JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

The One Health Approach

Challenges and Opportunities to Transform Systems at the Local and Global Scale

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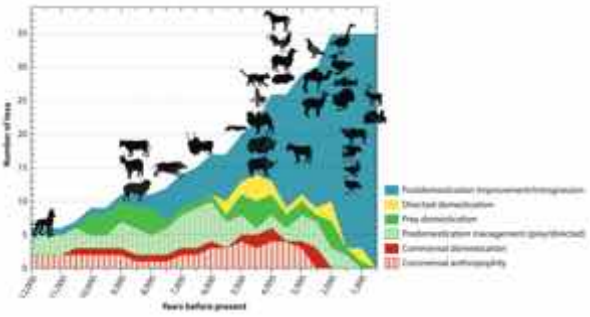
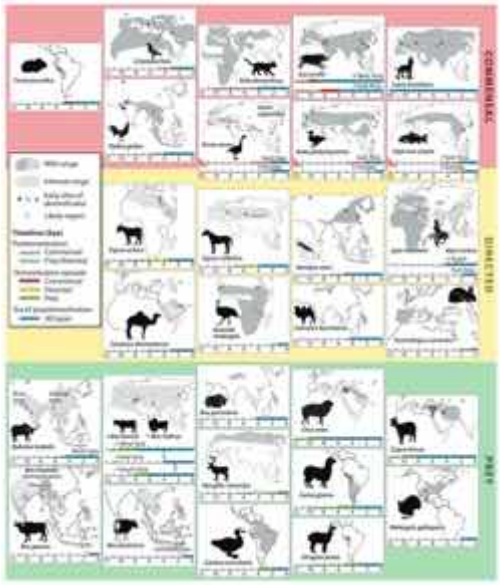
1

Human-Animal Relationship

- Domestication started 12k years ago
- Global phenomenon
- Commensal, direct and prey pathway

Larson and Fuller. 2014. Annu. Rev. Evol. Syst.





2


Human-Animal Relationship
https://www.dlg.org
https://herz-fuer-tiere.de
https://www.borchelhof.de
https://www.foodnavigator.com
https://www.marienhof-puten.de
https://www.tierschutzbund.de
https://www.bz-berlin.de
https://www.landwirt-masterclass.com

3


Human-Animal Relationship
Common ground: close contact

4

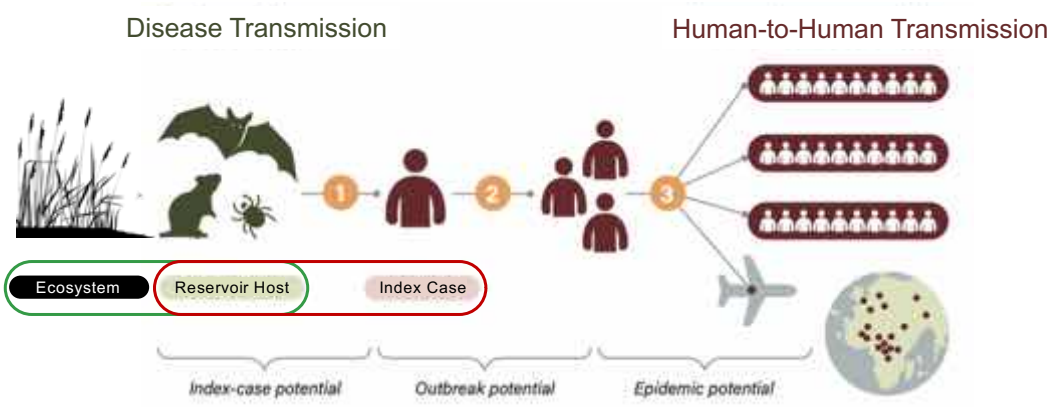
From One Medicine to One Health

Rudolf Virchow (1855)

“Infectionen durch contagiöse Thiergifte - Zoonosen”

5

From One Medicine to One Health



Africa CDC. 2020. modified

6

One Health High-Level Expert Panel (OHHLEP)

Definition of One Health

"One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems."

