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Zoonotic threats in traditional food markets

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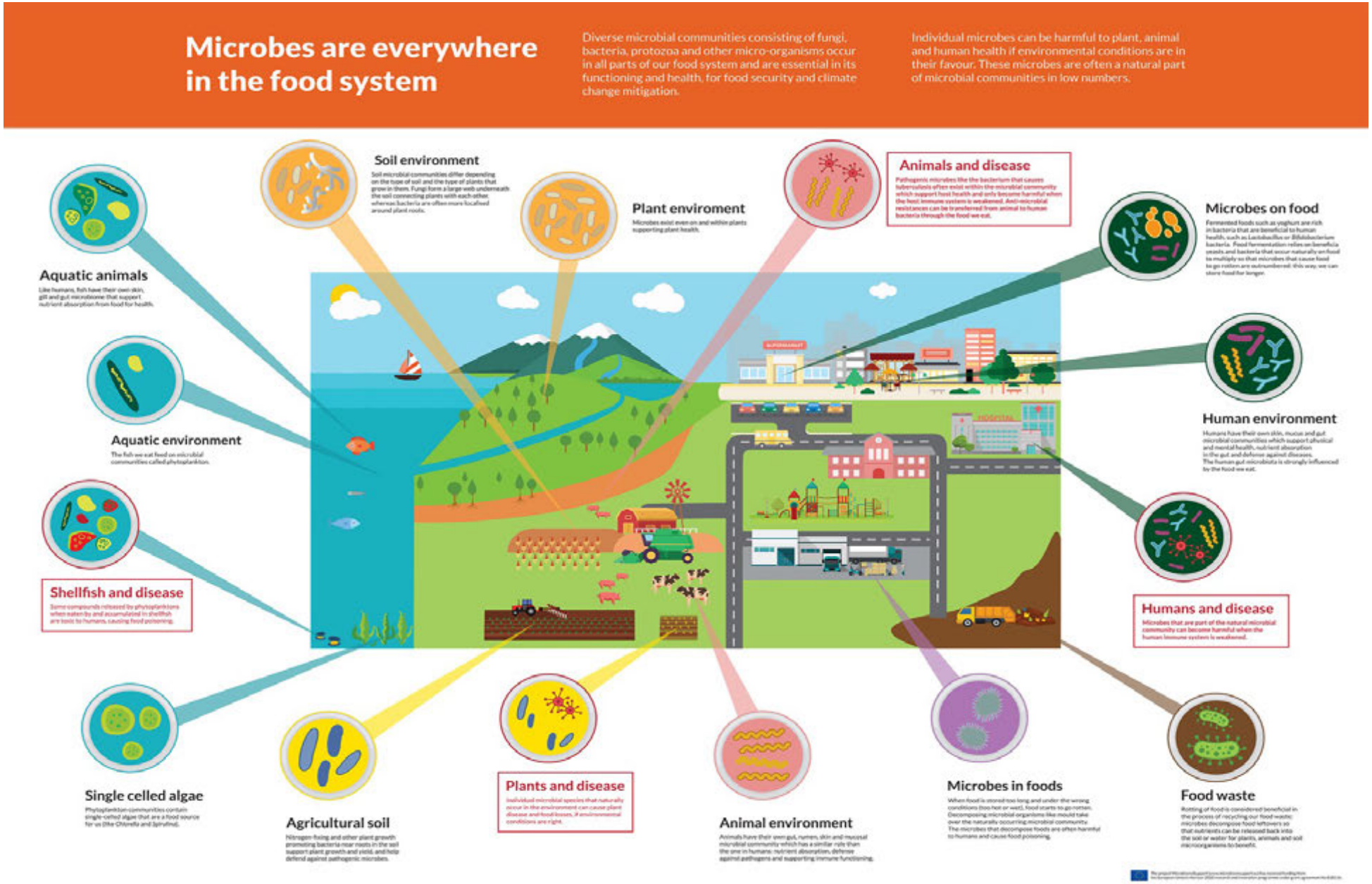
Food Safety: Farm to Fork


