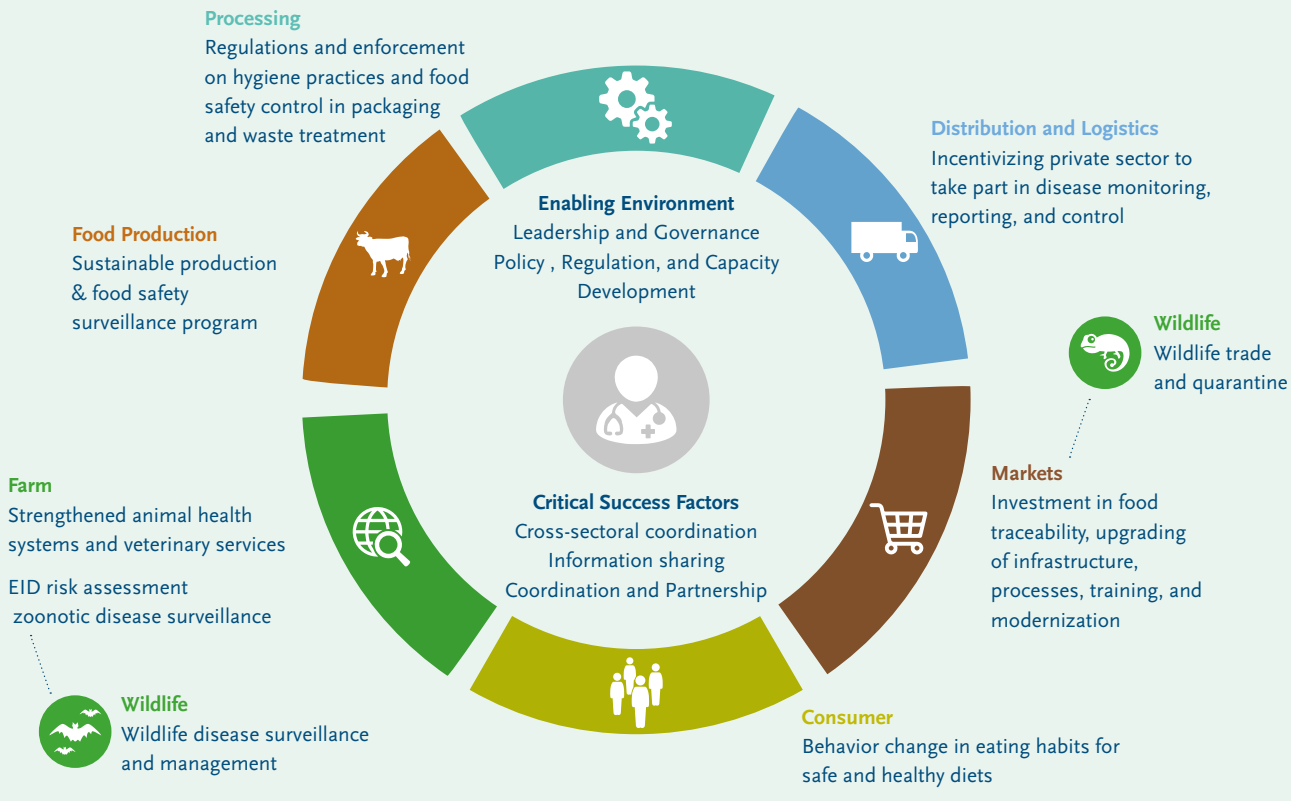


Figure 7.1: Entry points for One Health approach in food systems *Source:* Authors' own elaboration.

Food safety and value chain improvement – As many emerging and re-emerging hazards originate or are exacerbated in food systems, it is important to understand the nature of food safety risks in order to target interventions to prevent the hazards from occurring. The specific supply chains should be mapped to improve targeting of prevention and risk management of the movements and marketing of domestic animals and wildlife, whether alive or as meat and animal products. Food safety programs should be established based on risk analysis using HACCPs. Risk analysis should be undertaken with a sound understanding of domestic animal and wildlife diseases, food-borne infections, and residues and the risk from potential zoonotic pathogens. Quality assurance programs should be used to support investment in food safety and the reduction in risk. Animal and animal product identification and traceability will support the delivery of food safety and also improve disease control. Traders, markets, and other 'aggregation points' such as collection yards and slaughterhouses pose a high risk for disease transmission between animal populations and humans. Programs should be developed that reduce this risk using the principles of structured science-based risk assessment.

Countries need to strengthen their ability to identify and trace animal and animal products. This is critical to the effective management of supply chains, to identify sources of infection, and to support food safety, including to reduce the risk of antimicrobial and other contaminants. The ability to trace back to the source of the animal or product is imperative in mitigating the risk, and the ability to trace forward allows identification of other at-risk animals or products, which is critical to reducing the impact and ensuring cost-effective control measures are put in place. While a number of livestock identification and traceability trials have taken place in several countries in the region (for example, Mongolia, China, Vietnam, Indonesia), national programs must be established and implemented.

Box 7.5: Case study: Food safety program in Ho Chi Minh City

Ho Chi Minh City, Vietnam, has a strong commitment to improving food safety and has largely been successful in banning traditional markets with live animals. It has established a series of slaughterhouses at which high standards of hygiene and animal welfare are being maintained. The city has also established an animal and product identification and traceability program, and this is being developed into a formal program of product quality assurance. This approach of providing customer confidence in the product rather than simply banning a traditional market source of animals is being well accepted and is also benefiting the better producers with higher market returns. Compared with other parts of the country Ho Chi Minh City now has a significantly high rate of consumers using supermarkets.

It is apparent in the region that food safety remains poor in many countries and that addressing this requires a development program that addresses the socioeconomic and cultural context of consumers, the market, and its suppliers and builds on public awareness as the main drivers of change to reduce the risk of food-borne illnesses.

Source: Authors' own elaboration.

A need to control AMR

Animal production practices need to be significantly improved throughout the region and this will reduce the need to use antimicrobials. Improving animal husbandry is considered a key element for the prevention and control of animal diseases and zoonoses and needs increased focus and support, as currently the emphasis has been on surveillance of infectious diseases in animal populations with too little on prevention using good animal husbandry practices. Farmers need to adopt good biosecurity and hygiene (with direct cost-benefit), good feeding practices, and improved animal welfare as this will reduce the risk of disease introduction. There needs to be increased investment in promoting good animal production practices. This approach also supports improved quality and safety of food through quality assurance programs.

Antimicrobials used to treat various infectious diseases in animals are similar to those used in humans and the FAO/WOAH/WHO Tripartite Collaboration on AMR therefore advocates a holistic, One Health approach to address the threat of AMR. Resistant bacteria that arise either in humans, animals, or the environment may spread from one sector to another and from one country to another. AMR does not

recognize geographic or human/animal borders. Countries should comply with the Global AMR Action Plan which requires that national action plans are established to address the risk of AMR. The aim is to

- Ensure that antimicrobial agents continue to be effective in humans and animals;
- Promote prudent and responsible use of antimicrobials; and
- Ensure global access to medicines of good quality.

Countries in EAP need to develop the necessary legislation and enforcement to stop the use of critically important antimicrobials and strengthen their surveillance on antimicrobial use and AMR. The reduction in the use of antimicrobials needs to be supported by increased awareness of the issue among producers and service providers, the improvement of husbandry practices, and promoting of their prudent use only.

Box 7.6: Control of antimicrobial usage and resistance in Denmark

Denmark has been in the forefront in addressing the issue of AMR using an integrated One Health approach and provides a role model for other countries to follow. Denmark adopted three key strategies:

- Ending the use of antimicrobial growth promoters
- Monitoring antimicrobial consumption
- Surveillance of AMR.

Time	Event
May 1995	Denmark banned the use of avoparcin as an antimicrobial growth promoter (AGP)
Dec 1997	The European Union banned avoparcin in all member states
Jan 1998	Denmark banned the AGP, virginiamycin
Feb 1998	Voluntary ban of all AGPs by Danish cattle and in finisher pigs
July 1999	The European Union banned AGPs from the classes of antimicrobials used in human medicine
Sep 1999	The European Union banned two additional AGPs – owing to human health concerns
End 1999	All AGPs banned in Denmark

It has been shown that stopping the use of AGPs resulted in a substantial reduction of antimicrobial use in food animals, with a 54 percent reduction of total antimicrobial use from 1994 to 2001. However, stopping the use of AGPs in pigs resulted in increased use of therapeutic antimicrobials, including those also used in human medicine, indicating that additional measures to promote animal health were required (improved biosecurity, use of vaccinations, etc). The ban on AGPs was associated with some loss of productivity in the pig industry, but the increased costs to the poultry industry were shown to be minimal.

The Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP) has been operating since 1995. DANMAP monitors the use of antimicrobials in both livestock and humans and the prevalence of AMR in bacteria isolated from food animals, foods of animal origin, and humans. Capturing this data allows the study of the associations between antimicrobial usage and antimicrobial resistance. (Bager 2000)

The surveillance system also allows comparison of AMR patterns from livestock, food, and humans. By comparing levels of resistance found in bacteria isolated from food, estimates can be made on the spread of resistance from animals to man. The Danish approach requires a high level of commitment, public awareness, and monitoring to ensure its effectiveness but shows what can be achieved with strong commitment and good planning.

Impact

A long-term program in Denmark reduced the use of antimicrobials but required significant commitment and support from government and producers.

Lessons learned

It is important to address the issue of increasing AMR through overuse of antimicrobials in livestock production but establishing effective programs takes time and requires the engagement with producers to address the limitations on their ability to comply (poor animal husbandry and disease control). Effective AMR programs must be delivered through developing One Health partnerships that are science based and address policy needs and apply a multi-sectoral approach to identifying and implementing mitigation measures.