OHHLEP. 2022. PLoS Pathogens

Co-chairs: OHHLEP II

OHHLEP I


Thomas C. Mettenleiter


Wanda Markotter

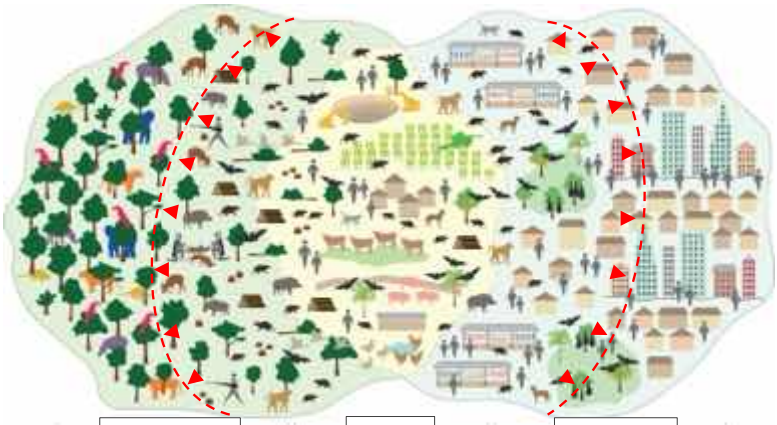

Carlos Goncalo des Neves

Food and Agriculture Organization of the United Nations | World Organisation for Animal Health | UN environment programme | World Health Organization

FLI

7

The Human-Animal-Environmental Interface



Pristine Forest
- Penetration of intact ecosystems
- Biodiversity loss and habitat destruction

Ecotone
- Human activities incl. livestock farming (interface)
- Sylvatic pathogens are no longer controlled by environmental stochasticity

(Peri-)Urban
- Wild animals enter urban areas in search for resources
- Exposure of wildlife to urban diseases

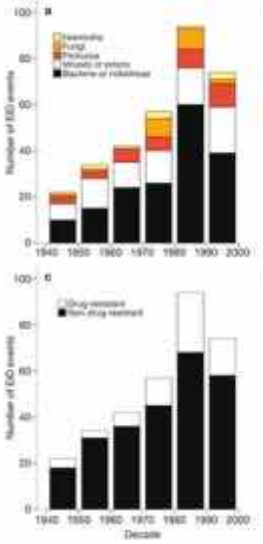
Wegner, G. et al. 2022. Eclinicalmedicine (mod.)

FLI

8

Emerging Infectious Diseases

- EIDs have increased at more than four times the rate of prior decades

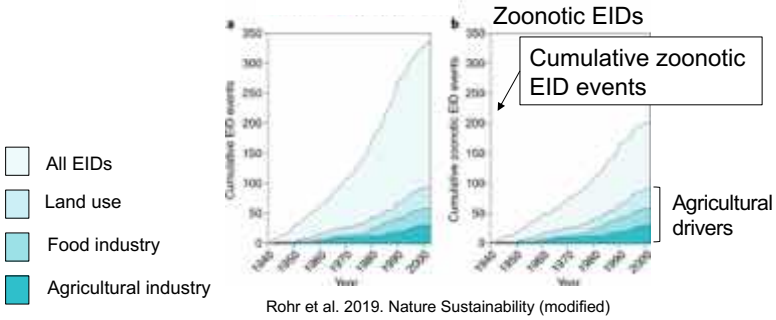


Jones et al. 2008. Nature

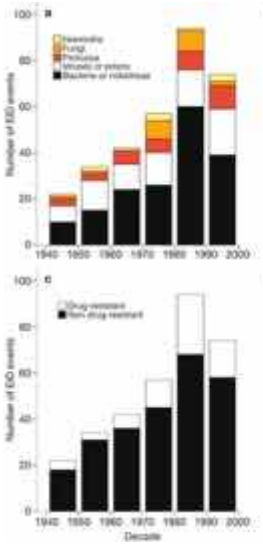
9

Emerging Infectious Diseases

- EIDs have increased at more than four times the rate of prior decades
- Since 1940, an estimated 50% of zoonotic disease emergence has been associated with agriculture