Microbes are everywhere in the food system
Diverse microbial communities consisting of fungi, bacteria, protozoa and other micro-organisms occur in all parts of our food system and are essential in its functioning and health, for food security and climate change mitigation.
Individual microbes can be harmful to plant, animal and human health if environmental conditions are in their favour. These microbes are often a natural part of microbial communities in low numbers.
Soil environment
Soil microbial communities differ depending on the type of soil and the type of plants that grow in them. Fungi form a large web underneath the soil connecting plants with each other, whereas bacteria are often more localised around plant roots.
Plant enviroment
Microbes exist even on and within plants supporting plant health.
Animals and disease
Pathogenic microbes like the bacterium that causes tuberculosis often exist within the microbial community which support host health and only become harmful when the host immune system is weakened. Anti-microbial resistances can be transferred from animal to human bacteria through the food we eat.
Microbes on food
Fermented foods such as yoghurt are rich in bacteria that are beneficial to human health, such as Lactobacillus or Bifidobacterium bacteria. Food fermentation relies on beneficia yeasts and bacteria that occur naturally on food to multiply so that microbes that cause food to go rotten are outnumbered: this way, we can store food for longer.
Aquatic animals
Like humans, fish have their own skin, gill and gut microbiome that support nutrient absorption from food for health.
Aquatic environment
The fish we eat feed on microbial communities called phytoplankton.
Human environment
Humans have their own skin, mucus and gut microbial communities which support physical and mental health, nutrient absorption in the gut and defense against diseases. The human gut microbiota is strongly influenced by the food we eat.
Shellfish and disease
Some compounds released by phytoplankton when eaten by and accumulated in shellfish are toxic to humans, causing food poisoning.
Humans and disease
Microbes that are part of the natural microbial community can become harmful when the human immune system is weakened.
Single celled algae
Phytoplankton communities contain single-celled algae that are a food source for us (like Chlorella and Spirulina).
Agricultural soil
Nitrogen-fixing and other plant growth promoting bacteria near roots in the soil support plant growth and yield, and help defend against pathogenic microbes.
Plants and disease
Individual microbial species that naturally occur in the environment can cause plant disease and food losses, if environmental conditions are right.
Animal environment
Animals have their own gut, rumen, skin and mucosal microbial community which has a similar role than the one in humans: nutrient absorption, defense against pathogens and supporting immune functioning.
Microbes in foods
When food is stored too long and under the wrong conditions (too hot or wet), food starts to go rotten. Decomposing microbial organisms like mould take over the naturally occurring microbial community. The microbes that decompose foods are often harmful to humans and cause food poisoning.
Food waste
Rotting of food is considered beneficial in the process of recycling our food waste: microbes decompose food leftovers so that nutrients can be released back into the soil or water for plants, animals and soil microorganisms to benefit.

Traditional Food Markets

Fresh food markets where live animals are sold, most commonly for food or medicine, and are slaughtered in the market.

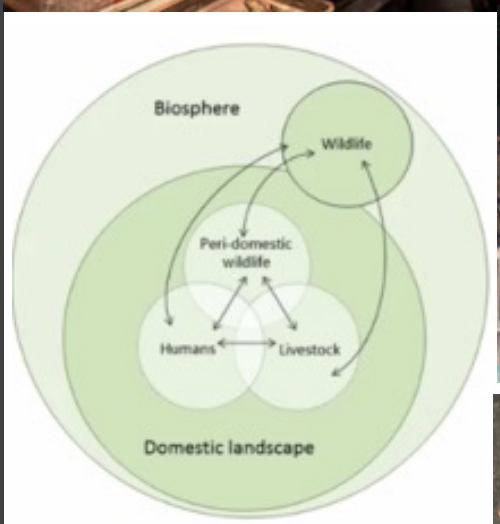
- About 77% of consumers in Asia choose wet markets as the primary source of fresh meat
- The biggest issue is the safe disposal of slaughterhouse waste.
- Cause of environmental contamination

(Warwick and Steedman, 2021)