Source: Authors' own elaboration based on DANMAP 2018.

Leveraging digital technologies for reducing One Health risks in food systems

Livestock identification and traceability systems are critical for the effective management of value chains, to identify sources of infection and to support food safety, including to reduce the risk of antimicrobial and other food contaminants. The ability to trace back to the source of the animal or animal product is imperative in mitigating the risk, and the ability to trace forward allows identification of other at-risk animals or animal products which is critical to reducing the impact and ensuring cost-effective control measures are put in place. A broad range of digital technologies and platforms is now available to facilitate the establishment of effective livestock identification and traceability systems. These technologies are all data driven and under the following categories: (a) wireless and mobile technologies for animal health monitoring, disease surveillance, reporting, and information sharing; (b) advanced data processing technologies such as big data and data analytics used to uncover hidden patterns, predictions, correlation, and other information; and (c) promising technologies such as blockchain applications used for effective and efficient management of various input supply chains.

E-surveillance with mobile devices provides an opportunity to radically change early detection and monitoring systems. Over the last decade, mobile cellular networks have become readily accessible across the region and the number of subscriptions has increased rapidly to a range of 86 to 148 per 100 people (World Bank 2018). The mobile phone paradigm shift offers cutting-edge opportunities in e-surveillance utilizing mobile technologies – short message services (SMS) and more recently mobile apps. This is especially important in some countries in the region where the electronic infrastructure and internet access are less well developed. Examples of the use of this technology include the Infectious Disease Surveillance and Analysis System (IDSAS) in Sri Lanka (Robertson 2010) and Indonesia's integrated animal health information system (iSIKHNAS) (Hatchison et al. 2019).

Box 7.7: Use of blockchain technologies in China and Taiwan, China

China: In 2016, Walmart completed a pilot using IBM's blockchain solution to improve the 'farm-to-fork' traceability of Chinese pork. Coupled with the use of animal radio frequency identification devices and cameras at the farms and slaughterhouses, pork products could be traced from individual animals on a farm level through the value chain to the retailer. Such a comprehensive traceability system not only supports improved food safety but also provides a competitive edge to all the value chain stakeholders, allowing better informed business and strategic decisions. In the event of food safety incidents, the problem can be traced back, allowing rapid identification of the problem and early interventions to minimize interruptions to supply and mitigation of any business risk. Consumers have been shown to be increasingly willing to pay a premium for safer food products.

Taiwan, China: More recently, in 2020, blockchain technology was utilized in Taiwan, China, during the COVID-19 response. The Central Epidemic Command Center implemented a strict rationing system for facemasks. A blockchain enterprise partnered with a Google Developer Group assisted in building a real-time mask inventory system that tracked the distribution and quantities of facemasks to pharmacies and reduced the problem of queuing at outlets. The experience demonstrated the potential of the new technology to improve the efficiency and logistics of the distribution of essential materials during emergencies.

Impact

Using DLT to capture and manage access to data along a value chain can result in efficiencies in managing supply, allow rapid response to any emerging problems, and protect data confidentiality and privacy issues.

Lessons learned

DLT is a powerful tool that diversifies data ownership and dilutes the holding power of centralized information. Concerns remain over the confidentiality of the data and potential lack of trust in the developers. Currently, blockchain technology also incurs higher setup and maintenance costs and it is more questionable in resource poor settings.

Source: Authors' elaboration based on Karnath 2019.

21 A distributed ledger is a database that is consensually shared and synchronized across multiple sites, institutions, or geographies, accessible by multiple people.

Distributed ledger technologies (DLTs)[21] or blockchain is an evolving technology and transaction system that has the potential to support animal and public health and the management of EIDs, zoonoses, and food-borne infections. DLT is better known for its use in cryptocurrency and financial trading. An important feature of DLT is the 'dis-intermediation' of processing and storage of data. In contrast to the traditional surveillance, in which data are stored in a centralized database or on cloud storage, in a DLT system information is stored in a decentralized manner in multiple servers or nodes. This dis-intermediation improves data security and privacy (FAO 2018). This approach offers improved access to timely data with appropriate protection of confidentiality and with good system security.

Enhancing the Role of Private Sector in Strengthening One Health Practice

The private sector is a major resource largely untapped that can support policy development, program design, and implementation with increased efficiency and effectiveness and with reduced cost. It is important for governments to engage more vigorously with the private sector to develop joint programs in risk reduction using the PPP and blended financing models. There are real opportunities for synergy for improved delivery of animal health services with potential cost sharing for program delivery working together with the private sector. The private sector should be encouraged to take greater responsibility for biosecurity and risk reduction and share production and animal health data to maximize early detection and the economic efficiency of service delivery. Adopting PPP approaches will facilitate the development of the private sector and also improve government's ability to manage the risk from pathogen spillover, EIDs, zoonoses, and food safety.

Improving trade protocols and market infrastructure for One Health outcomes

There is a need to improve facilities and hygiene practices at traditional markets. Because of the structure of the animal-sourced food sector in many parts of EAP, simple closure of traditional markets might severely compromise food security and rural livelihoods and disadvantage vulnerable communities, without necessarily mitigating against zoonotic disease risk. Instead, with proper management of market facilities and improving of hygiene and appropriate regulation and enforcement, traditional markets can be managed to provide safe food products.

Box 7.8: Reducing public health risks associated with the sale of live wild animals in traditional markets

1. Suspend the trade in live-caught wild animals of mammalian species for food or breeding purposes and close sections of food markets selling live-caught wild animals of mammalian species as an emergency measure unless demonstrable effective regulations and adequate risk mitigations are in place.
2. Strengthen the regulatory basis for improving standards of hygiene and sanitation in traditional food markets to reduce the risk of transmission of zoonotic diseases. Additional measures for crowd control and physical distancing and hand-washing and sanitizing stations as well as education on respiratory hygiene should be introduced in market settings to limit the possibility of person-to-person transmission of disease.
3. Conduct risk assessments to provide the evidence base for developing regulations to control the risks of transmission of zoonotic microorganisms from farmed wild animals and live-caught wild animals that are intended for human consumption. Regulations should address the traceability of farmed wild animals to ensure that they are distinguished from caught wild animals and should include strict biosecurity measures.
4. Ensure that food inspectors are adequately trained to ensure that businesses comply with regulations to protect consumers' health and are held accountable. In addition, competent authorities responsible for managing traditional food markets should be adequately resourced, so that regulations focused on food animal production, processing, and marketing are consistently enforced.
5. Strengthen animal health surveillance systems for zoonotic pathogens to include both domestic and wild animals. This will provide early warning for pathogen emergence and provide the evidence base for the development of controls to prevent risks to human health, in association with public health surveillance systems.
6. Develop and implement food safety information campaigns for market traders, stall holders, consumers, and the general public. These campaigns should communicate the principles of food safety and the risks of transmission of zoonotic pathogens at the human-animal interface and the risks associated with the consumption and trade of wildlife. The campaigns should also disseminate information to all stakeholders about the importance of biodiversity and the need for any use of wildlife to be legal, sustainable, safe, and responsible.

Source: WHO, WOAH and UNEP, adapted by authors.

There is a need to strengthen management of the wildlife trade in alignment with WOAH international standards for the safe trade in other animal products. The extensive wildlife trade needs to be better regulated, including reducing the risk from informal and illegal trade. Improved border control, risk analysis of cross-border disease entry, identification, and certification of animals (both domestic and wildlife) and their products and increased awareness and management of informal movement will reduce the risk of international spread of animal diseases, including zoonoses. The high risk of spillover from wildlife to livestock or to humans during the transport of mixed consignments of animals and the mixing of live animals and wildlife at traditional markets and at slaughterhouses needs to be urgently addressed.

The potential for improved animal health and welfare policy development and the implementation of services in the veterinary domain through PPP has been well recognized. A number of initiatives have been taken by international agencies and philanthropists such as FAO, WOAH, and the Bill and Melinda Gates Foundation. Recently OIE, prior to its name change to WOAH, published guidelines on developing PPP in the veterinary domain, the 'OIE PPP Handbook, OIE (2019)'. It is recognized that governments will retain overall responsibility for policies and that involving relevant private sector stakeholders in their development should lead to better policies and more efficient and effective delivery of programs. Such programs include disease surveillance and the ability to detect and respond quickly to disease incursions and the improved design and compliance with disease control. The establishment of PPPs contributes to a more efficient and effective use of both public and private sector resources – a 'win-win' situation. PPP also mitigates the risk of unregulated private sector servicing areas that should be a public responsibility and also of the public sector providing services that would better and more efficiently be conducted by the private sector.

Public-private partnerships offer real potential to improve animal health and welfare policies as well as better veterinary services

Public-Private Partnerships Blended Finance for One Health

1. PPP development can be considered in three broad categories:

- Transactional: government procurement of specific animal health/sanitary services from private veterinary service providers, for example, delivering a rabies vaccination program
- Collaborative: joint commitment between the public sector and end-beneficiaries to deliver mutually agreed policies/outcomes, for example, support in controlling HPAI or ASF to re-establish an export market
- Transformational: development of sustainable capability to deliver otherwise unattainable major programs, for example, establishment of a veterinary service in remote rural areas by introducing livestock insurance schemes or other approaches to sustaining an income for the private veterinarians.

Box 7.9: Public-private partnerships in China and Australia

China: In Guangdong, the provincial authorities and the private owners of a large live bird market jointly funded a PPP approach to improve biosecurity in the market. The project involved a detailed analysis of the market and its operations and made recommendations on how to improve biosecurity. This partnership resulted in the construction of privately operated facilities for the washdown of trucks, crates, cages, and equipment; design of improved workflows; replacement of crates; redesign of drainage; improved processes for cleaning; and reduction of time in market. Staff were also trained in improved hygiene and biosecurity practices.

