POLICY PAPER 104

One World, One Health

NATIONAL ACADEMY OF AGRICULTURAL SCIENCES NEW DELHI
February 2022

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CITATION : NAAS 2022. One World One Health. Policy Paper No. 104, National Academy of Agricultural Sciences, New Delhi, pp 28

Published by Executive Director on behalf of
NATIONAL ACADEMY OF AGRICULTURAL SCIENCES
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Preface

Public health issues have become complex because of a strong human-animal-plant-environment interface. Emerging and re-emerging infectious diseases first occur in animals and are then transmitted to humans. Examples are HIV, Ebola, Nipah, Hendra, Highly Pathogenic Avian influenza H5N1, Severe Acute Respiratory Syndrome (SARS) and COVID 19. Around 60% of the infectious diseases in humans have linkages with animals. Zoonotic diseases, thus, can have severe implications for the societal and economic health of the nations.

The concept "One World, One Health" emphasizes the non-separability of human, animal, plant, and environmental health. Each component needs adequate attention to ensure a safe, secure and healthy life for humans. Achieving this requires collaborative, multisectoral, and transdisciplinary approaches at different geographical scales that recognize interconnections among humans, animals, plants, and their shared environment. The "One Health" approach focuses on the consequences, responses, and actions at the animal-human–plant-ecosystem interface. It is, therefore, essential to search for optimal solutions along this interface collectively.

Keeping this in view, the National Academy of Agricultural Sciences (NAAS) organized a brainstorming session, "One World, One Health", on September 19, 2020, to evolve a comprehensive strategy for strengthening the interface among different components of "One Health". A galaxy of academicians and researchers participated in this. I gratefully acknowledge their contribution and thank Prof A. K. Srivastava and Dr R. S. Aulakh for putting together their views and suggestions in the form of this document. Thanks to Drs P.S. Birthal and Malavika Dadlani for their editorial support. I am sure that this document will be helpful to academicians, policymakers and other stakeholders in ensuring a healthy interface between humans, animals and plants in their shared environment.

(Trilochan Mohapatra)
President, NAAS

January 2022
New Delhi

One World, One Health

1. BACKGROUND

The concept of "One World, One Health" can be traced back to at least two hundred years. Initially, the idea was termed as "One Medicine". Over time, it was refined, recognized, acknowledged, and adopted by the scientific community and policymakers as One Health. It may be mentioned that "One World, One Health" is also a trademark of the Wildlife Conservation Society, New York (USA). The concept conveys that the health of animals, humans, plants, and environment are interlinked, and their integration is essential to ensure good health for all. Adopting this concept will change the planet's health, besides offering scope for cooperation, coordination, and collaboration among multiple actors and sectors. The recent focus of "One World, One Health" has been studying emerging and re-emerging infectious zoonotic diseases. However, it cuts across the disciplinary boundaries and embraces environment, ecosystem, land use, biodiversity, non-infectious and chronic diseases, antimicrobial resistance, regulations and policies.

There are several definitions of "One Health". The Food and Agriculture Organization of the United Nations, on reviewing these, conclude that "One World, One Health" stands for collaboration among human, animal and environment sectors across different scales (local, national and global) for achieving the objective of good health for all.

Recently, several events regarding the evolution of zoonosis and zoonotic diseases and the "One World, One Health" have occurred. The key events are listed below:

One World, One Health

- "One World, One Health" is a broader concept where humans, animals, plants and the environment are inseparably linked, and each of these needs equal attention to ensure optimal health for all.
- "One World, One Health" is a collaborative, multisectoral, and transdisciplinary approach, working at the local, regional, national, and global levels to achieve optimal health outcomes, recognizing the interconnection between people, animals, plants, and their shared environment.

Period	Events
1800s	• Rodolf Virchow (1821-1902), a German Physician and Pathologist, reported that "Between animal and human medicine, there is no dividing line, nor should there be. The object is different, but the etiology and the basis of treatment are same for both medicine". Virchow also studied the pathogenesis of trichomoniasis in pigs and humans, TB and Cysticercosis in cattle and humans, and noted the link between the diseases of humans and animals and coined the term **"Zoonosis"**. • There was global pandemics of Bubonic plague, Yellow fever and Cholera, which spread from rats and other animals. This further emphasized the concept of zoonoses. • William Osler: Established the relation of animals to man in transmitting many other diseases.
1900s	• James H. Steele: Founded the Veterinary Public Health Division at CDC (1947). • Calvin Schwabe: Coined the term "One Medicine". • Pandemics: Influenza, Epidemic typhus and Cholera. • Infectious bacterial and viral diseases emerged: HIV, Lyme disease, Ebola, Marburg, Enterohaemorrhagic E. coli, Listeriosis, Rift Valley fever, Nepah, Hendra, Dengue, West Nile fever. • Antimicrobial resistance, food safety and climate change.

2000s	• **2003**: Severe Acute Respiratory Syndrome (SARS). • **2003**: Highly Pathogenic Avian Influenza A (H_5N_1) • **2004**: The Wildlife Conservation Society published 12 Manhattan Principles highlighting the importance of animal health and ecosystem health in preventing zoonotic diseases in humans. • **2005**: Establishment of United Nations Systems for Influenza Coordination (UNSIC). • **2005**: Implementation of Asia Pacific Strategy for Emerging Diseases (APSED). • **2006**: Development of Global Early Warning System (GLEWS) by WHO, FAO and OIE for major animal diseases. • **2007**: “One Health Initiative Taskforce” formed by the American Veterinary Medicine Association. • **2008**: FAO, OIE, WHO, UNICEF, World Bank and UNSIC developed a joined strategic document entitled ‘Contributing to “One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface.” • **2009**: H_1N_1 influenza pandemic. • **2009**: Establishment of One Health Commission. • **2009**: Formation of One Health Alliance of South Asian (OHASA). • **2010**: Tripartite Concept Strategy: An FAO-OIE-WHO collaboration to address health risks at the animal-human-ecosystems interface. • **2011**: Crimean-Congo Hemorrhagic Fever (CCHF).
	• **2011**: First international One Health Congress was held in Melbourne, Australia. • **2011**: Formation of One Health Central and Eastern Africa (OHCEA). • **2012**: Middle East Respiratory Syndrome (MERS) disease. • **2014**: Outbreak of Ebola virus in West African countries. • **2015**: Zika virus epidemic. • **2016**: One Health Day on 3^{rd} November. Coordinated by the One Health Commission, the One Health Platform, and the One Health Initiative Team. • **2018**: Outbreak of Nipah virus in India. • **2019-20**: COVID-19 pandemic.

2. APPLICATION OF “ONE WORLD, ONE HEALTH”

The “One World, One Health” focuses on the consequences, responses, and actions at the animal-human–ecosystem interfaces across a range of public health issues that have severe health implications. The main areas are (i) Zoonoses, (ii) Food Safety, (iii) Antimicrobial Resistance (AMR), (iv) Ecosystem and Environmental Health, (v) Non-communicable Diseases, and (vi) Beneficial Microbes.

Public health issues have evolved into complex, difficult to handle in an increasingly interconnected world focusing on human health alone. As seen in the last few decades, emerging and re-emerging new infectious diseases were first observed in animals and then spilt into humans. Examples include HIV, Ebola, Nipah, Hendra, Highly Pathogenic Avian influenza H5N1, Severe acute respiratory syndrome (SARS), Middle East Respiratory Syndrome (MERS), and the current COVID -19 pandemic.