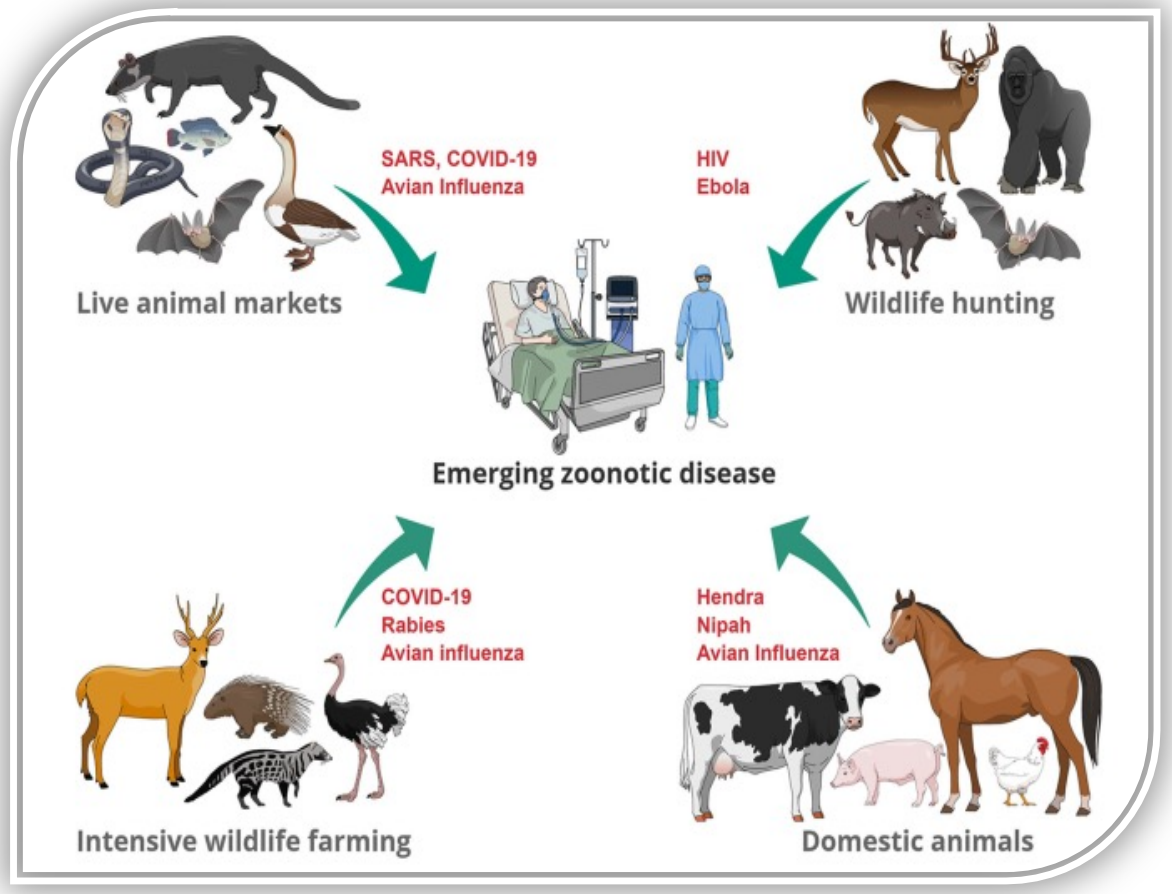
Traditional food market: Hotspot for EIDs (?)

- Common in Asia having sociocultural root
- Wild animals, birds, products from wild animals (Trad. Medicine) and agri. produces
- Fresh, cheap, choice and convenient (One stop shop)
- Limited space and poor infrastructure
- Poor hygienic and sanitary conditions
- Ignorance of zoonoses among workers
- Consumer psychology about live animal and fresh meat