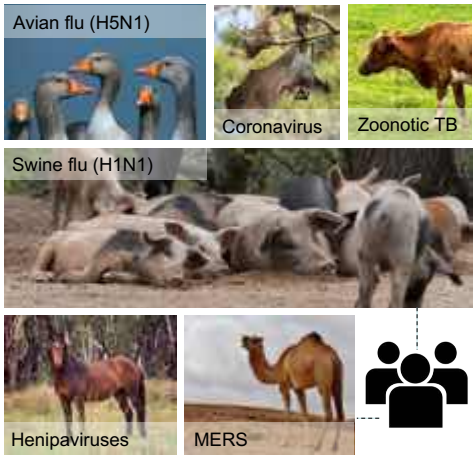
Rohr et al. 2019. Nature Sustainability (modified)

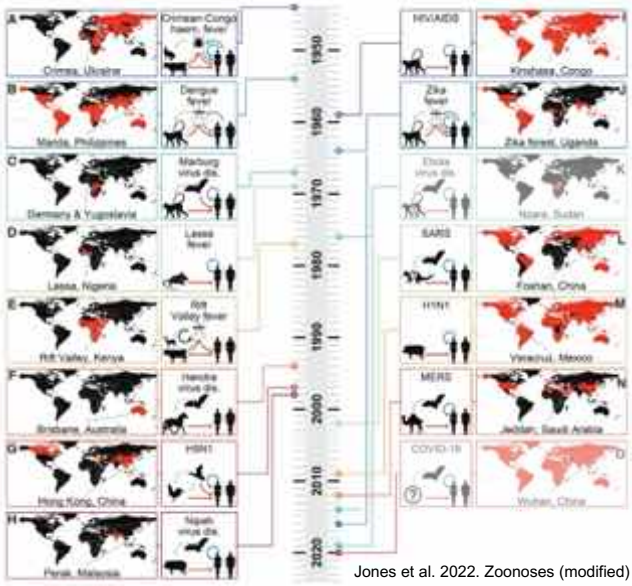


Jones et al. 2008. Nature

10

Major Human Diseases of Animal Origin



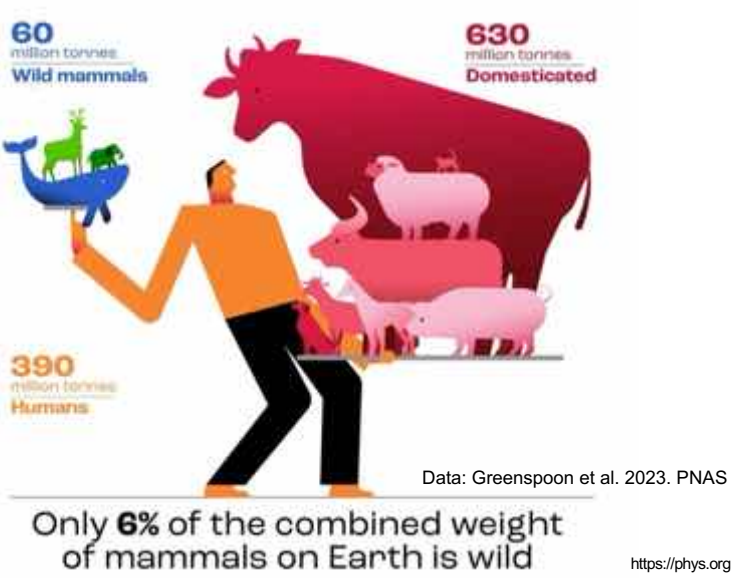


Jones et al. 2022. Zoonoses (modified)

11

Disease Ecology

- Wildlife is a source for pathogens with epidemic potential
- Livestock is contributing relatively more to zoonotic spillovers than wildlife
- Spillovers can also have positive effects