There are several factors associated with the emergence and re-emergence of infectious diseases. These include rapid increases in human and livestock populations, growing urbanization, changing farming practices, increasing interaction between livestock and wildlife, encroachment of commons, changes in ecosystems, and the increasing trade in food and animal products. International travel and illegal trade of animal and animal products and by-products have also contributed to diseases. The drastic increase in the poultry population has impacted the emergence and spread of H5N1 strain, the highly pathogenic avian influenza virus in China. Wildlife also has a role in the transmission of zoonotic pathogens. The role of migratory birds in spreading HPAI and 'bush meat' in Ebola is well known. Destruction of forests results in increased interaction between humans and animals, hence the spread of pathogens.

The antimicrobial drugs gradually lost their efficacies due to their injudicious and non-therapeutic uses in human and animal health. Moreover, with increasing trade, the food industry underwent rapid changes (e.g., technology and consumer preferences), exposing consumers to newer food-borne infections. On the other hand, environmental degradation, global warming, and climate change are altering the natural balance, increasing pathogens, pathogenicity, and the movement of vectors (dengue and malaria). Other factors such as rising income, changing food preferences, increasing air travel, adventure tourism, intensification of agricultural systems contribute to growing complexities of public health. These complexities cannot be handled singularly by any one agency unless (i) the expertise is brought together to understand nuances, (ii) the decision-making agency is made multisectoral for better planning, (iii) the resources from various agencies are mobilized to meet demands, (iv) hands are joined to execute integrated plans, and (v) a new pathway of addressing complex health challenges are developed. This multisectoral approach is embodied in the concept of 'One World, One Health.

2.1 Zoonoses

Zoonoses are infectious diseases common to vertebrate animals and humans and are transmitted from animals to humans or vice versa. Many zoonotic pathogens such as *Brucella* species, *Yersinia pestis and Listeria monocytogenes* bacteria and influenza viruses have their host range in animals and humans. Other zoonotic pathogens such as *Taenia solium* involve humans and animals to complete their life cycles. Additionally, animals serve reservoirs of many zoonotic pathogens.

Zoonoses

Infections naturally transmissible from vertebrate animals to humans and vice-versa are classified as zoonotic diseases (WHO, 2009).

- Zoonoses are the most dreaded and frequent risk the humans are exposed.
- 75% of emerging diseases that affected humans over the last two decades were not due to pathogens of animal origin.
- About 80% rural population of India is under threat of acquiring zoonotic diseases because of their intimate association with animals.
- July 6 is celebrated as World Zoonoses Day. On this day in 1985, Louis Pasteur administered the first rabies vaccine to humans.
- Ethiopia, Nigeria, Tanzania, and India have the highest zoonotic disease burden.

Source: Kotwal et al. (2006)

Mode of Transmission of Zoonotic Pathogens	
Contact	
Direct contact	Buffalopox, Cowpox, Scabies
Inhalation	Bird flu, Aspergillosis, Influenza
Bite (Animal & vector)	Rabies, Plague, Japanese, encephalitis, Trypanosomiasis
Abraded skin/ wound infection	Tetanus, Anthrax
Ingestion (Food-borne Disease)	
Milk	Salmonellosis, Brucellosis, TB, Listeriosis, Cambylobacteriosis
Meat	Taenia *solium*, T. *saginata*, Trichinella, Cysticercosis
Fish	Diphyllobothrium (fish tapeworm)
Poultry/ eggs	Salmonella, Campylobacterium

Type of Zoonoses

1. **Direct zoonoses:** disease is directly transmitted from one vertebrate to a human, e.g., Anthrax, rabies and Brucella.
2. **Cyclozoonosis:** requires more than one vertebrate host to complete the lifecycle, e.g., cestodes and hydatid cyst disease.
3. **Metazoonosis:** disease is transmitted from animals to humans by one intermediate vector, e.g., Japanese encephalitis and yellow fever.

The zoonotic diseases in South East Asia are grouped as Endemic, Re-emerging and Emerging diseases with Endemic potential

Neglected zoonotic diseases (NZDs): The neglected zoonotic diseases affect the poor people in resource-poor countries. The endemicity and seriousness of NZDs such as rabies, brucellosis, cystic echinococcosis (CE), and porcine cysticercosis (PC) in India are well known (Knobel et al., 2005; Singh et al., 2016). It has been reported that in India, annually, the US $ 212.35 million are lost due to CE (Singh et al., 2014). and US$ 3.4 billion due to brucellosis (Singh et al., 2015). Note that 19,713 human deaths occur in India due to rabies (Knobel et al., 2005).

New and emerging infectious zoonotic diseases: Emerging and re-emerging zoonotic diseases pose a severe threat to animal and human health. Of the 1415 species known to be pathogenic to humans, 61% (868) are zoonotic, and 175 pathogenic species are associated with emerging diseases, of which 132 are zoonotic (Taylor et al., 2001). The emergence and re-emergence of zoonotic diseases are not new. In the last few decades, the outbreaks of infectious diseases emerging from animal reservoirs to infect humans have increased. Ebola virus, highly pathogenic avian influenza (HPAI) viruses H5N1, H1N1 and the Severe Acute Respiratory Syndrome (SARS) coronavirus and Middle East Respiratory Syndrome (MERS) coronavirus are the examples. Many pathogens originate in wildlife and create havoc on human health, for example, the recent novel SARS-CoV-2.

New Emerging Viral Zoonotic Diseases		
After 1970, many new viral zoonotic diseases are reported, which are emerging & re-emerging in nature		
Rota virus	-	1973
Ebola and Marburg virus	-	1977
Hanta virus	-	1978
Bird Flu (Avian influenza) H5N1 virus	-	1997
Nipah virus	-	1999
Arena virus (Lassa fever)	-	2003
Severe Acute Respiratory Syndrome (SARS) Coronavirus	-	2003

Zoonotic Diseases

- Of the five new human diseases appearing every year, three are animal origin.
- 80% of the microbial agents of potential bioterrorist use are zoonotic pathogens.
- Globally, about 2.6 billion people suffer and 2.7 million die every year due to zoonotic and vector-borne illnesses.
- Of the one million enzootic viruses in animals, about 50% can invade humans (SARS, MERS, Influenza, Corona).

NAVSI (2010)

Endemic and emerging zoonotic diseases cause human mortality and morbidity. There has been a significant increase in the emergence of new zoonotic diseases and the risk of pandemics. Many drivers of these zoonotic diseases fall beyond the domain of the human health system; hence an emphasis on cross-sectoral actions to strengthen global health security under the umbrella of "One Health". Prevention and control of most of these zoonotic pathogens involve collaborative efforts of medical, veterinary and eco-health specialists. For example, *Taenia solium,* a cestode causing severe clinical disease in humans [e.g., Neurocysticercosis (NCC)] and substantial economic loss in pig farming (due to condemnation of meat), can be controlled by following the "One Health" approach only. Some most dreaded zoonotic diseases are discussed below.