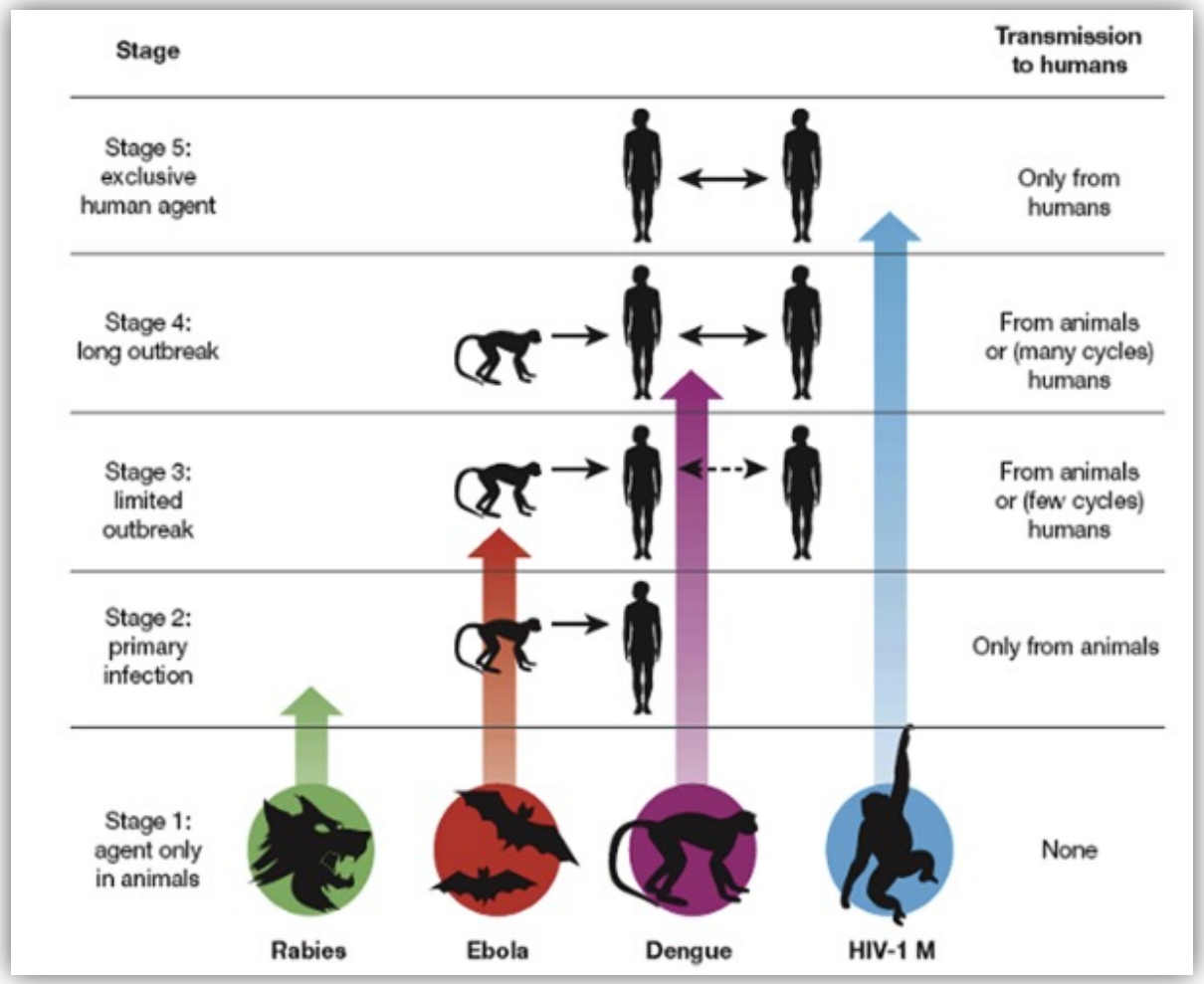
The desire for wildlife as food or medicine drives a trade in wild animals (Demand driven)



Drivers of Emerging Zoonoses…..