Australia: Animal Health Australia (AHA) is a partnership between multiple levels of Australian Government (that is national and state/territory), the livestock industries (beef, sheep meat, wool, dairy, etc.), and other stakeholders set up as a not-for-profit public company, to protect animal health and the sustainability of the Australian livestock industry. AHA works in partnership with its members and other stakeholders to "keep Australia free of new and emerging diseases and to improve animal health, enhance market access and foster the resilience and integrity of the Australian animal health system." The AHA PPP model supports negotiation and discussions between parties to generate sustainable change while also maintaining goodwill.

A crucial function that AHA provides is to facilitate trust and cooperation between industry and government on animal health matters by sharing information and initiatives, developing joint programs, and coordinating and funding a number of agreed priority strategic programs; operational costs are largely the responsibility of the relevant governments and industry stakeholders. AHA was carefully constructed after considerable negotiation and provides a forum of shared responsibility with national government responsible for border biosecurity and negotiating trade access, states and territories for legislation, and local disease control and industry responsible for farm biosecurity. Among other activities, the partnership has developed Emergency Animal Disease (EAD) response strategies, provided EAD

response training to members, as well as developed services in the areas of biosecurity, traceability, surveillance, and animal welfare standards. The collaboration minimizes the risk of EAD occurrence and provides the ability to respond quickly and effectively to an EAD incident should one occur. The AHA model is an example of a PPP that is functioning extremely well and delivering benefits to both the public and private sector.

Impact

Public and private sectors working together have improved the performance and quality of services delivered utilizing private sector resources, such as for the capital investment in infrastructure. PPP has enabled the public and private elements of veterinary services to focus on their respective responsibilities and capabilities where they are most efficient and effective. For the private sector, effective PPP presents an opportunity to increase profitability by increasing services and reducing costs to clients, producers, and consumers and to the public sector veterinary services.

Lessons learned

In the EAP region, there is huge potential to develop greater partnerships between the public and private sectors to improve the veterinary services overall; to promote animal production, health, and welfare; to better protect public health; and to increase compliance with international standards.

The key to making PPP work is that the public sector must trust and empower its private sector partners to deliver agreed activities; it should avoid unnecessary prescriptive regulation or contract obligations and allow the private sector flexibility to determine how best to operate. The private sector partner is responsible for delivering its obligations with appropriate quality assurance checks on the activities conducted and the outcomes achieved.

Source: Authors' own elaboration.

Another opportunity for PPP is the WOAH concept of disease-free compartments or zones. Compartmentalization is based on a production system having a known disease-free health status with a negligible risk of disease incursion (through rigorous biosecurity on the farm itself and for all farm inputs such as replacement animals, feed, water, movement of people/equipment/transport, etc.). Compartments are a PPP as they require investment from the private owner in improved facilities and practices and certification by government, or their delegated assessors, that is the public. Compartments are increasingly being used to support export market access for poultry and pigs and in time can be used for more extensive production systems. Rather than disease-free compartments, there is also the opportunity to use PPP to support the development of high-health compartments with improved control of multiple diseases, including zoonoses, and these would have preferential market access and improved market returns.

Disease-free compartments are based on the known health status of a production system which has rigorous biosecurity on the farm and for all farm inputs

Strengthening Regional Programs for One Health

International support is needed, especially for the more disadvantaged countries. Regional policy support in required to better coordinate and strengthen policy, legislative, and regulatory environments across the region. Regional centers should be further developed as regional resources to support less developed countries – this applies particularly to the Pacific Island countries. Evaluations, such as the WOAH-PVS (World Organization for Animal Health – Performance of Veterinary Services) and WHO-JEE (World Health Organization – Joint External Evaluation), should be encouraged and, following identification of gaps and weaknesses, support provided in addressing these limitations. A parallel tool is required to sufficiently assess capacity needs for wildlife and environmental health services to cover the full One Health 'triad.' Regional information sharing and coordination systems should be further enhanced and mandated with full transparency, together with dynamic real-time sharing of data and information. The development of national animal health information systems will support the more efficient exchange of information across the region. The focus should be on innovative, integrated, effective, and efficient use of scarce resources to achieve the full benefits of interdisciplinary and multi-sectoral approaches. Funding of regional collaborative research with provision of laboratory networking and reference laboratory services is needed to harmonize protocols and SOPs for the detection of TADs and EID threats.

Box 7.10: Regional programming in animal health and One Health threats

Given the transboundary nature of many infectious animal diseases and the extensive trade networks in EAP, developing consistent regional and national approaches to disease prevention and control are critical to delivering effective and sustainable improvements to One Health, animal health, and wildlife health.

Regional organizations, in collaboration with their member countries, are important for ensuring commitment and to provide platforms for improved disease prevention and control. The ASEAN Sectoral Working Group on Livestock supports collaboration on animal health and is promoting self-reliance in delivering animal health projects. The ASEAN Coordinating Centre for Animal Health and Zoonoses has also been established.

The regional and sub-regional programs play a very important role because they support the building of regional integrated systems for resilience and the capacity for disease prevention and control. These include enhanced surveillance and information sharing, emergency prevention, response, and control through improved regional capacity in epidemiology and delivering One Health. Managing the risk from cross-border trade in animals and animal products across borders requires a regional approach.

The international lead organizations for animal health, FAO and WOAH, have active regional and sub-regional programs and support a range of issues including improved advocacy and evidence-based policy development, increased capacity and capabilities (staff development, investment in laboratories and other infrastructure), strengthened systems of risk assessment, disease prevention, surveillance and information management, disease detection and response, and improved regional coordination and transparency. The FAO and WOAH with the WHO promote One Health and work with national governments to develop and deliver their programs and activities and coordinate closely with regional entities such as ASEAN and the South Pacific Commission (SPC). In addition to the World Bank and Asian Development Bank, a number of international donors have active programs in the region including the United States of America, Australia, the European Union, Republic of Korea, Japan, New Zealand, Canada, and Switzerland. International agricultural research groups such as ACIAR, ILRI, and CIRAD are also active. Integrated approaches are needed to ensure the most effective targeting and implementation of investment in animal health systems.

The international organizations and individual donors use regional and bilateral country programs to assist with animal health system development at the national and sub-national levels. While the WOAH's main role is at global and regional levels, it works with individual countries to develop their animal health systems through its Program for Strengthening of Veterinary Services (PVS). This program evaluates national veterinary services, identifies gaps, and estimates the resources needed to address deficiencies. The WOAH Standards for Animal Health are the basis for countries to manage animal health and trade. The FAO often provides bilateral support for member countries in developing food security and food safety and by addressing risks and limitations of their livestock production systems. The FAO achieves this through a combination of Technical Cooperation Projects (TCPs) and longer-term development programs. The FAO and WOAH support regional training, operations, emergency response, and information to develop capacity and capabilities in threat identification and risk management.

Key elements for strengthening animal health systems in East Asia and Pacific countries

	Key elements for strengthening animal health systems
Technical factors	• Policies and legislation in place • Operational cross-sectoral and inter-disciplinary systems (One Health) • Field services adequately resourced • Effective information management - Surveillance for early detection of EIDs - Accredited laboratories - Data analysis and reporting • Emergency preparedness and response capacity developed - After action reviews (AARs)[22] are undertaken to identify weaknesses and lessons learned • Disease control programs operating • Staff skills including epidemiology, laboratory sciences, operations, and emergency response
Critical factors	• Political commitment • National commitment and prioritization to minimize gaps in resourcing • Coordinated and targeted global and regional donor support • Support for less-developed and high-risk countries

22 An AAR is a qualitative review of actions taken to respond to a public health event or following a project or a public health intervention (WHO 2020). It is considered an important management tool for continuous performance improvement and learning.

Impact

Substantial progress has been made across EAP since the avian influenza epidemic (from 2003) with considerable strengthening of disease surveillance and laboratory diagnostic testing. Notwithstanding this progress, animal health systems in much of the region remain weak and underresourced and are in need of additional investment and development. Further, the national wildlife systems are barely functional across the region and are in urgent need of support.

Lessons learned

Regional coordination is imperative to develop effective coordinated programs to support the weaker national systems and to implement cross-border risk mitigation. Effective regional programs provide the platform for efficient use of resources, the development of professional networks, and the transparency to alert colleagues of emerging issues.

Source: Authors' own elaboration.

An overview of the main recommendations on how to strengthen animal health and zoonotic disease management in eight countries in the region are presented in Table 7.2. It should be noted that the countries in the EAP region are not homogeneous, varying widely, and tailored sub-regional approaches reflecting country conditions will be needed. For example, the Pacific area has its unique specific challenges, ASEAN countries including Timor Leste form another sub-region, and East Asian countries another grouping. The recommendations in the table are based on the individual country assessments covering both the livestock and wildlife sectors.