- ### Rabies

Due to paralysis of deglutition muscle, the patient develops a fear of drinking water, i.e., "hydrophobia". Rabies is caused by Lyssavirus and is transmitted from animals (i.e., dog, cat, cattle and buffalo) to humans through the bite or contact with infected saliva. As the virus remains in very high concentration in saliva, the infection may even occur by licking from infected animals. Rabies is present in all continents, except in Antarctica. Approximately 40% of people bitten by rabid dogs are children under 15. In the US, bats are now a major source of human rabies. Worldwide about 59,000 people die every year. Every year, in India alone, 25,000-30,000 people die due to rabies (15 million require vaccination), and in 99% of cases, it is through a dog bite. It is the only communicable disease of the man with 100% mortality. Infection from man to man and through food is rare. The "Rabies" has been included in WHO's "One Health" roadmap for 2021-2030 for its control and eradication, and it has launched the "United Against Rabies" Forum (WHO, 2021a; CDC, 2020).

- ## Plague

Plague is an infectious, acute and highly fatal disease caused by *Yersinia pestis* bacterium and transmitted by the bite of infected rat fleas. It is a primary disease of rodents and small mammals. Two significant plague pandemics were recorded in 6th in Egypt 14th century in Europe. There are three types of plague: (i) Bubonic (inflammation of lymph node), (ii) Pneumonic, (iii) Septicemic. The pneumonic form of the disease also spreads to humans via air droplets. In India, the Bubonic plague killed 12 million people in 1889, and the subsequent plague pandemic that occurred in 1898 killed 12.5 million people. The most plague endemic countries are Congo, Madagascar and Peru. Between 2010 and 2015, globally, 3248 cases of plague with 584 deaths were reported(Sanburn, 2010; John, 2016; Nicholas, 2020)

- ## Anthrax

Anthrax is a bacterial *(Bacillus anthracis)* zoonotic disease mainly of herbivores (cattle, sheep, goat and wild animals). The animals are more susceptible to *B. anthracis* than human beings, and *the soil spore is the major source of infection in grazing animals*. The organism *Bacillus anthracis* forms spores when the bacteria contact air. There are three forms of the disease, i.e., cutaneous, intestinal and pulmonary, intestinal and pulmonary are fatal. Anthrax spores released in the air can cause human death. Humans are infected through contact with infected animals or by inhaling spores. Butchers, veterinarians, pathologists, and persons involved in wool, hair, and hide processing are at a greater risk of infection. Contaminated animal products are also a source of infection. Each infected bovine can affect ten humans by consuming uncooked meat, unpasteurized or poorly boiled milk. Globally, 20,000-100,000 cases of human anthrax are reported (Charles, 2020).

- ## Japanese Encephalitis

It is a mosquito-borne zoonotic viral disease from pigs, birds and horses. The virus-carrying mosquitoes usually bite during the night, not transmitted from person to person. It is caused by a flavivirus, for which pigs and birds are the primary carriers. It is a leading cause of acute encephalopathy in children in tropical and subtropical countries. It is endemic in India, Bangladesh and China. Every year, in Asia, there occur about 70000 cases, of which more than half are in India. In India, the disease appeared first in 1955, and the first outbreak was reported in 1973 from West Bengal. Presently, 16 states of India are at risk. Rural children are mostly infected between July-October (during rice cultivation). In 2007, in eastern Uttar Pradesh, 220 children died due to Japanese encephalitis. Again in 2018, as many as 1745 cases were reported, and 1360 children died. *Rice cultivation and ill-planned piggeries have a bearing on its epidemiology* (Halstead and Jocobson, 2008)

- ## Avian Influenza

Avian influenza is also known as ‘Bird Flu’ or ‘Avian Flu’ and is a zoonotic viral disease. The virus is naturally adopted in wild waterfowl; it spreads to domestic poultry, including chicken, ducks, and turkey. It is transmitted via contact with faeces and secretions from the infected birds’ noses, eyes, and mouths. Of three types of influenza viruses (A, B, C), influenza A virus is zoonotic with a natural reservoir in birds. Of the 100 strains of influenza virus A, Only 4 (H5N1, H7N1, H7N7 and H9N2) are known to cause human infection, and H5N1 is the primary zoonotic virus. The virus H5N1 was first detected in 1996 in geese in China and 1997 in humans in Hongkong. Since then, avian influenza has infected birds, humans, and mammals in more than 50 countries. The incubation period is seven days. It initially causes typical flu-like symptoms and then failure of multiple organs in humans. In India, the first bird flu was reported in 2006 in Maharashtra, and from then, 25 episodes in 15 states have been reported, but no case of bird flu in humans has been reported. Globally, from January 2003 to June 2021, there were 862 cases of human infection with H5N1 in 17 countries, with 455 death. There is no report of the spread of disease in humans from eating properly cooked poultry meat, eggs and other poultry products. (Humberd et al., 2006).

- **Severe Acute Respiratory Syndrome (SARS)**

It is a contagious and fatal respiratory disease caused by the coronavirus. It appeared in 2002 in China and spread worldwide (29 countries) within a few months. In China, it originated from the meat of bats and other wild animals, as 99.6% nucleotide sequence homology has been established between human and animal coronavirus. In humans, the SARS disease is transmitted through droplets. Globally, 8422 cases of SARS with 916 deaths have been reported in humans. However, since 2004 there have not been any established known cases of SARS-coronavirus outbreak in humans. *In December 2019, SARS-CoV-2 (another strain of SARS-Cov) was identified and named Corona Virus Disease 2019 (COVID-19), resulting in a pandemic* (Fouchier, 2003; Rat et al., 2020).

- **Tuberculosis**

Tuberculosis, caused by *Mycobacterium tuberculosis*, usually attacks the lungs. Robert Koch discovered M. tuberculosis (causative organism in humans) in 1881 and M bovis (causative organisms of cattle and buffalo) in 1898. Tuberculosis is spread through air droplets. In the 20th century, TB was a leading cause of human deaths, but in the present day, most TB cases can be successfully treated and cured with high-end 3rd/4th generation antibiotics. BCG vaccination is effective if administered in childhood. However, WHO has recommended vaccination of health workers. In 1993, WHO declared TB a global emergency as about 1/3rd of the population (2 billion) carried infection, while only 5-10% developed the disease (active TB). It is reported that globally, 8 million new infections and 2 million deaths occur due to tuberculosis every year. In 2019, ten million people suffered from TB (5.6 million men, 3.2 million women and 1.2 million children). India has the highest incidence of TB, followed by China, Indonesia and Bangladesh. *In India, about 40% of the population is sub-clinically infected, and there appear 1.8 million new cases every year, killing more people than HIV, STD, Malaria, Leprosy and Tropical diseases together, and a loss of Rs. 130 billion* (Bapat et al., 2017; WHO, 2021b).

- **Bovine Tuberculosis**

The pathogenic species of mycobacteria of humans and animals are collectively called the mycobacterium tuberculosis complex (MTBC), comprising of *M. tuberculosis*, *M. bovis* and others. *M. bovis* (bovine tuberculosis) has a wide range of hosts, including cattle, buffaloes, wildlife and humans. Humans can be infected with *M. bovis* by inhaling the infective droplets or consuming raw milk and meat from infected animals. More than 3% of tuberculosis in humans in developed countries is not due to *M. tuberculi* but due to *M. bovis,* and it is 10-16% in developing countries.