Transmission pathways of EZDs



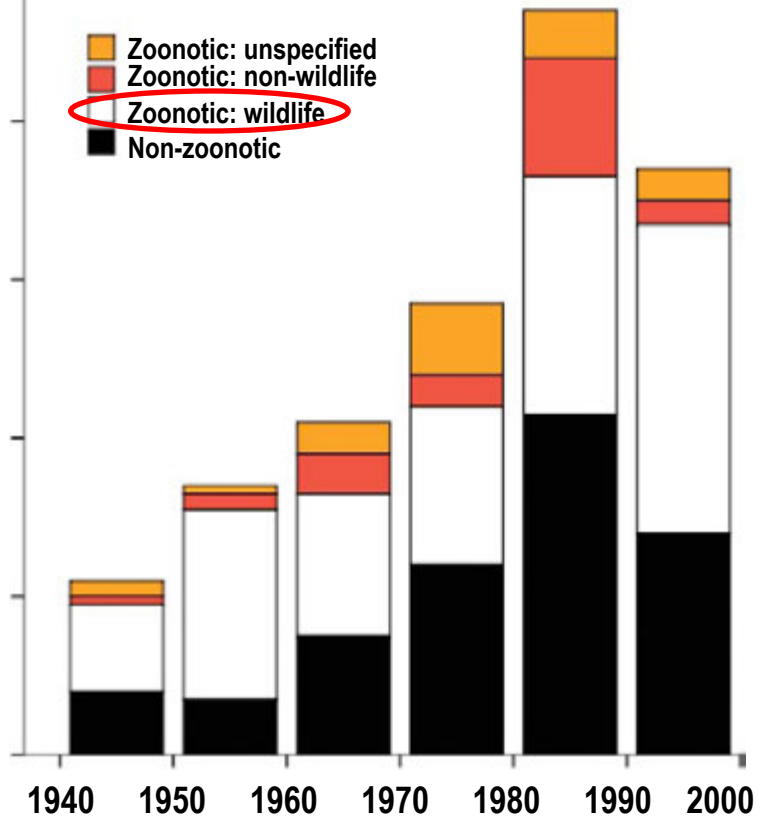
Five stages through which pathogens of animals evolve to cause diseases in humans

(Magouras, 2020)

Breaches in species barrier: selected emerging infections in humans identified since 1976

Ebola virus	Bats	1976
HIV-1	Primates	1981
E. coli O157:H7	Cattle	1982
Borrelia burgdorferi	Rodents	1982
HIV-2	Primate	1986
Hendra virus	Bats	1994
BSE/vCJD	Cattle	1996
H5N1 influenza A	Chickens	1997
Nipah virus	Bats	1999
SARS coronavirus	Palm civets	2003
Influenza H1N1	Swine	2009
SFTS virus	Ticks	2010
MERS-CoV	Bats (?)	2012

Types of EID events, 1940-2000



Jones et al, Nature 21 Feb 2008

Ebola outbreaks in Central Africa: Wildlife-Human interface

Outbreak location, year	*Country*	*Ebola species*	*Number of cases*	*Number of deaths*	*Animal source*
Yambuku, 1976	DRC	EBOV-Z	318	280	Unknown
Nzara, 1976	Sudan	EBOV-S	284	151	Unknown
Tandala, 1977	DRC	EBOV-Z	1	1	Unknown
Nzara, 1979	Sudan	EBOV-S	34	22	Unknown
Cote d'Ivoire, 1994	Cote d'Ivoire	EBOV-IC	1	0	Chimpanzee
Mekouka, 1994	Gabon	EBOV-Z	52	31	Chimpanzee, gorilla
Kikwit, 1995	DRC	EBOV-Z	315	254	Unknown
Mayibout, 1996	Gabon	EBOV-Z	33	23	Chimpanzee
Booué, 1996	Gabon	EBOV-Z	60	45	Chimpanzee
Gulu, 2000	Uganda	EBOV-S	425	224	Unknown
Mekambo, 2001–2002	Gabon	EBOV-Z	65	53	Gorilla, chimpanzee, duiker
Mbomo Kelle, 2001–2002	RC	EBOV-Z	59	44	Gorilla, chimpanzee, monkey
Kelle, 2003	RC	EBOV-Z	143	128	Gorilla, duikers
Mbandza Mbomo, 2003	RC	EBOV-Z	35	29	Monkey, duikers
Yambio, 2004	Sudan	EBOV-S	17	7	Unknown
Etoumbi, 2005	RC	EBOV-Z	12	10	Unknown
Bundibugyo, 2007	Uganda	EBOV-B	116	30	Unknown

DRC, Democratic Republic of Congo; RC, Republic of Congo; EBOV-Z, Ebolavirus Zaire; EBOV-S, Ebolavirus Sudan; EBOV-IC, Ebolavirus Ivory Coast; EBOV-B, Ebolavirus Bundibugyo.

Ebola is worse than the war. The enemy you're fighting you don't know. In a war, the bullet only strikes one person.