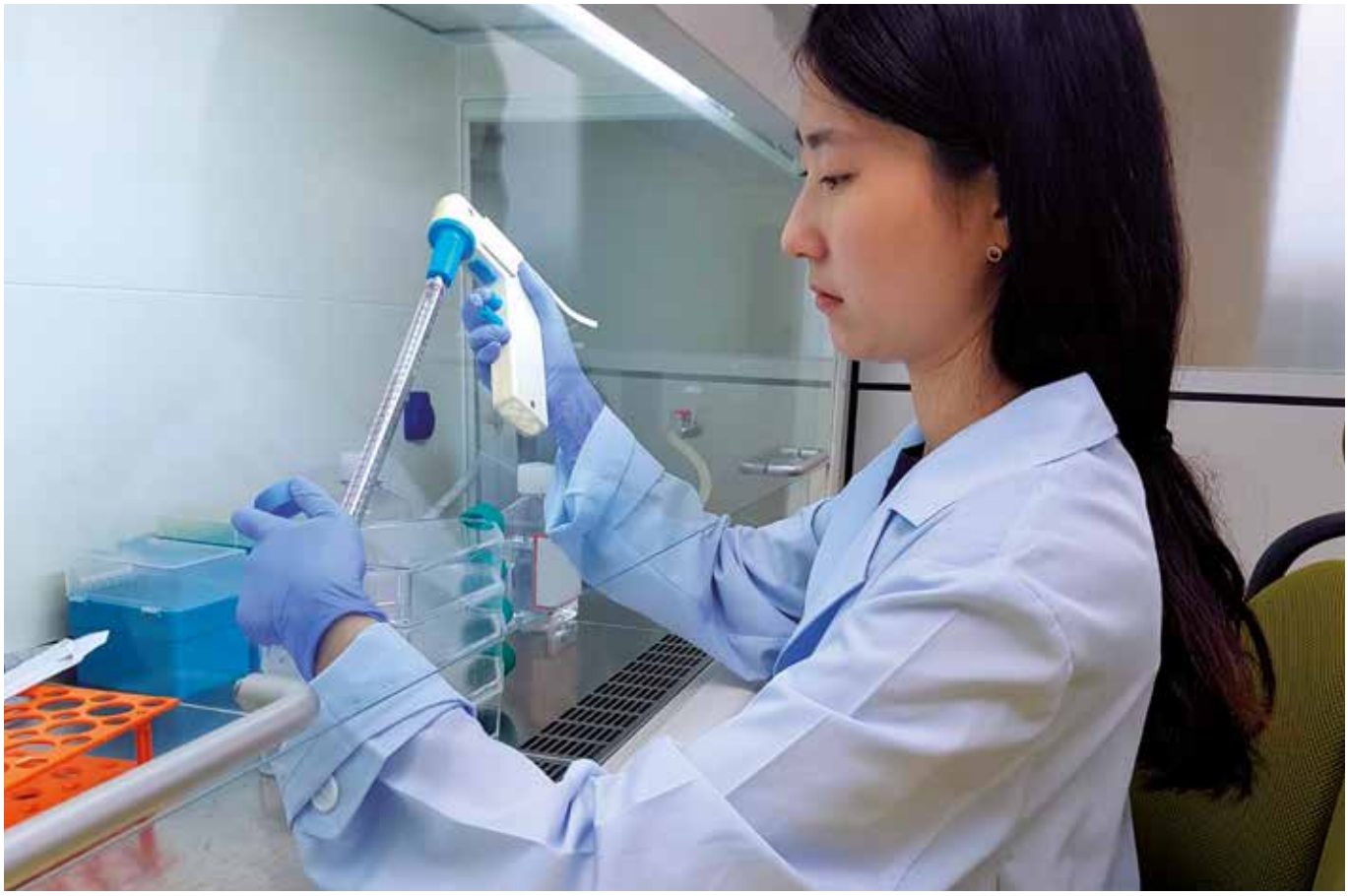
Table 7.2: Recommendations for strengthening One Health systems in select EAP countries *Source:* Authors' own elaboration based on NAPHS, JEE, PVS reports, and expert reviews.

Country	Recommendations	
	Animal Health	**Wildlife Systems**
Cambodia	Improve coordination and service delivery. Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Train veterinarians and paraprofessionals. Develop cross-sectoral rapid response teams to ensure a coordinated response. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
China	Strengthen enforcement of laws and adoption of good practices to improve bio-security, food safety, and AMR control stewardship along the agri-food production and value chains to better prevent the EIDs like H7N9 influenza, COVID-19, etc.	Review and define institutional mandates for wildlife health risks and harmonize the regulations and enforcement procedures to address vulnerabilities in the detection of emerging disease. Reduce contact between wildlife, animals, and humans at farms, aggregation, and markets. Improve community engagement and promote public awareness.
Indonesia	Improve coordination and chain of command of animal health services. Strengthen One Health coordination and collaboration. Strengthen cross-sectoral emergency preparedness and response systems. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies and specialist veterinary skills.	Strengthen surveillance systems and improve One Health coordination and collaboration. Train staff at provincial and district levels. Promote public awareness. Reduce contact between wildlife, animals, and humans at markets. Improve food safety at markets and slaughterhouses. Provide resources for activities and development of institutional capacity and systems.

Lao People's Democratic Republic	Improve coordination and service delivery. Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Strengthen mechanisms for intersectoral collaboration, including with environmental health. Increase information sharing between sectors for timely response. Develop cross-sectoral rapid response teams for a coordinated response with the use of FETP/FETPV. Provide resources for programs. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
Mongolia	Strengthen One Health coordination and collaboration. Strengthen emergency preparedness and response systems and provide resources. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies and specialist veterinary skills. Strengthen cross-sectoral emergency preparedness and response systems.	Develop human resources for wildlife surveillance and management. Undertake surveillance and develop mechanisms for sharing information across the human, animal, and wildlife sectors. Provide resources for activities and development of institutional capacity and systems.
Myanmar	Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses. Strengthen cross-sectoral emergency preparedness and response systems.	Increase support and coordination for the One-Health approach. Improve wildlife disease surveillance and the integration of information across sectors. Develop human resources for wildlife surveillance. Provide resources for activities and development of institutional capacity and systems.
Philippines	Further develop One Health coordination and collaboration. Strengthen coordination for emergency preparedness and response systems and provide resources. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Develop staff competencies, and specialist veterinary skills.	Improve wildlife surveillance and the harmonization, data exchange, and multi-sectoral analysis of data between human and the animal/ wildlife sectors.
Timor-Leste	Increase veterinary staff capacity and reduce dependence on veterinary paraprofessionals. Improve coordination and service delivery. Review and strengthen zoonoses and animal disease surveillance and control programs. Strengthen border control. Improve food safety at markets and slaughterhouses.	Develop human resources for wildlife surveillance and management. Undertake surveillance and develop mechanisms for sharing information across the human, animal, and wildlife sectors. Reduce contact between wildlife, animals, and humans at markets. Provide resources for activities and development of institutional capacity and systems.
Vietnam	Improve coordination and service delivery. Increase use of risk assessments for disease surveillance, control, and the reduction in AMR. Improve food safety at markets and slaughterhouses. Strengthen border control. Develop staff competencies and specialist veterinary skills.	Improve coordination between the wildlife, animal, and human sectors – both for wildlife hunting/trade and farming. Reduce contact between wildlife, domestic animals, and humans at markets. Contribute to planning, data sharing, and coordinated response to zoonoses. Provide resources for activities and development of institutional capacity and systems.

Top
The scientist pipettes an animal cell sample on a clean bench.
Photo credit: Shutterstock

Bottom
MONGOLIA
Livestock Commercialization Project, Mongolia
Photo credit: Erdenechimeg S.



INDONESIA
Land Use Change, Indonesia.
Photo credit: Flore de Preneuf/World Bank

Annexes

Annex 1: Valuing One Health Investments

Effectiveness and Efficiency Gains of One Health

The World Bank analysis on the economics of One Health shows that investment in One Health systems for prevention and control of zoonotic diseases offers extraordinarily high expected benefits, with rates of return far above those of other public and private investments (World Bank 2012). Every year, an investment of USD 3.4 billion would produce an expected benefit of USD 30 billion for the international community. The annual expected rate of return would be between 44 percent and 71 percent (corresponding to, respectively, half or all mild pandemics being prevented). The required investments in One Health systems of between USD 1.9 billion and USD 3.4 billion per year are substantially below the average USD 6.7 billion per year in losses due to the six major zoonotic disease outbreaks in 1997–2009, in particular considering that none of the disease outbreaks developed into a pandemic. The potential economic benefit of averting a pandemic like COVID-19 would be much higher and deliver public good to the whole world.

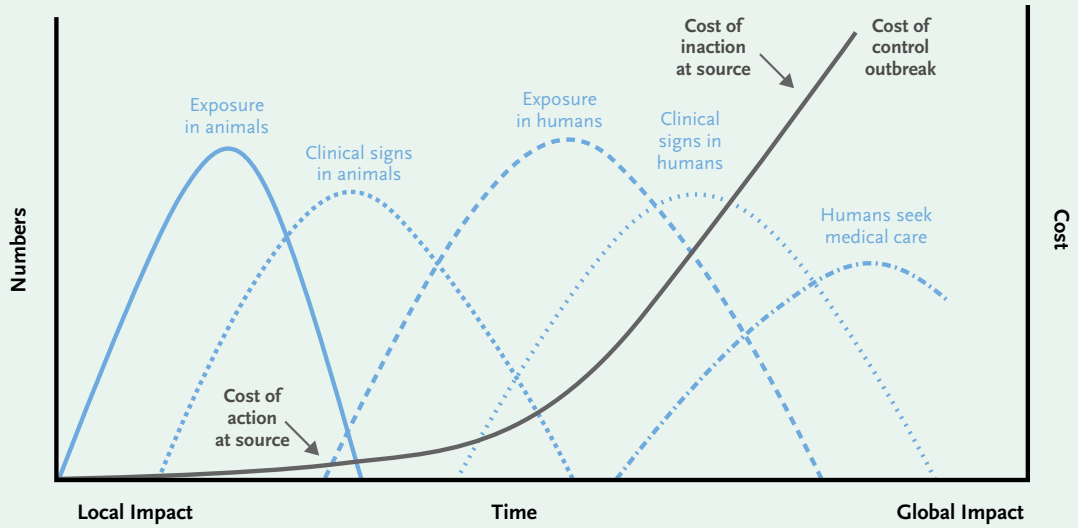


Figure A1.1: Cost of actions and inaction as the pandemic traverses from local to global proportions *Source:* World Bank 2012 adapted by the authors.