- ## Brucellosis

Brucellosis is a widespread zoonotic disease found in 86 countries. There are five species of Brucella, i.e., *B. abortus*, *B. melitensis*, *B. ovis*, *B. canis*, *B. Suis*, which infect cattle, buffaloes, pigs, goats, sheep, dogs and humans. *B. melitensis* is the most prevalent cause of human brucellosis. Brucellosis is rampant in bovines in India, with a prevalence rate of at least 20%. In animals, the main symptoms are abortion, retention of the placenta, architis and epidedysmitis. In canine, brucellosis is sexually transmitted, causing infertility in males. In animal treatment, humans (primarily veterinarians) acquire infection through direct contact (percutaneous, conjunctival or nasal nucosa) with infected animals. Unpasteurized milk is also one of the major sources of infection. In humans, the symptoms of the disease are not restricted to only reproductive organs, as in the case of animals. *The joint pain and arthritis symptoms are very severe in human brucellosis* (Yadav and Srivastava, 2012; Singh et al., 2015; Singh et al., 2018).

- ## Paratuberculosis

Mycobacterial avium paratuberculosis affects cattle, sheep, camels, goats, and chickens and causes Johne’s disease, one of the most complex animal diseases. In humans, *M. avium* paratuberculosis causes Crohn’s disease (CD); a chronic inflammatory bowel disease (abdominal pain, diarrhoea, bleeding, obstruction), including ulcerative colitis and rheumatoid arthritis. *In humans, the aetiology, pathogenesis, and symptoms of Crohn’s disease are similar to Johne’s disease in ruminants*. *M. paratuberculosis* has been isolated and cultured from 100% of humans with Crohn’s disease in the US, Australia, the Netherland and France. Globally, in 2015 about 11.2 million people were affected, with 47,400 death. The incidence of Crohn’s disease is increasing in South America. Presently, 1.4 million people in the US are infected with *M. avium paratuberculosis.* Although it cannot survive outside the host, it is present in dairy and meat products and can stay for months in soft cheese and ten months in hard cheese (Collins, 2021).

- ## Listeriosis

It is a significant bacterial disease of bovine, sheep, goat and poultry. The organism is found in soil, feed, faeces and milk. In animals, the disease manifests with an infection in the uterus, causing metritis, abortion, septicaemia, mastitis and meningoencephalitis. It is reported that almost 98% of human listeriosis and 85% of animal listeriosis cases are due to listeria monocytogenes. It is a resistant and opportunistic pathogen in both humans and animals. It causes a range of symptoms from flu to gastroenteritis, muscular and joint pain, and abortion and stillbirth in pregnant women. It also causes meningitis and septicemia with a 20-30% fatality rate. *In humans, the infection usually occurs by consuming uncooked/half-cooked/unboiled/contaminated animal-source foods*. It received little attention until an outbreak of food poisoning due to *L. monocytogenes* in 1980 in Germany. In the US, 1600 cases of human listeriosis with 260 death were reported in 2017 (Al Holy et al., 2018)

3. FOOD SAFETY

More than 250 microbial agents, including bacteria, viruses, parasites, and chemicals, contaminate food and cause food-borne illness. Most of the food-borne diseases are zoonotic (e.g., *E. coli* O157:H7 and *Campylobacter jejuni*) or geonotic (which are widespread in the environment (e.g., *Listeria monocytogenes* and *Bacillus cereus*) in origin. However, in some cases, the human can also be a source of contamination (e.g., Hepatitis A and *Staphylococcus aureus*).

Food-borne Zoonotic Diseases
• Food-borne zoonotic diseases remain a significant cause of morbidity and mortality in developing and developed countries. • About 1/3rd of the population in developed countries is affected by microbiological food-borne diseases, while the problem is likely more severe in developing countries. • In India, food-borne diseases cause 75 million illnesses, 3,25,000 hospitalization and 18000 deaths every year. • Food safety is no longer an issue of a public health issue, but it is also an issue of the food marketing system. The focus on "food safety" in international trade has also made it a critical "trade issue". Source: WHO (2015); Annual Report of OPZD 2014 to 2019

The advent of modern food processing technologies also triggered concerns for food safety. The widespread use of refrigerated ready-to-eat food cast doubt on food safety, especially about psychrophilic pathogens (e.g., *Aermonas* sp., some strain of *Bacillus cereus*, *Yersinia enterocolitica* and *Listeria monocytogens*). In addition, the challenge due to pesticide and antibiotic residues in food also warrant a robust "One Health" framework to act upon. The important food-borne diseases are:

Most Important Emerging Animal Food-borne Pathogens	
o Salmonella Species o Campylobacter Species o Haemorrhagic E. coli o M. tuberculii and M. bovis o M. avium subspecies Paratuberculli	o Toxoplasma gondi o Crytosporodium o Vibro species o Aeromonas species o Clostridium perfringens
o Listeria monocytogenes o Brucella Species o Leptospira Species	o Norovirus o Hepatitis A and Hepatitis E o Rotavirus
• Most outbreaks of animal food-borne diseases occur due to bacteria and viruses. • WHO's first-ever global estimates of food-borne diseases show that about one-third of the death of children under five years is due to food-borne zoonotic diseases.	

The number of food-borne disease outbreaks has been increasing. The diverse approaches to food safety worldwide make it challenging to implement a unified, risk-based approach. The "One World, One Health" approach is required to prevent and control the outbreak of food-borne diseases and food poisoning. In India, as a part of the consolidation process, the Food Safety and Standards Authority of India (FSSAI) is the central food regulatory authority to address all issues related to food safety and standards. The Food Standards Act intends to promote the science-based standards for food items and regulate their manufacturing, storage, distribution, sale, and import. In association with global agencies like Codex Alimentarius Commission (a joint intergovernmental body of the Food and Agriculture Organization and WHO), the FSSAI regularly formulates and revises its guidelines/standards as per the modern international food safety and quality standards for "building healthy India with safe food".

Transboundary Animal Diseases: A Serious Threat to Food Safety and Security
• African Swine Fever (ASF) is a transboundary disease affecting swine with a 100% fatality rate. • China is the world's largest producer (50%) and consumer of pork. ASF outbreak in China in 2018 resulted in a 50% reduction in pig population and a 45% increase in meat imports. • Avian influenza (AI), PPR and FMD are other important transboundary diseases requiring a "One World-One Health" approach for their control and eradication. • BSE in the US and HPAI in Thailand caused a loss of $1 billion each in bovine and poultry. Source: Domenech *et. al*.(2006); Ward (2020)

4. ANTIMICROBIAL RESISTANCE

Antibiotics are used to treat infectious diseases. However, their overuse and misuse may cause antibiotic resistance. Antimicrobial resistance (AMR) is a phenomenon when microbes are no longer killed, or their growth is halted by using antimicrobial drugs that were once effective. These resistant microbes (very often pathogens) are called 'Superbugs'. Though the emergence of resistance is reported for many classes of microbes, their effects on public health are more significant due to bacterial pathogens.

Antimicrobial resistance is a major challenge. Addressing its threat requires a holistic and multisectoral "One Health" approach, as the antimicrobials used to treat infectious diseases in animals are the same as used for human diseases. Resistant microbes in humans, animals or the environment may spread from one subject to another and from one location to another. AMR does not recognize geographic or human-animal borders. The antibiotic resistance gene reservoirs of bacteria are augmented by the continuous influx of resistance genes from animals and human waste into the environment. These are supplemented by the entry of antibiotic residues from pharmaceutical industries, intensive livestock farming, injudicious use of antibiotics in health services and hospitals, and crop production.