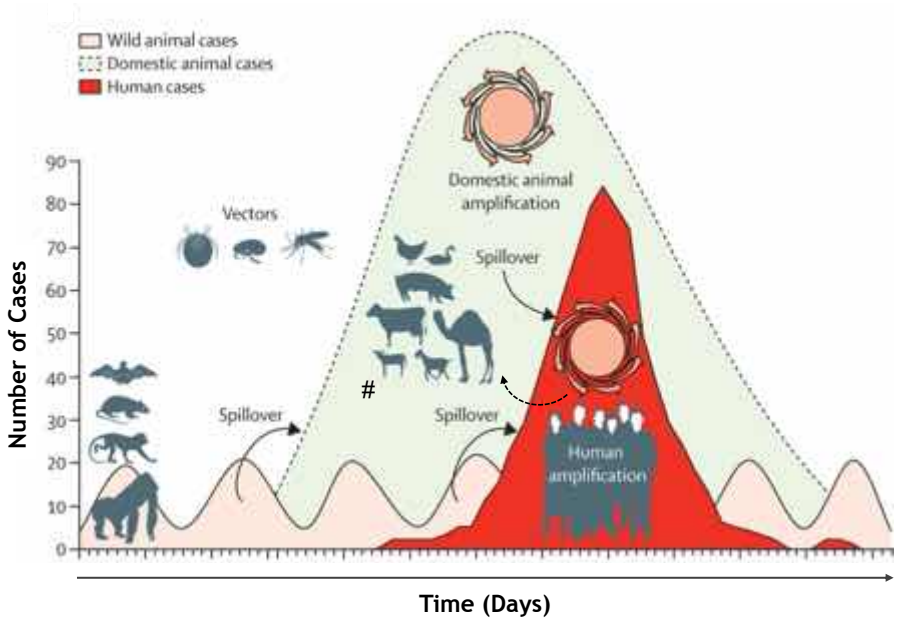


Data: Greenspoon et al. 2023. PNAS

12

Farmed Animals are Central to One Health

#Bridging host



Karesh, W. B. et al. 2012. Lancet (modified)

13

Amplificatory and Incubator

Science

REPORTS

Cite as: B. B. Oude Munnink *et al.*, *Science* 10.1126/science.abe5901 (2020).

Transmission of SARS-CoV-2 on mink farms between humans and mink and back to humans

Bas B. Oude Munnink[1]*, Reina S. Sikkema[1], David F. Nieuwenhuijse[1], Robert Jan Molenaar[2], Emmanuelle Munger[1], Richard Molenkamp[1], Arco van der Spek[2], Paulien Tolsma[3], Ariene Rietveld[3], Miranda Brouwer[3], Noortje Bouwmeester-Vincken[4], Frank Harders[5], Renate Hakze-van der Honing[6], Marjolein C. A. Wegdam-Blans[6], Ruth J. Bouwstra[3], Corine GeurtsvanKessel[1], Annemiek A. van der Eijk[1], Francisca C. Velkers[6], Lidwien A. M. Smit[10], Arjan Stegeman[6], Wim H. M. van der Poel[7], Marion P. G. Koopmans[1]

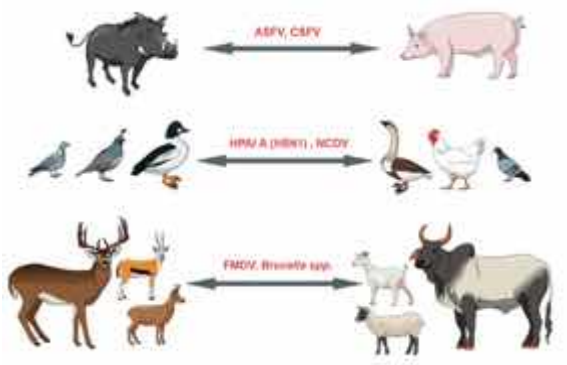
[1]Erasmus MC, Department of Viroscience, WHO collaborating centre for arbovirus and viral hemorrhagic fever Reference and Research, Rotterdam, Netherlands. [2]Royal GD, Deventer, Netherlands. [3]Netherlands Food and Consumer Product Safety Authority (NVWA), Utrecht, Netherlands. [4]Municipal health Services GGD Brabant-Zuidoost, Eindhoven, Netherlands. [5]Municipal health Services GGD Hart voor Brabant, 's-Hertogenbosch, Netherlands. [6]Municipal health Services GGD Limburg-Noord, Venlo, Netherlands. [7]Wageningen Bioveterinary Research, Lelystad, Netherlands. [8]Stichting PAMM, Veldhoven, Netherlands. [9]Farm Animal Health, Utrecht University, Utrecht, Netherlands. [10]Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, Netherlands.