It is critical to prevent the disease from reaching the point of spreading among humans, because when the spread of the disease among humans is established, it may be difficult to slow or reverse, and the cost of disease control will usually increase rapidly. Figure A1.1 illustrates such typical pattern of progression that involve a pathogen that originates in wildlife, then passes to livestock, and is then transmitted from livestock to humans.

Effective zoonotic disease control requires early detection at the animal source, speedy identification of clinical signs, accurate diagnosis and rapid control measures

Therefore, effectiveness of zoonotic disease control requires early detection at the source of the disease in animals, an early identification of clinical signs and accurate diagnosis in animals, and rapid disease control measures. Delays substantially reduce effectiveness. The more effective the approach is, the more lives it will save, and the higher the benefits in terms of avoided losses. Through the approach, efficiency gains would be achieved by arriving earlier, identifying the zoonotic disease more accurately, and undertaking control actions in animals accordingly, which result in either doing more with the same resources or doing the same with fewer resources.

Furthermore, it is critically important to ensure that interdisciplinary collaboration occurs through the One Health approach. This collaboration reduces the gaps between institutions and disciplines where poor coordination and weak integration between the relevant departments led to human deaths, illness, significant livestock losses, and other economic costs, causing costly delays, and even failures, in disease detection and control.

The most important effectiveness gain of improved One Health systems will be the faster and more accurate identification of health risks. The closer integration of human, animal, and wildlife health services will lead to a more accurate or faster diagnosis at the source of disease outbreak, resulting in reduced disease spread and lower control costs of an eventual emerging disease outbreak. The Mongolia case provides an example where "control at source" led to more efficient and effective control of human health risk of brucellosis.

The One Health system offers much greater effectiveness in the speedier and more accurate identification of health risks

The One Health approach could be more efficient as it entails sharing of human, equipment, and operational costs among the services responsible for animal, human, and environmental health. From the introduction of One Health, the surveillance program is estimated to save up to 30 percent investment and 40 percent recurrent costs. Sharing diagnostic facilities and laboratory equipment will help save up to a quarter of investment and nearly one-third of recurrent costs. Joint quarantine, hygiene campaign, rapid response and control measures would further save up to 15 percent of new investment and 30 percent of staffing costs. According to the World Bank estimates, these savings would range from 10 to 15 percent of the total costs of a global surveillance and disease control system.

Among the most significant indirect effects of One Health are market access, food security, poverty reduction, reduced loss of biodiversity, and increased income from tourism. The One Health strategy is pro-poor especially as the producer costs and losses of an outbreak are disproportionately felt by those most in need: the poorer rural communities of the developing world. The spillover effects of a One Health approach will apply to enhanced food security and to the promotion of poverty reduction from improved production systems. Cost-benefit analysis of preventing and control of animal diseases suggest that there are significant benefits in terms of both productivity gains and potential trade gains from investing in such improvements.

As part of the One Health approach, investment in food safety is imperative in preventing future pandemics and will be cost-effective. A key take-away from the COVID-19 pandemic is that investing in the development of local government capacity to monitor, trace, contain and prevent emerging disease is a major requirement, especially in food systems where animals and humans interact. Effective pandemic control also requires engagement along the entire food value chain including the farming community, epidemiologists, animal science researchers, traditional market traders, exporters, local businesses and consumers. Proper economic incentives can help overcome the problem that social benefits and costs of food safety outweigh private benefits and costs of implementing such practices. In addition, social and behavioral interventions and social mobilization will be important to facilitate behavior change and incentivize stakeholders to internalize social costs of underinvesting in food safety practices in the food value chain.

From the perspective of rate of return, investment in early detection and effective control of zoonotic diseases at their animal source can be justified by their extraordinarily high returns to pandemic prevention. Such a high rate of return offsets the additional expenditures required to bring animal and human disease prevention and control systems up to acceptable standards and to sustain them in the medium and long-term horizons. According to the WOAH/World Bank joint study (Prevention and Control of Animal Diseases Worldwide, Economic Analysis—Prevention versus Outbreak Costs, Final Report, Part I), when a comparison of prevention versus outbreak costs is made, the majority of the reviewed studies conclude that the significant benefits that accrue from improved prevention and control measures outweigh the cost of investment in animal health services to control the disease. The expected rates of return of these investments range from high (14 percent) to very high (123 percent), indicating that investments in prevention are strongly justified. For instance, under a plausible expectation that improved systems could detect and control half of the pandemics at an early stage, the rates of return range from 44 to 88 percent, which is well above the returns available on nearly all other public spending and private capital markets.

National/Regional/International One Health Priorities

Following these strategies, the World Bank in consultation with the WOAH, FAO, WHO and the UN System jointly developed a model that defines the key components of the response to avian and human influenza (AHI) at the country, regional, and global levels. The model can be further extended in the adoption of a One Health approach to prevent and control other EID with animal origins.

Countries adopting a One Health strategy should have integrated human and animal health plans with clear objectives, results, outcomes and costs

At national level, countries should adopt a One Health strategy with medium term objectives to i) prepare integrated plans for human and animal health, which identify clear and common objectives across sectors, with associated results, outcomes, and costs, to which all sectors can contribute, ii) develop policy, legislation, and related strategy work to support the interventions identified, iii) develop surveillance and early warning systems for animal health. Systems for surveillance and early warning involve the enhancement of laboratory and diagnostic capacity, operational support to active and passive surveillance, including routine serological survey, and related information system support, training, and technical assistance and support to research, iv) develop country capacity for undertaking rapid outbreak containment measures including culling, compensation, disposal, post-culling disinfection, and vaccination, v) ensure effective communication and coordination among human health, animal health and wildlife sectors to minimize panic and disruption and to engage the active involvement of all stakeholders. In addition, countries should develop long-term One Health objectives which include strengthening the capacity of the veterinary system to deal with animal disease outbreaks; and restructuring the domestic animal industry to systematically lower the risks to zoonotic diseases. In all these activities there are roles for both the public and private sectors.

At the regional level, activities should not duplicate country-level activities but be complementary and support cross-country efforts. Important regional activities such as cross-country risk assessment would help countries with their overall planning and prioritization of investment and facilitate effective cross-country support to and learning among countries facing similar sets of challenges. Regional activities could also include collaborative research to harmonize protocols and SOPs and support for reference laboratories (when these are set up to serve a region rather than an individual country), coordination of activities undertaken across countries on implementation policies, surveillance methods, and control measures, given the transboundary nature of the disease. A key focus of the regional assistance would be capacity building in response to demands made on regional organizations by countries. These could be organized through direct support for regional bodies (including animal health organizations, regional organizations, and technical organizations), building on existing infrastructure and mechanisms such as the global framework for the control of zoonotic diseases and the global early warnings system. Finally, regional support to research, communication, and exchange activities e.g., meetings, workshops and data exchange can be organized with support to regional/international organizations.

At a global level, various support activities can complement those at the country and regional levels, including support to the standard setting and global strategy development; support to laboratory networks development of materials and new technologies (e.g., vaccines and antiviral treatments); coordination of the response to avoid duplication and waste; and communication.

Table A1.1 provides a summary of the main risk factors by sector and possible actions needed to address these risks by transforming into One Health Model, as well as a comparison of relevant cost and benefit.

Table A1.1: Costs and benefits of transforming animal health and wildlife systems for One Health

Country	Recommendations			
	Risk Factor	**Actions needed to transform into One Health Model**	**Investment/Cost**	**Benefit**
Wildlife	- Environmental degradation and increased wildlife/domestic animal and wildlife/human contact - Fragmentation and gaps in institutional mandates/ authority to effectively cover wild animal diseases and pathogens - Ad hoc wildlife disease surveillance and risk management activities - Inadequate human resource due to poorly recognized value in wildlife health and limited training/career opportunities - Insufficient investment and poor infrastructure in wildlife health services - Lacking channels for multi-sectoral information sharing/coordinated risk management actions - Lacks research on wildlife pathogen, mutations and spillover risks in the context of ecosystem degradation	- Establish the appropriate enabling regulatory and political, institutional, and operational frameworks for One Health - Review and refine institutional mandates for wildlife disease and pathogens risk - Strengthening wildlife services and their integration with the human and livestock health services to enable them to prevent, detect and mitigate the risk of disease spillover and spread management - Harmonize policies and strengthen regulatory and enforcement capacity on illegal wildlife trade on integration of health considerations in land use planning, and other contexts that facilitate spillover risk - Include wildlife and environment sector representatives in national and regional multi-sectoral coordination platforms and initiatives - Sustain funding mechanisms for wildlife health services provision - Development capacity for effective wildlife risk monitoring and reduction - Improve health literacy and awareness of potential zoonotic disease risks from wildlife exposure - Sustain funding of research to enhance pathogen detection	- Capital investment zoonotic disease surveillance and management system - Ear-marked funding for institutions with clear mandates to provide wildlife health services at national and local levels - Recurrent budget for wildlife workforce development incl. training - Dedicated resources to support multi-sectoral research, information sharing and actions - Collaborative research to harmonize protocols and SOPs to enhance pathogen detection	- Lower burden of zoonotic diseases and emerging infectious (reduced cost of human deaths and disability measured in DALYs) - Preventing production and revenue losses to livestock sector (culling of poultry, trade ban, compensation, etc.) - Avoidance of social economic cost incurred from epidemic control or mitigation measures (lock-down, vaccination etc.) - Long-term benefit from re-establishing ecosystem equilibria (or preventing their disruption) - Co-benefits from protection of biodiversity and ecosystem services - Early and rapid detection of pathogen to implement quick response and build national and regional database for quick referencing