While the development of AMR in bacteria and other microbes is a biological phenomenon, recently, bacteria's resistance to antimicrobial drugs has started posing a challenge to modern medicine. The medical, social, and economic costs associated with AMR are huge and can retard the global progress towards achieving the millennium goals. Bacteria, when developing antibiotic resistance, infections are harder to treat. Globally, antibiotic-resistant bacteria cause at least 2.8 million illnesses and more than 35,000 deaths every year (CDC, 2020). By 2050, the global annual human deaths due to drug-resistant pathogens may increase from 700,000 to 10,000,000, if no actions are taken. The economic costs associated with loss in global production due to AMR by 2050 are estimated to be the US $ 100 trillion (Jim O' Neill, 2016). By 2050, as the proportion of the projected GDP of the top 32 countries in 2050, which is 259.28 trillion US$ (Price Waterhouse Coopers, 2017), approximately 38% of the global GDP will be lost due to AMR. Although such estimates are not available for India, antibiotic-resistant neonatal infections cause about 60,000 deaths annually (Laxminarayan et al., 2013).

Several factors are responsible for increasing antimicrobial resistance. In countries like India, where antibiotics are available without a prescription, their over-prescription is the leading cause of antibiotic resistance. Lack of policies for controlling infectious diseases in humans and animals leads to more infections and, thus, more antibiotics. Among disposing factors, the injudicious use of antimicrobials in livestock and poultry for therapeutic and non-therapeutic purposes is considered important. Evidence indicates a likelihood of the spread of resistant microbes from animals to humans. The drug-resistant bacteria may also infect humans through the food chain. Although an accurate estimate is lacking, globally, more antimicrobials are used to treat animals than humans.

Antimicrobial residues in the environment promote resistance among non-target bacteria. Although there is no information on an environmental load of antibiotic residues, it requires action to assess the relationship between environmental antibiotic residues and the expression of resistant traits. Horizontal gene transfer across various classes of bacteria is a key to the spread of resistance among bacteria (Aminov, 2011).

There are many known drivers of AMR. These are biological (bacterial physiology), anthropological (human behaviour), agricultural (crop and animal husbandry practice), medical (clinical application of antibiotics, lack of access to healthcare), social (sanitation), veterinary (veterinary usage of antibiotics), industrial (effluent discharge from pharmaceutical plants), commercial (over-the-counter sale of antibiotics, counterfeit medicines, and unavailability of newer antibiotics), and legal (unregulated sales of Schedule H drugs, poor enforcement of pollution control norms). Containment of AMR, therefore, requires action in each of these areas. A meaningful action requires specialists from human and animal health fields to make AMR a quintessential “One World, One Health” problem. Global agencies like WHO, FAO, OIE and World Bank have been furthering the cause of “One Health” (Kahn, 2017; Queenan et al., 2016; Van Puyvelde et al., 2018).

To minimize AMR, collective action is crucial to ensure that antimicrobial agents effectively cure diseases in humans and animals. Human and animal public health agencies should coordinate in evolving public health policy and designing strategic interventions to combat AMR. The holistic approaches using “One Health” teams must be adopted to control and tackle the menace of antimicrobial resistance. All stakeholders, including veterinarians, health professionals, the general public, farmers, livestock and healthcare industries and policymakers, must be a part of the “One Health” approach (Fig. 1).

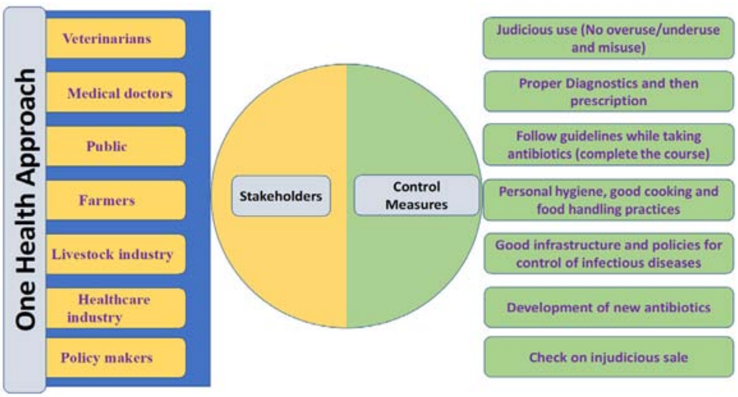

Fig. 1. One Health approach to combating antimicrobial resistance

5. ECOSYSTEM AND ENVIRONMENTAL HEALTH

There are four pillars of environmental health: soil, water, air and biodiversity, and "One Health" consists of the triad of human health, animal health, and the environment (Fig. 2). The ecosystem is more responsible for spreading diseases in humans and animals. It has started gaining attention because of climate change and its adverse effects on the health of humans, animals, and the environment. Moving from a reactive, typically resource-intensive, curative, prevention and preparedness through the "One Health" approach is crucial for environmental health.

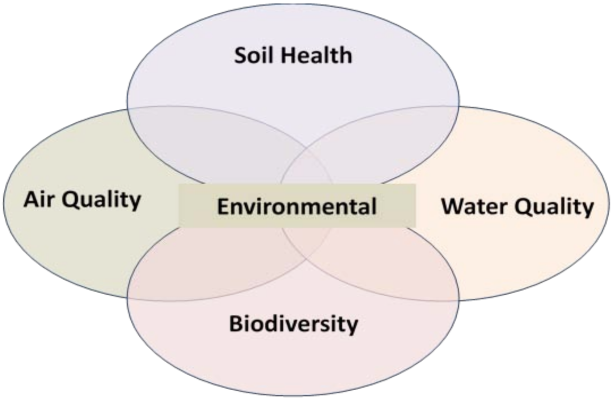

Fig. 2. Four pillars of environmental health

The application of the "One Health" approach has successfully been demonstrated for risk assessments and the effective regulation of the spread and persistence of toxic substances (pharmaceuticals including antimicrobials, chemicals and pesticides) in the environment (Bousfield and Brown, 2011). The "One Health" concept also emphasizes that the healthcare providers, industries and agricultural farms should manage their waste disposal efficiently and regularly monitor the degree of pollution for potential sources of pollutants. Further, the antibiotic resistance genes (ARGs) and their bacterial hosts, part of the microbial resistance, are also released in the soil during manure and pharmaceutical waste disposal. This reservoir of the resistant gene has full opportunity to flow into antibiotic susceptible disease-causing bacteria leading to AMR. As such, water and wastewater service providers should be assisted in designing necessary interventions to limit the spread of AMR through effluent, sewage treatment, water drainage and water supply systems.

Five Major Causes of Deteriorating Environmental Health
• Growing human and animal population, unplanned urbanization, industrialization and intensification of the food production system. • Inadequate understanding of food quality and food safety among consumers. • Lack of awareness among farmers about the negative impacts of food production system on environment and health. • Poor regulatory enforcements regarding agricultural activities and input use, skewed policies on agriculture subsidies, deforestation and land use planning.

Ecological Alteration and Diseases Transmission	
• Deforestation and animal habitat destruction leads to biodiversity loss and movement of animals to human habitat, thus increasing the incidence of zoonotic diseases. Wild animals are considered reservoirs of many serious zoonotic infections. • Ecological changes increase migratory birds' untimely and frequent movement, responsible for transmitting highly pathogenic avian influenza (HPAI) and many other viral diseases. • Inter-species jump of Ebola virus from wild animals to humans because of ecological changes. • Following other viral diseases originating from non-human species jumped to humans due to ecological change.	
Present: Human Virus	**Origin: Animal Virus**
Measles virus	Cattle (Rinderpest virus)
HIV	Primates
SARS corona virus, Nipah virus, Hendra virus	Bats (China banned bats mixing with other species after SARS outbreak)
The pandemic strain of the influenza virus	Swine

Ecosystem and Vector-borne Diseases

Ecological factors play an essential role in transmitting vector-borne disease (VBD). Climate change and global warming will drastically affect the geographical distribution of several vectors responsible for transmitting the diseases, e.g., Bluetongue, dengue, malaria, RVF, etc.