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infectious agents, all with zoonotic potential, were reported to be carried by commensal rats

(Strand and Lundkvist, 2019)

- ***Parasitic pathogens :*** *Anaplasma, Babesia, Capillaria, Cryptosporidium*, '*Echinococcus multiloculari*', '*Entamoeba histolytica', Fasciolia, Giardia, Hymenolepis, Leishmania*, *Sarcocystis, Taenia*, '*Toxocara cati*', '*Toxoplasma gondii*', *Trichinella*, *Trypanosoma*,
- **Parasitic diseases :** Anaplasmosis, Babesiosis, Capillariasis, Crypdosporidiosis, 'alveolar echinococcosis', 'Amoebic dysentery', 'Human fasciolosis', Giardiasis, Leishmaniasis, Sarcosporidiosis, Taeniasis, Toxocariasis, Toxoplasmosis, Trichinosis, 'Chagas disease',
- ***Bacterial pathogens :*** *Bartonella spp.*,'*Borrelia burgdorferi', Borrelia spp., Campylobacter*, '*Coxiella burnetii*', '*E. coli*', '*Francisella tularensis', Leptospira spp., Listeria spp.*, *Pasteurella, Pseudomonas, Salmonella*, '*Streptobacillus moniliformis', Yersinia*,
- **Bacterial diseases :**'Bartonella Illness', 'Lyme disease', 'Relapsing fever', Campylobacteriosis, 'Q fever', 'VTEC', Tularemia, 'Leptospirosis', 'Weil's disease', Listeriosis, 'Pasteurellosis, Plague, Meliodosis, 'Salmonellosis, 'Rat bite fever', 'Haverhill fever', 'Yersiniosis'
- ***Rickettsial pathogens:*** *Rickettsia typhi', 'Orientia tsutsugamushi',*
- **Rickettsial diseases :** 'Murine /Endemic/ Flae-borne typhus', 'Scrub/ Chigger-borne typhus'
- ***Viral pathogens:*** Cowpox virus, Hantaviruses (Sim nombre, Seoul hantavirus' etc.), HEV, LCMV, Rhabdovirus, TBEV
- ***Viral diseases :*** Cowpox, 'Hepatitis E', 'Lymphocytic choriomeningitis', Rabies, ' 'Tick-Borne Encephalitis' (TBE) 'Haemorrhagic fever' or 'Hemorrhagic fever', Haemorrhagic Pulmonary Syndrome etc.

Zoonotic Diseases transmitted through live markets

PATHOGENS	ORIGINAL ANIMAL/ NATURAL HOST	POTENTIAL FOR SPREAD IN MARKETS
CCHF virus	Ticks, ruminants	Live ruminants brought to markets could spread virus through body fluids, or through vectors
Ebola viruses	Bats and/ or primates	Sale of live exotic animals or bush meat brings the pathogens close to humans
Hanta viruses	Rodent, shrews, moles, bats	Reservoir animals may be sold at markets, but scavenging rodents may also bring the pathogens close to the markets and contaminate products
Hepatitis E virus	Domestic pigs, wild boars	Spread through blood products or contact with live animals at markets
Avian influenza virus	Wild birds, poultry	Infected birds can transmit the virus to humans
Marburg virus	Fruit bats of the *Pteropodidae* family	Bats sold at markets, or products contaminated by bats
Monkeypox virus	Monkey	Through bush meat or live animals sold at markets
Nipah virus	Fruit bats, pig	Contaminated food products or live animals sold
Rabies virus	Carnivores, bats, dogs	Not transmitted by food, but, by bringing carnivores or bats live to markets
Coronaviruses	Bats and mammals	Large variety of coronavirus could be brought by live animals taken to the market; some of these virus may have zoonotic potential
Leptospira spp.	Livestock, rodents	Could be brought to markets through infected animals for sale

Unhygienic slaughter and associated human health risks

Absence of quality-control programs of a traditional bovine slaughterhouse

Major food-borne zoonotic diseases

- **Taeniasis**
- **Tuberculosis**
- **Brucellosis**
- **Listeriosis**
- **Salmonellosis**
- **Toxoplasmosis**
- **Botulism**
- **Staphylococcal intoxication**
- **Campylobacteriosis**
- **Diphyllobothriosis**
- **Hemolytic uremic syndrome**

Environmental damage and poor hygienic conditions of a bovine slaughter

(Nespolo, 2021)

Preventing the next pandemic: Priority Actions & Policy Recommendation

Strengthening policy and institutional framework

ASEAN nations need to ensure their policy frameworks and legislation prohibit the highest risks parts of the wildlife trade where zoonotic pathogens can emerge. Our research has shown that is the commercial trade in wild birds and mammals for human consumption.