Animal Health	- Major increases in livestock production with limited investment in good husbandry practices and health systems resulting in low biosecurity and increased likelihood of disease - Weak animal health services with inadequate legislation, policies and programs and insufficient resources (skilled staff, funding, equipment, and materials) - High risk of cross border disease transmission with the high volumes of trade and informal movement of animals and animal products - A mixture of domestic animal production and captive wildlife farming increases the risk for spillover of emerging pathogens into humans - Increasing antimicrobial resistance (AMR) - Complex supply chains with multiple players and nodes making quality assurance, attribution and disease control more difficult - The science-policy interface for developing evidence-based policies and programs is weak - Poor animal disease diagnosis services in low- and middle-income countries	- Update legislation that mandates multi-sectoral cooperation and collaboration to deliver effective One Health programs covering animal health services - Establish the appropriate enabling regulatory and political, institutional, and operational frameworks for One Health - Develop human capacity and capability at the institutional level to ensure policy, legislation and compliance for animal health and farm biosecurity in place - Engage private sector to take more responsibility for biosecurity and risk reduction, and share production, animal health data - Develop integrated information management systems using modern systems for data capture, analysis, reporting and sharing of zoonotic diseases - Develop program to address the priority neglected animal diseases and neglected zoonoses - Implement programs to monitor and reduce the risk from the spillover of emerging pathogens from wildlife - Build multi-sectoral and interdisciplinary surveillance systems for early detection of priority zoonotic diseases - Accredit laboratories and laboratory tests	- Fixed costs associated with surveillance, coordination, research and education that cannot be assigned directly to a specific zoonotic disease - Variable costs directly associated with the surveillance, control and prevention of a disease and reflect the scale of the disease outbreak or problem - Costs associated with reducing the risks of the entry of disease and its early detection once in a herd or flock - Public investment (financial, technical and human resources) in the development of coherent policies and effective management of zoonotic disease prevention, detection, control and recovery - Veterinary personnel and overall cost of the veterinary system - Private investment by companies and individuals to prevent and manage diseases - Laboratory modernization, human capacity development and sustained operation budget	Economic gain through efficient and profitable livestock production - Cost saving due to early detection of diseases and effective response (averted massive culling, compensation, and movement control measures) - Averted cost due to loss or restriction in animal trading due to disease outbreak - Economic efficiency of service delivery through engagement with private sector in early detection and disease prevention - Reduced losses caused by ripple effects (impact on food prices and on upstream and downstream industries i.e., feed supply, processors, retailers, consumers), and spillover effects (impact on tourism and wider society i.e., food availability, environmental impact and/or loss of ecosystem services) - Early and rapid diagnosis of EID and endemic diseases to support disease surveillance and quick response to prevention and control

Food Production, Distribution, and Consumption	- Food safety has been a low priority with very little progress in developing systems for animal and animal product identification and traceability - Insufficient knowledge of or commitment to food safety practices by food producers and consumers - Suboptimal hygienic conditions of farmers' markets - Coexistence of wild animal and peri-domestic mammal products in market - Cross-contamination through human-animal contact in food distribution/handling - Poor enforcement of inspection and certification along with the food value chains. - Lack of an early detection and documentation system to contain and trace outbreaks in food systems	- Establish the appropriate enabling regulatory and political, institutional, and operational frameworks for One Health - Strengthen food safety regulation and supervision, set up standards and licensing mechanism for food production and sales - Provide to incentive packages to encourage adoption of good food handling practices e.g., 'Five Clean Actions' on environmental hygiene and sanitation in farmers' markets - Apply market zoning and other measures to prevent cross contamination - Improve traceability, documentation and reporting in food system that interact with other existing human/animal disease surveillance systems - Make resources available for training and capacity development on food safety/security - Strengthen coordination and information sharing between wildlife disease, animal health and public health in disease monitoring and early warning - Rational uses of antimicrobial agents in terrestrial and aquatic animals	- Transitional or implementation costs for required changes in infrastructure or processes, training, and redesign of existing marketplaces - Financial, technical and human resources needed for developing, enforcing and supervising food safety standards, and schemes - Compliance cost of private sector - Financial, technical and human resources needed for food safety training - Investment in food traceability, disease surveillance and early warning systems, and coordination with human and animal health systems - Cost related to behavior change in prudent use of antimicrobial agents in terrestrial and aquatic animals	- Reduced spillover risks and biodiversity loss; lower exposure and likelihood of transmission at all phases of production - Averted productivity losses and medical expenses resulting from unsafe food - Averted cost associated with loss or restriction in markets due to the presence of disease in a population - Externalities related to enhanced consumer confidence for food farming systems and markets - Food safety program lead to long-term production contracts, higher prices for output and longer shelf life for products

Public Health	- Increasing risks and burden of emergence or reemergence, spread, and persistence of diseases that come from wild and domestic animals, - Current paradigm for addressing zoonotic disease outbreaks is typically highly reactive by human health sector with detection and control efforts implemented after spillover to humans has already occurred and often spread across human populations - Emergence and spread of antimicrobial resistance (AMR) pose a significant challenge to healthcare with high medical and economic consequence - Lack of incentives encouraging collaboration across disciplines - Funds for addressing pandemic threats are typically made available for reactionary responses in epidemic situations, rather than long-term capacity building	- Establish the appropriate enabling regulatory and political, institutional, and operational frameworks for One Health - Make the case for human health sector to prioritize prevention, early identification and control of zoonotic diseases and AMR - Facilitate risk-based approach based on joint priority setting, assessment and preparedness planning, including the identification of disease or risk hot spots - Establish appropriate mechanisms to support and finance joint actions among human, animal, and environment sectors on disease surveillance, early warning, prevention, laboratory services, risk communication and emergency response - Develop common disease information systems, establishing protocols for information sharing between sectors - Develop formal and on-the-job training that integrates human, veterinary, and ecosystems health sectors and encourages multi-sectoral research - Establish network between human health professionals, veterinarians, wildlife and environment specialists	- Investment in strengthened human, veterinary, and environmental health services under the One Health framework, including capacity and infrastructure needs (capital and recurrent) - Resource sharing (e.g., in laboratory infrastructure, sentinel monitoring) - Investment in coordination and collaboration mechanisms (e.g., data-sharing systems, outbreak investigation and response) - Investments in joint prevention and intervention measures for specific diseases - Cost for integrated risk and impact assessment, disease surveillance and monitoring, laboratory test, after action review - Cost for organizing applied joint epidemiology training and simulation program with participation of human, animal and wildlife professionals	- Reduced cost of medical treatment, and preventing human-human spread - Improved effectiveness of core public health systems, in their ability to achieve the objectives of prevention, early detection, correct diagnosis, and control of the outbreak - Achieving results more efficiently through avoiding duplication of tasks, prioritizing interventions, and selecting most cost-effective options to address cross-sectoral issues - Economic benefit from the prevention of pandemics and epidemics

Annex 2: Compilation of Data from PVS and JEE Reports

Table A2.1: Anonymized PVS scores by regional groupings[23]

	ASEAN									Pacific				Asia		
Critical competency/Region	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I. Human, physical and financial resources																
I.1A Staffing: vets and other professionals	3	na	1	2	2	4	2	2	3	1	4	2	2	3	3	2
I.1B Staffing: vet paraprofessionals	1	na	2	1	2	3	2	3	3	1	5	2	2	3	na	2
I.2A Competencies of vets	3	2	1	1	2	3	3	4	1	3	4	3	3	3	2	2
I.2B Competencies of vet paraprofessionals	1	1	2	2	2	4	2	2	2	2	5	2	2	3	na	2
I.3 Continuing education	2	2	2	2	2	5	3	4	2	2	4	2	2	3	2	2
I.4 Technical independence	4	2	2	2	3	4	3	3	2	3	3	3	3	3	3	1
I.5 Stability of structure and policies	5	1	3	3	3	3	3	5	3	2	5	2	3	3	5	2
I.6A Internal coordination	3	2	2	3	3	4	3	4	2	2	4	3	3	4	4	2
I.6B External coordination			3	3	3	4	3	4	2	2	3	2	2	3		2
I.7 Physical resources	4	na	2	3	3	4	2	3	2	3	5	1	2	3	1	1
I.8 Operational funding	4	2	1	2	2	4	2	3	3	2	4	2	2	4	2	2
I.9 Emergency funding	3	3	2	2	3	4	2	4	2	3	5	1	2	4	3	2
I.10 Capital investment	3	2	2	2	3	4	2	3	3	3	5	2	2	3	2	2
I.11 Mgmt of resources and operations	na	na	2	2	3	4	2	3	2	2	3	2	2	3	na	1
II. Technical authority and capability																
II.1A Access to lab diagnosis	3	2	2	2	2	4	4	5	5	2	5	1	2	2	3	1
II.1B Suitability of lab structures	na	na	na	3	3	3	2	na	na	2	5	1	2	3	na	na
II.2 Lab quality assurance	2	na	1	1	3	3	1	5	2	1	4	1	2	3	1	1
II.3 Risk analysis	2	2	1	1	2	3	2	3	2	3	3	2	3	2	2	1
II.4 Quarantine and border security	2	2	2	1	3	4	3	3	2	4	3	4	3	3	2	2
II.5A Passive surveillance	2	2	1	2	2	3	2	3	2	2	4	2	2	4	2	2
II.5B Active surveillance	2		2	2	2	4	3	4	2	2	4	1	2	3	2	2
II.6 Early detection and emergency response	3	2	1	3	3	4	3	4	3	3	3	2	3	4	2	2
II.7 Disease prevention, control and eradication	2	na	2	2	2	4	3	3	3	2	4	2	3	3	na	2
II.8A Regulation, authorisation of establishments	2	na	na	1	1	2	2	na	na	2	4	2	2	2	2	na
II.8B Ante and post mortem inspection		na	1	1	1	3	3	3	2	3	4	3	2	3	1	1
II.8C Inspection of processing & distribution		na	1	1	na	3	2	3	2	3	4	1	2	na		1
II.9 Veterinary medicines and biologicals	2	1	1	2	2	3	2	2	3	3	4	2	2	3		2
II.10 Residue testing	2	na	2	1	2	3	2	3	3	2	4	1	1	3	2	1
II.11 Animal feed safety	na	na	na	1	2	3	2	na	3	2	2	2	1	2	na	na
II.12A Animal identification & traceability	2	1	2	1	2	3	2	3	2	2	3	2	2	3	1	1
II.12B Identification & traceability of products			1	1	1	3	2	3	1	2	3	2	1	3		1
II.13 Animal welfare	na	na	1	1	2	3	2	2	1	na	3	3	2	2	na	1
III. Interaction with stakeholders																
III.1 Communications	2	2	2	3	2	4	3	4	3	3	4	2	2	4	3	2
III.2 Consultations	2	1	1	3	3	4	4	4	1	2	5	2	2	3	3	2
III.3 Official representation	2	2	2	3	3	4	4	5	2	2	3	2	3	3	2	2
III.4 Accreditation & delegation	2	1	1	1	2	1	2	3	1	1	4	1	1	3	1	1
III.5A Veterinary Stautory Body authority	4	2	1	2	3	3	3	2	1	1	4	1	2	4	4	1
III.5B Veterinary Stautory Body capacity				1		4	2	2			4		1			1
III.6 Participation of stakeholders in joint programmes	2	1	1	2	2	3	2	3	1	1	5	2	2	3	3	2
IV. Access to markets																
IV.1 Preparation of legislation	3	2	2	3	2	4	3	4	2	2	4	3	3	4	3	1
IV.2 Implementation/compliance with legislation	2	1	1	1	2	3	2	3	3	2	3	2	1	3	1	1
IV.3 International harmonisation	2	2	2	3	3	4	4	3	3	2	4	3	2	3	na	2
IV.4 International certification	3	2	2	2	2	3	3	3	2	2	5	4	2	3	2	1
IV.5 Equivalence & sanitary agreements	2	2	2	2	2	3	3	3	2	4	na	2	1	2	2	1
IV.6 Transparency	3	3	3	3	3	4	4	3	3	2	4	2	2	3	2	1
IV.7 Zoning	2	2	1	1	1	3	na	3	2	2	4	na	1	3	1	1
IV.8 Compartmentalisation	2	na	1	1	1	2	na	4	2	2	na	na	1	2	na	1