- Temperature, humidity, and rainfall influence vector populations' breeding, distribution, and density. This is why most of India's endemic parasitic, protozoan, and viral diseases are related to the monsoon.
- Change in temperature and humidity favours the intermediate host of vectors and free-living stage of vectors.
- Temperature and soil moisture affect the spore germination of anthrax and clostridium. Further, heavy rainfall stirs up dormant spores of these organisms.

Vector-borne Diseases: A Bigger Challenge for "One Health"

- Vector-borne pathogens of humans are more severe than non-vector-borne pathogens.
- Globally, vector-borne diseases (VBD) account for more than 17% of all infectious diseases causing more than 700,000 deaths annually.
- Every year, Malaria affect about 219 million people globally and causes more than 400,000 deaths (mainly in children below five years old).

- Globally, dengue affects more than 3.9 billion people, of which 96 million are symptomatic annual and more than 40,000 die.
- During 2003-2013, dengue cases have increased five-fold, making it a leading cause of illness in the tropics/sub-tropics.
- Other VBDs such as Chagas disease, leishmaniasis and schistosomiasis affect hundreds of millions of people every year worldwide.

Source: WHO (2009)

Vector-borne Diseases (VBD Cross International Boundaries and Challenging to "One Health" Approach		
Disease	**Origin of report**	**Recently Spread**
West Nile Virus	Africa	USA, EU, Middle East, West Asia
Rift Valley fever virus	Kenya	Africa, Saudi Arabia and Yemen
Crimean-Congo hemorrhagic fever	Eastern Europe	Spread to more than 30 countries. Endemic in Africa, Middle East & Asia
Japanese encephalitis	Japan	Australia, India, Bangladesh and China
Heartland virus	China	USA
Bluetongue virus (BTV)	Africa, Middle East Asia	EU
African swine fever (ASF)	South Africa	India, Russia, South America and the USA
In the last two decades, although VBD mediated mortality (e.g., Malaria) has reduced in humans, VBD(s) (e.g. Trypanosomiasis, Babesiosis, Anaplasmosis, heartwater disease, ASF) are causing a considerable loss in animal production. Source: Stanley *et. al.* (2008)		

6. NON-COMMUNICABLE DISEASES

Non-communicable diseases (NCDs), including heart diseases, blood pressure, heat stroke, cancer, diabetes, obesity, kidney and musculoskeletal diseases, mental disorders, and chronic lung diseases, are collectively responsible for almost 70% of deaths all death worldwide.

The concept of "One World, One Health" can also improve the epidemiological understanding of non-communicable diseases in humans through comparative medicine. Given technological advances, rising animal rights and controversies regarding animal use, and inconsistent animal welfare policies in medical and veterinary research, attention is needed to advance human and animal health through translational research and pursue possible alternatives. In the future, through comparative medicine, the "One Health" approach will also help monitor the surveillance of newer NCDs in multiple species, which could effectively manage human diseases.

7. BENEFICIAL MICROBES

Until recently, the "One World, One Health" concept focused on the infectious zoonotic pathogens transmitted from animals to humans or vice versa. Recently, the beneficial role of a specific microbial community, known as the microbiome, has also been realized at each trophic level. The beneficial microbes evolve with their hosts and provide services to them. It has been reported that the gut microbiome (probiotics) significantly influences the metabolism, immune system and disease resistance in humans and animals. The microbiome is also used in medicine for disease management Impairment, and alteration in microbiome's pharmacology due to 'dysbioses' or any other reason can lead to acute diseases/disorders. The microbiome also serves as connecting links between gut, brain and heart. Considering the microbiome's influence on the ecosystem's overall health, the recommendations have been made to extend the "One Health" framework to include the full breadth of microbes. However, the balance of interdependent eco-health systems (health of humans, animals and environment) may be disturbed by negative changes such as rapid urbanization, stressors (increasing use of antibiotics and pesticides), and poor quality of food and feed. Antimicrobial drugs, environmental pathogens, and pesticides residues in food and feed have been shown to disturb the healthy microbial community.

8. POTENTIAL ECONOMIC BENEFITS OF "ONE HEALTH"

The recent estimates from World Bank and FAO show that in low and middle-income countries, the adoption of the "One Health" concept could potentially save 10 - 15% ($184 - $506 million per year) of the total disease prevention costs, excluding the potential savings of time, human resources and budget in planning, education, training, research and communications (FAO, 2020; World Bank, 2018). Further, it is reported that a considerable expenditure is involved in the management and control of an outbreak of diseases, most of which are either zoonotic or potentially zoonotic in origin (Singh et al., 2014; Singh et al., 2016). It is estimated that the losses were $41.5 billion due to SARS CoV-1 during 2002-03, $30 billion due to H5N1 Influenza during 2004-06, $50 billion due to H1N1 Influenza during 2010, and as of September 2020, the total losses dues SARS CoV-2 was $3.5 trillion (FAO, 2020). Some specific numbers are as follows (Coker et al., 2011).

- The brucellosis control program in livestock through mass vaccination under the "One World, One Health" program reduced the brucellosis transmission by 52% and saved 49,027 Daily Adjusted Life Years (DALY) of humans.
- In Mongolia, for the brucellosis control programme under the "One Health" umbrella, the estimated intervention cost was $ 8.3 million, and the overall benefit was $ 26.6 million.
- For the Echinococcosis mitigation programme in Spain, with the "One Health" approach, the cumulative benefit-cost ratio had exceeded one after eight years.
- In the Schistosomiasis mitigation programme in China under the umbrella of "One Health", society's net benefit was U$6.20 per U$1 invested.
- Rabies control program through vaccination in dogs under the "One Health" programme has saved $32 per DALY after six years.
- A dollar spent on the Rinderpest control and eradication programme has paid off U$20 to the Indian dairy industry.
- There was a 15% reduction in operational costs by sharing and conducting the medical and veterinary vaccination campaign together in rural areas. Further, more people and animals could be vaccinated during the joint vaccination than vaccination programmes of humans and animals alone.
- Diagnostic laboratory facilities designed to serve both human and animal diseases (e.g., rabies, brucellosis, tuberculosis, salmonellosis, etc.) will be more cost-effective.

9. STAKEHOLDERS IN THE "ONE WORLD, ONE HEALTH" APPROACH

The success of the "One Health" approach relies on the participation of stakeholders from multiple disciplines and multiple institutions, and none remains excluded from it. This creates a sense of belongingness and ownership of the programme. Therefore, it is crucial to bring government institutions, private enterprises, academic institutions, civil society organizations, and communities to the "One Health" platform.

Joint efforts of the scientific community across the disciplines are essential to mitigate the challenges of disease emergence before they enter into human populations. In India, the response to COVID – 19 is one of the best examples of the "One Health" approach.

The outbreak of COVID – 19 shocked the world. Public health agencies have struggled due to insufficient infrastructure and workforce for diagnosis, especially in developing countries. The veterinary institutions provided the much-needed laboratory support as the veterinarians are also trained virologists, microbiologists, pathologists, and biotechnologists.