Strengthen pandemic prevention through a multi-sectoral "One Health" Approach

Create a high-level multi-sectoral authority at the highest level of government, to oversee wildlife–livestock- human– environment issues of risk for zoonotic diseases; Develop a national strategy as an umbrella to bridge the multi-sectoral work & translate into priority areas and sub-national policy level

Reduce consumer demand through BCC approach

Identify zoonotic disease risk in wildlife markets and trade; raise public awareness of disease risks; implement behavior change interventions targeting key wildlife consumers

Innovative meat and meat products retailing models

‘Meat on wheels’ and ‘e-kart’ –mobile unit for the popularization of clean meat production

Hygienic slaughter interventions

Infrastructure Developed at ICAR-NRC Meat, Hyderabad for Hygienic slaughter and Utilization of slaughter house waste

Designed Portable Meat Production and Retailing Unit (P-MART) Sheep and Goats

Rendering-cum-pet food processing plant

Poultry processing plant

Utilization of inedible poultry by-products

Impact assessment of scientific food safety interventions in reducing food borne pathogens in poultry processing retail shops

- Screening of meat, water and meat contact surface swab samples viz. cutting woods, knife, hand and floor done to study the prevalence of microorganisms in retail poultry processing units.
- Major critical control points identified were crates used for keeping birds, water for washing of dressed bird and wooden platform used during retailing.
- Base line information through structured questionnaire revealed that 76% de-skinned and eviscerated poultry on cutting wood whereas 83% reused water for hand, knife and poultry carcass washing. About 86% did not have prior training on scientific and hygienic processing of poultry meat.,
- The study highlighted the importance of scientific interventions and organisation of capacity building training to create awareness among meat shop workers to minimize the microbial load of public health significance in poultry meat.

Impact assessment of scientific food safety interventions in reducing food borne pathogens in poultry processing retail shops

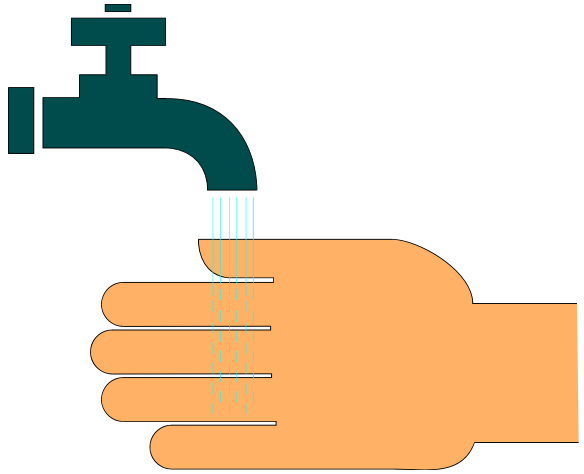
- Simple scientific meat safety interventions such as
  - wearing of gloves,
  - use of chlorinated water for carcass washing and
  - use of hot water for sterilization of cutting knives significantly reduced the microbial contamination of meats from retails shops.

Key interventions

- Education
- Hand washing

  (The most effective prevention)

  - Most zoonoses transmitted fecal-oral
- Carcass sanitization
- Food away from animals
- Signs
- Cleaning/disinfection
- Environment



Conclusions

- We developed a pilot project which needs to be supported to adapt Food Safety and Standards Authority of India (FSSAI) and WHO manual under field conditions as modality may differ from country to country.

- Undertaking participatory situational assessment of the TFM and planning action plan to fill the gaps

- Addition of value at the local level will be more important, as it will limit and reduce transport of animals, contain environmental pollution to local levels

- It is important to introduce private participation

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Thank you very much