23 Note: Colors in the table indicate to what degree countries comply with the WHO IHR or WOAH Terrestrial Animal Health Code Standards: red - no capacity, orange – limited capacity/compliance, yellow – developed capacity/some compliance, light green – demonstrated capacity/ broad compliance, and dark green – full compliance/international best practice; 'n.a' refers to not assessed owing to a change in the assessment formatting over time or information not being made available; some cells are merged also because the assessment tool changed over time.

Table A2.2: JEE scores by country[24]

Indicator/Country		Philippines	Vietnam	Cambodia	Lao PDR	Thailand	Myanmar	Indonesia	Singapore	Mongolia	Timor Leste	Micronesia
Prevent												
National legislation, policy and financing	P1.1 Legislation	2	3	3	3	5	2	3	5	3	2	3
	P1.2 Legislation - updating	na	3	3	4	4	2	3	5	3	na	3
IHR coordination, communications and advocacy	P2.1 Coordination mechanisms	2	4	4	4	4	2	3	5	3	1	3
AMR	P3.1 Coordination	4	2	3	2	4	3	2	4	2	3	4
	P3.2 AMR surveillance	2	2	2	1	3	3	2	4	3	1	4
	P3.3 Infection prevention/control	2	3	2	3	3	1	3	5	3	1	1
	P4.4 AM stewardship	2	2	2	1	2	1	3	4	2	1	1
Zoonoses	P4.1 Coordinated surveillance	3	4	2	3	4	3	3	5	4	1	2
	P4.2 Workforce	na	4	3	3	4	2	3	5	2	na	2
	P4.2 Response mechanisms	3	3	3	3	4	2	2	5	3	1	3
Food Safety	P5.1 Surveillance	2	3	2	2	3	2	3	5	3	2	2
	P5.2 Respone mechanisms	2									1	
Biosafety & biosecurity	P6.1 Whole of government systems	2	3	2	2	4	2	3	5	2	1	2
	P6.2 Whole of government training	2	3	2	2	4	1	3	5	2	2	3
Detect												
National laboratory system	D1.1 Priority diseases	4	3	4	4	4	3	4	5	4	3	4
	D1.2 Specimen referral	3	3	2	3	4	3	4	5	3	2	4
	D1.3 National network	3	3	2	3	4	2	3	5	3	2	3
	D1.4 Quality systems	3	3	2	2	3	3	3	5	4	1	2
Surveillance	D2.1 Surveillance system	3	4	4	4	4	4	3	5	4	3	4
	D2.2 Electronic tools	3	3	3	3	4	2	3	4	3	2	2
	D2.3 Data analaysis	4	3	3	4	4	3	2	5	4	3	4
	D2.4 Syndromic surveillance	na	4	4	4	4	3	4	4	4	na	4
Reporting	D3.1 WHO and WOAH - reporting	3	3	3	4	3	3	3	5	3	2	3
	D3.2 Country reporting protocols	2	2	2	4	3	2	3	5	3	2	2
Human resources	D4.1 Workforce strategy	2	3	2	2	3	3	3		3	2	2
	D4.2 Human resources available	2	3	2	3	4	3	3	5	3	2	3
	D4.3 Training	2	na	na	na	na	na	na	5	na	2	na
	D4.4 FETP/epi training	5	4	3	3	5	3	4	5	4	2	3
Respond												
Emergency preparedness	R1.1 Emergency risk assessments	2	2	1	2	4	1	3	5	3	1	5
	R1.2 Emergency response plans	3	2	1	2	2	1	2	4	2	1	2
Emergency operations	R2.1 Emergency operations - coordination	3	2	2	2	3	2	3	4	3	2	4
	R2.2 EOC, procedures and plans	3	3	1	1	3	1	2	4	3	1	4
	R2.3 Operations, exercises	3	3	1	3	3	2	3	5	3	2	4
Public and security authorities	R3.1 Liaison	3	2	2	4	4	2	4	5	3	1	2
Medical countermeasures	R4.1 Systems in place for implementation	3	2	2	2	4	1	4	4	2	1	5
	R4.2 Systems in place for human resources	4	2	2	2	4	2	4	4	2	1	4
	R4.3 Case management	3	3	1	2	3	2	3	4	3	2	2
Risk communications	R5.1 Risk communication systems	3	3	3	2	4	1	3	5	3	2	2
	R5.2 Partner coordination	2	3	3	3	4	3	3	4	3	3	2
	R5.3 Public communications	3	3	3	3	4	3	4	5	3	3	3
	R5.4 Communications with affected communities	3	2	3	3	4	2	4	4	3	3	3
	R5.5 Risky behaviour communications	2	3	3	2	4	2	4	5	3	2	3
Other												
Points of entry	PoE.1 Capacity	4	3	3	3	4	2	4	5	3	2	3
	PoE.2 Response	3	2	2	2	3	2	4	4	2	2	2

24 Note: Only JEE indicators directly relevant to animal health and One Health are included; other countries have recently undertaken a JEE, but the reports are not yet available.

Annex 3: Detailed Livestock Value for Available Countries (FAOSTAT)

Country	Producer price per tonne (USD)	Number animals	Liveweight per animal (kg)	Total liveweight (tonne)	Value (USD)
Indonesia					
Cattle	3806.5	16,432,945	300	4,929,884	18,765,601,543
Chicken	1985.6	2,384,147,000	2	4,768.294	9,467,924,566
Duck	3109.6	60,011,000	2	120,022	373,220,411
Goat	6334	36,119,000	40	1,444,760	9,151,109,840
Pig	2296.1	8,542,000	75	640,650	1,470,996,465
				total	**39,228,852,825**
Malaysia					
Cattle	3717.4	752,547	300	225,764	839,255,465
Chicken	1313.5	321,309	2	643	844,079
Duck	1982.6	10,477	2	21	41,543
Goat	6691.2	581,844	40	23,274	155,729,383
Pig	1623.2	1,654,801	75	124,110	201,455,474
				total	**1,197,325,944**
Mongolia					
Cattle	955.3	4,380,879	300	1,314,264	1,255,516,113
Goat	497.9	28,839,753	40	1,153.590	574,372,521
Pig	1,866.5	27,819	75	2,086	3,894,312
Sheep	729.3	28,839,753	50	1,441,988	1,051,641,593
				total	**2,885,424,539**
Philippines					
Cattle	2042.5	2,553,937	300	766,181	1,564,924,897
Chicken	1900.8	175,772	2	352	668,215
Duck	2407.8	11,220	2	22	54,031
Goat	2620.5	3,754,808	40	150,192	393,578,975
Pig	2194.8	12,604,441	75	945,333	2,074,817,033
				total	**4,034,043,150**
Thailand					
Cattle	2960.1	4,656,654	300	1,396,996	4,135,248,452
Chicken	1064.7	281,684	2	563	599,818
Duck	2106.5	12,373	2	25	52,127
Pig	1723.3	7,908,775	75	593,158	1,022,189,397
				total	**5,158,089,794**
Vietnam					
Cattle	4089.5	5,802,907	300	1,740,872	7,119,296,453
Chicken	4194.8	316,916	2	634	2,658,798
Duck	1978.8	76,911	2	154	304,383
Goat	4640.4	2,683,942	40	107,358	498,182,578
Pig	1822.2	28,151,948	75	2,111,396	3,847,385,973
				total	**11,467,828,186**