Fig. 3. Stakeholders of One Health

Several research projects on "One Health" have been planned by the national institutions such as the Indian Council for Medical Research, Indian Council of Agricultural Research, Department of Science and Technology, and Department of Biotechnology, Government of India, involving scientists across various disciplines of medical, veterinary and environmental sciences.

The main focus of the "One Health" concept is to achieve sustainable health of humans, animals, and the environment by connecting multidisciplinary stakeholders at local, national, and international levels. This includes the creation of strategic networks, partnerships, awareness, education, effective information sharing and active health interventions. Following are the goals of the "One Health" concept in a holistic manner:

(i) Promoting and strengthening interdisciplinary collaboration and partnerships among international, national and regional stakeholders through

- establishing a framework for multidisciplinary collaboration,
- creating awareness among target groups on the "One Health" concept,
- ensuring networking and information sharing among stakeholders, and
- advocating for resources mobilization.

(ii) Strengthening surveillance and early disease detection system. Surveillance is a fundamental requisite for formulating prevention and control strategies. This prepares stakeholders for rapid response against infectious zoonoses and devises prevention and control strategies within the "One Health" approach. This can be achieved by:

- promoting joint preparedness and response efforts at the international and national level,
- strengthening the capacity building for diseases surveillance, prevention and control of diseases, and
- enhancing laboratory capacities and human resources.

(iii) Promoting applied research at the human-animal-ecosystem interface through:

- financing research projects on "One Health", and
- international and national networking of scientists across the human-animal-plant interface.

10. INDIA: SWOT ANALYSIS FOR "ONE WORLD-ONE HEALTH"

Strengths

(i) Several institutions (ICAR/ ICMR/ Wildlife/DBT/ CSIR/ DST/ ILRI/ NGOs/ National or International Foundations) are engaged in the diagnostics, vaccine development, and monitoring, reporting, prevention and control of pathogens/ diseases affecting humans, animals, avian and aquatic species and wildlife and also pathogens of crops, fruits and other plants., Hence, a sufficiently trained workforce and resources are available.

(ii) The Ministry of Fisheries, Animal Husbandry and Dairying has a network of laboratories to report infectious animal diseases. Likewise, the ICMR has an Integrated Disease Surveillance Programme (IDSP) of human illnesses, the Wildlife Institute of India for wildlife diseases, and the ICAR for plant pathogens. If all these institutions follow an integrated 'One Health" approach, it is possible to control zoonotic pathogens.

Weaknesses

(i) There is neither an institute nor authority for "One Health" to plan and coordinate multisectoral national programme on "One Health".

(ii) In India, it is not mandatory for real-time reporting of diseases either by the government or private institutions/agencies/ units to any apex government organization, as the CDC and NHI in the USA, Public Health Agency (PHA) and Canadian Food Inspection Agency (CFIA) in Canada, and Health Protection Agency (HPA) in the UK.

(iii) Prioritization of zoonotic diseases on "baseline data" and "area based-mapping" is lacking.

(iv) The inventory and interlinking of the human resource, labs, and infrastructure either lacks or is non-functional.

(v) There is no traceability system of spurious drugs, medicine and contaminated food products.

Opportunities

(i) There is an opportunity for inter-ministerial collaboration for the implementation of the 'One Health' programme

(ii) There is an opportunity to initiate the All India Network programs on the "One Health" approach to control the zoonoses, with a team of inter-sectoral experts and focussed programmes for each identified/prioritized zoonotic disease.

(iii) Formation of "Zoonoses Control Committee (ZCC)", comprising veterinarians, medicos and wild-life persons for reporting daily cases of sickness, deaths in domestic animals, wild animals, and humans at the lowest administrative level, i.e., village panchayat.

Threats

(i) Climate change, increasing AMR, emerging and re-emerging pathogens (zoonotic, food-borne), and illegal trade of animals, wildlife, plants, and biological systems.

(ii) Bioterrorism: 80% of the microbial agents for bioterrorism are zoonotic pathogens.

(iii) Biosecurity breaches and violations.

(iv) Degrading eco-health (soil, water, and air) on agricultural intensification, environmental pollution, GHG emission, injudicious use of antibiotics, pesticides, herbicides and chemical fertilizers, deforestation and excess use of non-biodegradable polymers.

For the success of any new multi-stakeholder policy initiative, it is imperative to create an enabling environment. The concept of "One Health" is no exception to this. The idea is easy to grasp and appealing yet challenging to practice. Therefore, it requires effective and sensitive nurturing.

Of the many requirements, some key elements, as shown in Fig. 4, include political will, policy framework, engagement with broader participation, sharing of knowledge, capacity building, collaborative approach, awareness creation, and stable financing of the initiatives.

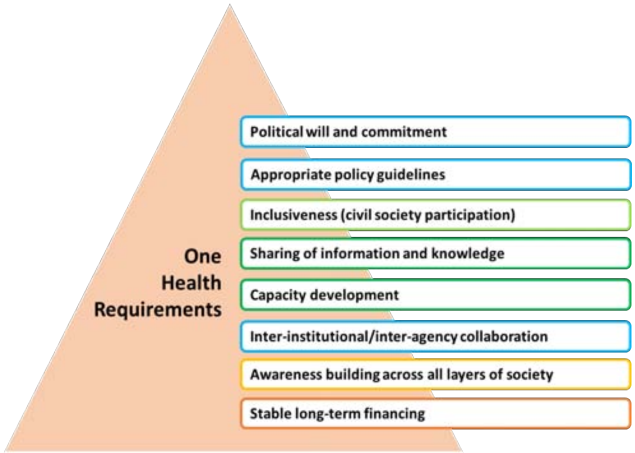

Fig. 4. Supporting requirements for One Health

In India, "One Health" has not been mainstreamed in the policy framework. Although, some fragmented efforts involving several central and state agencies are in place.

National level: To control zoonotic diseases, the Ministry of Health and Family Welfare and the erstwhile Ministry of Agriculture jointly constituted a National Committee on Zoonoses in 1978. Currently, this committee has evolved into a "Standing Committee on Zoonoses" with Director-General of Health Service as Chairperson and Experts from ICAR, ICMR, State agricultural and veterinary universities, national centre for disease control, wildlife institute of India, department of animal husbandry, state health departments, as members. Moreover, with advocacy from World Health Organization, a Joint Monitoring Group on Avian Influenza and a National Influenza Pandemic Committee were also formed in 2004 and 2005, respectively (Ghatak and Singh, 2015). Recently, (i) some joint research programmes, involving ICAR, ICMR and Department of Biotechnology of Ministry of Science and Technology, have been launched and (ii) the integrated disease surveillance programme of the Ministry of Health & Family Welfare began to engage veterinarians for reporting of the zoonotic diseases.

State level: Under the Indian constitutional setup, human health, animal health and agriculture are state-controlled subjects. Yet, a conspicuous lack of efforts at the state government level on "One Health" remains. A few states like Mizoram have a 'Standing Committee on Zoonoses', and only the state of Goa has mentioned public health in the mandate of the Department of Animal Husbandry. Kerala runs academic programmes on "One Health" through the State Veterinary University (Ghatak and Singh, 2015).

Local level: There are no significant efforts on the "One Health" approach at the local government level, barring veterinarians' deployment for meat inspection and slaughterhouse services in some states.