Annex 4: Dates of PVS and JEE Evaluation in the Region

Country	Region	PVS Evaluation	JEE
Brunei Darussalam	ASEAN	2008	2019
Cambodia	ASEAN	2018	2017
Fiji	Pacific	2014	
Indonesia	ASEAN	2007	2017
Lao People's Democratic Republic	ASEAN	2012	
Malaysia	ASEAN	2016	2019
Mongolia	E Asia	2019	2017
Myanmar	ASEAN	2018	2017
Democratic People's Republic of Korea	E Asia	2008	
Philippines	ASEAN	2016	2018
Papua New Guinea	Pacific	2015	
Singapore	ASEAN		2018
Thailand	ASEAN	2012	2017
Timor Leste	SE Asia	2011	2018
Vanuatu	Pacific	2014	
Vietnam	ASEAN	2010	2016

Annex 5: Summary of ECTAD Programme in Asia

Country	Client Agency	Year of commencing the engagement	Focus diseases and animal health risks	Areas of support
Cambodia	General Directorate of Animal Health and Production	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation
China[25]	Ministry of Agriculture and Rural Affairs - Animal Husbandry and Veterinary Bureau - China Animal Health and Epidemiology Centre	2005 – 2020	Animal influenza, capacity building (epidemiology, laboratory), AMR	Coordination, capacity development, value chain, policy implementation
Indonesia	- Directorate General of Livestock and Animal Health Services, Ministry of Agriculture - Ministry of Health - Ministry of Environment and Forestry - National Disaster Management Agency - National Agency for the Assessment and Application of Technology	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation

Lao People's Democratic Republic	Department of Livestock and Fisheries, Ministry of Agriculture and Forestry	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation
Myanmar	- Livestock Breeding and Veterinary Department, Ministry of Agriculture, Livestock and Irrigation - Department of Public Health, Ministry of Health and Sports - Department of Forestry, Ministry of Natural Resources and Environmental Conservation	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation
Philippines[26]	Bureau of Animal Industry, Department of Agriculture	2020	Important TADs, AMR	Coordination, capacity development, risk reduction, policy implementation
Thailand[27]	- Department of Livestock Development, Ministry of Agriculture and Cooperatives - Department of Disease Control, Ministry of Public Health - Department of Medical Sciences, MoPH	2005	GHSA, capacity building	Coordination, capacity development
Vietnam	Ministry of Agriculture and Rural Development - Department of Animal Health - Department of Livestock Production - National Agricultural Extension Center - CITES Management Authority	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation
Regional[28]	- Ministries of Agriculture or Livestock in Asia region - ASEAN	2005	Animal influenza, EIDs, priority zoonoses, important TADs, AMR	Coordination, capacity development, risk reduction, emergency preparedness and response, surveillance, value chains, policy formulation and implementation

25 USAID stopped funding for China in July 2020.
26 There is no country project in the Philippines.
27 There is no specific country project for Thailand. Thailand is engaging in regional activities through regional projects.
28 All ASEAN Member States are involved in various regional activities implemented by the RAP programme, such as field epidemiology and laboratory capacity development, ASEAN engagement, etc.

Glossary

Animal products – non-viable materials from animals such as meat, milk, eggs, honey, leather, and other by-products and includes genetic material and biological products.

Antimicrobial– a substance that can kill or inhibit the growth of microorganisms; this includes antibiotics, antibacterials, antiprotozoals, etc.

Antimicrobial resistance (AMR) – the ability of a microbe such as bacteria, viruses, fungi, and parasites to change in ways that render the medications used to cure the infections they cause ineffective.

Biosafety – the set of measures taken to ensure the safe handling of biohazardous materials.

Biosecurity – a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of diseases, infections, or infestations to, from and within a population of people, animals, and plants.

Biocontainment – the containment of extremely pathogenic organisms (such as viruses) usually by isolation in secure facilities to prevent their accidental release especially during research.

Control – in the case of an infectious disease refers to a reduction in the incidence, prevalence, morbidity or mortality of an infectious disease to a locally acceptable level.

Disease-risk taxa – disease risk-taxa would cover all those animal species that are important hosts, carriers or vectors of pathogens

Domesticated animals – are animals that have been selectively bred and genetically adapted over generations to live alongside humans. This includes but is not limited to cattle, goats, sheep, horses, pigs, poultry, dogs and cats.

EAP – East Asia and Pacific

Elimination – the complete removal of a disease, or reduction to zero of the incidences of disease or infection in a defined geographical area, however the disease may re-occur.

Eradication – complete elimination of a disease with negligible risk of it returning e.g., smallpox or rinderpest; eradication is the permanent reduction to zero worldwide incidence. (The pathogen may be retained in high containment laboratories).

Endemic – disease or infection that occurs most of the time in a given geographic area or species population sub-group.

Emerging infectious diseases – diseases caused by novel pathogens (through adaptation or evolution and host switching), variants of known pathogens, re-emergence of old pathogens in known or novel geographies, and diseases caused by antimicrobial resistance organisms.

Emerging zoonoses – new infections transmissible from animals to humans resulting from the evolution or change of an existing pathogen. Note that many transmissible agents that animals carry are not the cause of the human disease where human maintenance of the pathogen occurs and most infection is human to human e.g., COVID-19.

Epidemic – disease occurrence in animals or persons over a particular time and in a particular geographical area-species population sub-group that is higher than normal.

Epidemiology – the study of the distribution, patterns and determinants of health and disease in defined populations of humans, animals, or plants. It is a cornerstone of public health, and shapes policy decisions and evidence-based practice by identifying risk factors for disease and targets for preventive healthcare.

Feral animals – are animals that have escaped from a domestic or captive status and are living more or less as a wild animal, or that are descended from such animals.

Immunity – is the ability of an individual (human or animal) to resist a particular infection or toxin by the action of specific antibodies or sensitized white blood cells.

Incidence – (in epidemiology) is a measure of the probability of occurrence of new cases of a given disease/infection in a species population or a particular sub-group within a specified period of time in a particular geographical area.

Livestock – commonly defined as domesticated animals raised in an agricultural setting to produce labor and commodities such as meat, eggs, milk, fur, leather, and wool.

One Health – a collaborative cross-sectoral, multidisciplinary approach aimed at strengthening systems to prevent, prepare, detect, respond to, and recover from infectious diseases and related public health threats such as AMR that threaten human, animal and/or environmental health.

Outbreak – increase in the number of cases of disease or infections in a population of animals or persons in a particular geographical area and usually over a short time period, above what is normally observed.

Pandemic – is an epidemic that has spread over multiple countries or continents, usually affecting a large number of individuals (animals and or humans) simultaneously.

Pathogenicity – capacity of a microbe to cause damage in a host (while virulence refers to the degree of damage caused by the microbe).

Peri-domesticated animals – animals living in and around human habitations.

Prevalence – (in epidemiology) is the proportion of a particular species, population or a sub-group found to be affected by a disease/infection at a specific time.

Public Private Partnerships (PPP) – a cooperative arrangement between two or more public and private sectors, typically of a long-term nature.

Risk – the likelihood of a specified hazard occurring; the probability of suffering damage or harm.

Supply chain – the sequence of processes involved in the production and distribution of a commodity.

(Disease) Surveillance – is the ongoing systematic collection and analysis of data and the provision of information which leads to action to prevent and control a disease.

Threat – the potential damage or harm.

Transboundary Animal Diseases (TADs) – major epidemic diseases which are highly contagious or transmissible with the potential for rapid spread, including across national borders.

Transmissibility – capacity of a pathogen/microbe causing a communicable disease from an infected host individual or group to a particular individual or group, (regardless of whether the other individual was previously infected).

Value chain – the processes or activities which add value to an article, including production, marketing, and the provision of any follow-up/after-sales service.

Veterinarian – person with appropriate education, registered or licensed by the relevant authority in a country to practice veterinary medicine and surgery.

Veterinary paraprofessional – person authorized to carry out certain designated tasks which are delegated and under the responsibility of a veterinarian.

Veterinary services – both the government and non-government services that implement animal health and welfare measures in a country.

Wildlife – wild free-living animals, including feral animals (non-native animals that have become established in the wild).

Wildlife farming – captive animals normally found in the wild, as opposed to domesticated animals/livestock.

Zoonosis – a disease that is naturally transmissible between vertebrate animals and humans. Note that an ongoing zoonosis requires a maintenance host (animal or human reservoir). The term reverse zoonosis (or anthroponosis or zooanthroponosis) refers to a disease transmissible from humans to vertebrate animals.

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Investing in One Health – cross-sectoral, multidisciplinary coordination and collaboration across the human health, animal health, and environmental health sectors – is crucial for maintaining healthy agricultural and food systems and addressing global health security risks. Such action can reduce the threat of future pandemics through upstream preventive actions, early detection, and agile responses to zoonotic and emerging infectious diseases outbreaks, coupled with measures for promoting food safety, including anti-microbial resistance. This regional review, conducted jointly by the World Bank and the Food and Agriculture Organization of the United Nations, assesses the socioeconomic impacts of zoonotic diseases and epidemics across the East Asia and Pacific region, providing a background on why emerging infectious diseases are occurring more frequently in this region. This review looks at the benefits of using a risk-based approach, assesses the management of animal and wildlife health and the ability to identify and respond to emerging threats and protect the health, agricultural production, and ecosystem services. It provides recommendations on priority activities to be undertaken, and offers governments and their development partners the evidence and analysis needed to make more and better investments in wildlife systems and animal health to improve global health security.

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