11. OPERATIONALIZING "ONE HEALTH" APPROACH

Strategic Elements

A strategic action plan is needed to implement the "One Health" concept. While the strategic actions might vary, identifying elements are necessary for successful implementation. The five most critical strategic elements include:

- Recognition of "One Health" as an effective and sustainable means of addressing health challenges.
- Mainstreaming the concept of "One Health" into decision making and execution.
- Forging a long term, durable and mutually beneficial partnership among various disciplines and institutions for the collaborative planning and implementation of the "One Health" approach.
- Building capacity to respond to the existing and unforeseen health challenges.
- Prioritizing elements for the "One Health" approach at national, provincial, or even local levels. Some components of the prioritized activities would include (i) identifying the areas requiring immediate-early action (e.g. specific disease, toxicity, population and other health problems), (ii) target setting (e.g. reduction in human and animal brucellosis, reduction in human and bovine tuberculosis and control of avian influenza etc.), (iii) outlining monitoring and diagnostic indicators (serum sample analysis, epidemiological data evaluation etc.), and (iv)establishing evaluation protocols for achievements.

Implementation of "One Health":

- Ensure adequate capacity building in public and animal health, environment and soil health and water and air quality.
- Ensure global and national "emergency response capacity", including fast communication and action plan to prevent, detect and respond to disease outbreaks.
- Control the existing and potentially re-emerging and emerging infectious diseases in animals.
- Promote inter-agency and cross-sectoral collaboration and partnership to conduct strategic research.
- Develop international, regional and national surveillance capacity, using international standards, tools and monitoring processes.

Framework for Implementation

Being a large and diverse country, Indian governance is across many Ministries and Departments with specified domains. While these domain-specific administration systems are time tested and have generally been successful in implementing and realizing "One WorldOne Health" at the national level, there is an urgent need for inter-ministerial collaboration and partnerships. For example, the Ministry of Jal Shakti manages drinking water and sanitation. Still, the supply of safe drinking water is directly related to human and animal health and therefore should be in the national planning for "One Health". Similarly, the Ministry of Fisheries, Animal Husbandry and Dairying and the Ministry of Agriculture and Farmers' Welfare, which deal with livestock diseases (many of which are zoonotic) and crop and livestock-based food production, should be logically an essential partner in the formulation and implementation of "One World, One Health". Based on many such examples, a conceptual framework (Fig. 5) for "One World, One Health" implementation is prepared, including ministries and departments, directly or indirectly connected to "national health programme".

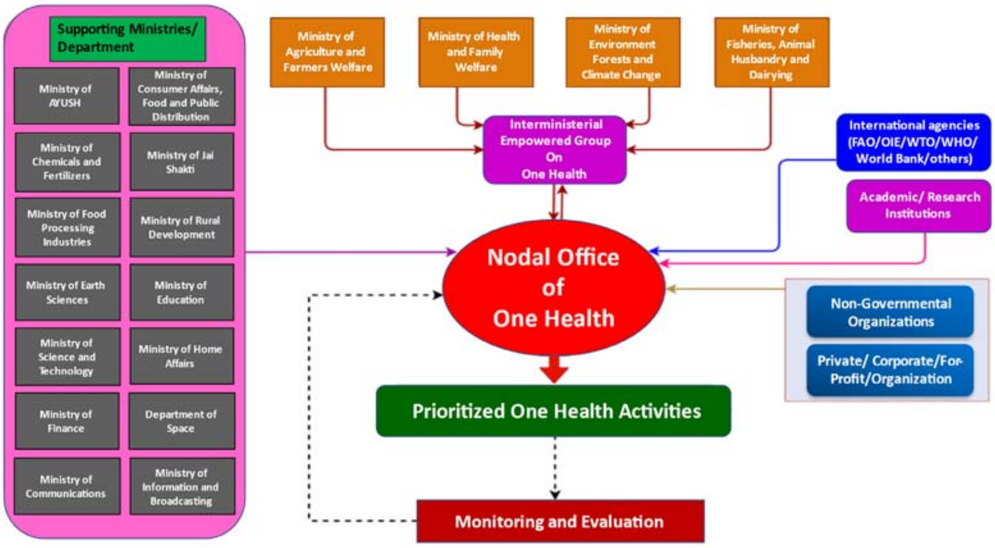

Fig. 5. Conceptual Framework of Indian National One Health

Political Commitment, Policies, Programmes, and Sustainable Financing

- To decentralize human, animal, plant and ecosystem health and take more integrated, interconnected and logical research and development programmes.
- To establish a formal "Apex Govt Body" on One Health like CDC (Centers for Disease Control and Prevention) & NHI (National Health Institute) in the USA, HPA (Health Protection Agency) in UK and PHA (Public Health Agency) in Canada, with experts and representatives from human, animal, plant and environmental sectors to develop a "Strategy plan" to engage in inter-sectoral communication. In India, the inter-ministerial collaboration for implementing the "One World, One Health" approach is a prerequisite.

Dynamic Platform for Continuous Sharing of Knowledge

- There should be continuous exchange and sharing of knowledge on evidence-based outcomes, the economic gains and global best practices of one health between FAO, OIE, WHO and national leaders, then between the national leader and national policy formulators & policy implementors down to stair at local & regional level.
- Conducting the joint national workshop and symposia for medical and veterinary professionals, under continuous Medical Education (CME) and Continuous Veterinary Education (CVE), to update their knowledge.

Long Term Multisectoral Institutional Collaboration and Partnership

- Joint planning and surveillance for early detection of diseases in humans and animals, and guidelines for preventing zoonotic diseases, soil degradation and environmental pollution.
- Collaborative research projects and teaching programmes on "One World, One Health".

Capacity Building and Awareness Programmes

- The course contents on “One Health” must be integrated into the curriculum at the graduation level of MBBS, BVSc & AH, B.Sc. (Agriculture) and BSc (Environmental Science). Some introduction and visibility should also be at the school level curriculum. Subsequently, the degree programmes on “One Health” may be thought of. In addition, the extension workers who may play major roles should also be involved as stakeholders in all “One Health” initiatives.
- Development of interdisciplinary public health training at the district level by involving humans, animals, plants, and environmental specialists to train the “One Health Trainer” team to ensure the Local Emergency Response (LER) team.

Active Participation of Communities

- Celebration of “International One Health Day” (November 3) at district/block level, engaging the civil societies, communities and NGOs.
- Prudent use of antimicrobials in and non-antibiotic growth promoters in poultry and livestock.

12. RECOMMENDATIONS

- Develop a white paper on “One World, One Health” to sensitize key stakeholders.
- Establish a National Centre on “One Health Research, Education and Communication”.
- Develop a joint surveillance mechanism for human, animal and environmental health. Improve national surveillance capacity and early detection system of animal and human diseases.
- Prepare an inventory of the most common diseases for the “One Health’ programme.
- Develop standard tools and monitoring processes for outbreaks of zoonotic diseases at the national level. Also, develop inter-sectoral communication strategies to direct, respond and prevent the disease outbreak.
- Mass public campaigns to control and eradicate zoonotic and food-borne diseases.
- Pilot ‘One Health Convergence Model’ at a few locations of each state.
- Se up a an All India Network programme on the “One Health” for controlling zoonoses, with a team of experts and focussed programmes for each prioritized zoonotic disease.
- Formalizing “Zoonoses Control Committee (ZCC)”, comprising experts from different disciplines at the district level, for mandatory reporting of cases of sickness and deaths on a daily basis to an “Apex Government Body”.
- Learn the modus operandi from international success stories which have successfully dealth with control pof zoonoses under the “One Health” and develop effective collaboration with internationally reputed institutions and persons.

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