*Corresponding author: Email: b.oudemunnink@erasmusmc.nl

14

The Wild Side of Livestock (and Human) Health

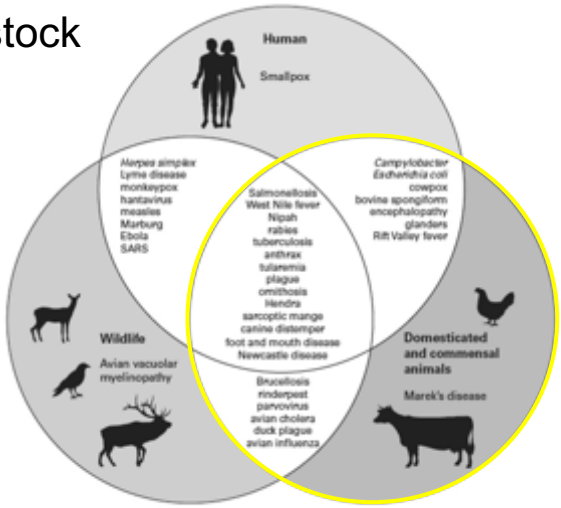
Pathogens transmitted between closely related species



Opportunistic pathogens in multi-genera systems

Jori, F. et al. 2022. Animal Frontiers

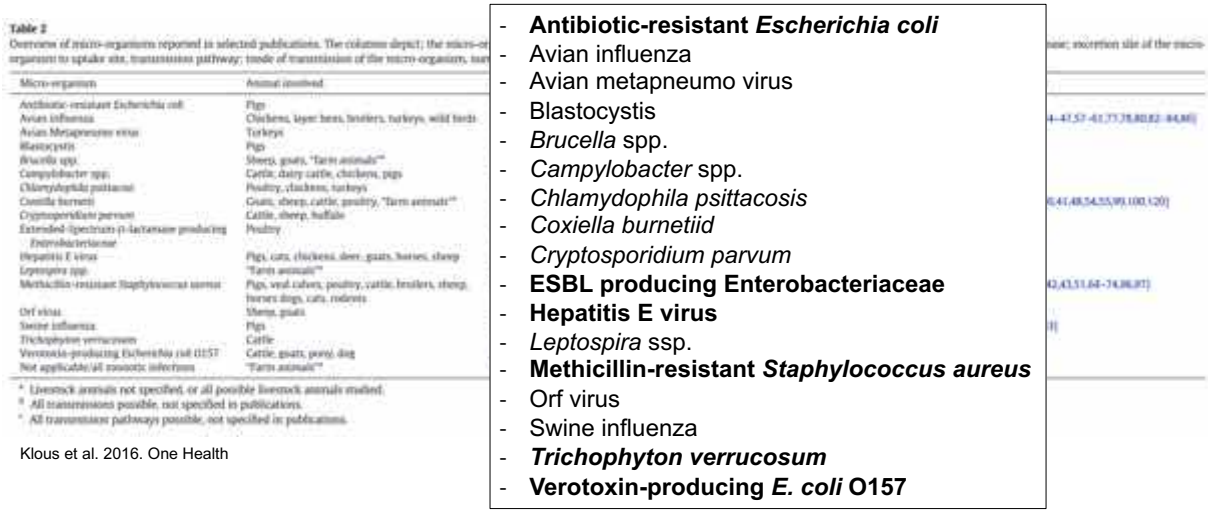
Zoonotic Livestock Diseases I



Examples of linkage between important infectious diseases of wildlife, domestic animals, and humans

mod. Friend, M. (2006). Biowarfare, Bioterrorism, and Animal Diseases as Weapons. Circular 1285.

Zoonotic Livestock Diseases II



Klous et al. 2016. One Health

- **Antibiotic-resistant *Escherichia coli***
- Avian influenza
- Avian metapneumo virus
- Blastocystis
- *Brucella* spp.
- *Campylobacter* spp.
- *Chlamydophila psittacosis*
- *Coxiella burnetiid*
- *Cryptosporidium parvum*
- **ESBL producing Enterobacteriaceae**
- **Hepatitis E virus**
- *Leptospira* ssp.
- **Methicillin-resistant *Staphylococcus aureus***
- Orf virus
- Swine influenza
- ***Trichophyton verrucosum***
- **Verotoxin-producing *E. coli* O157**

17

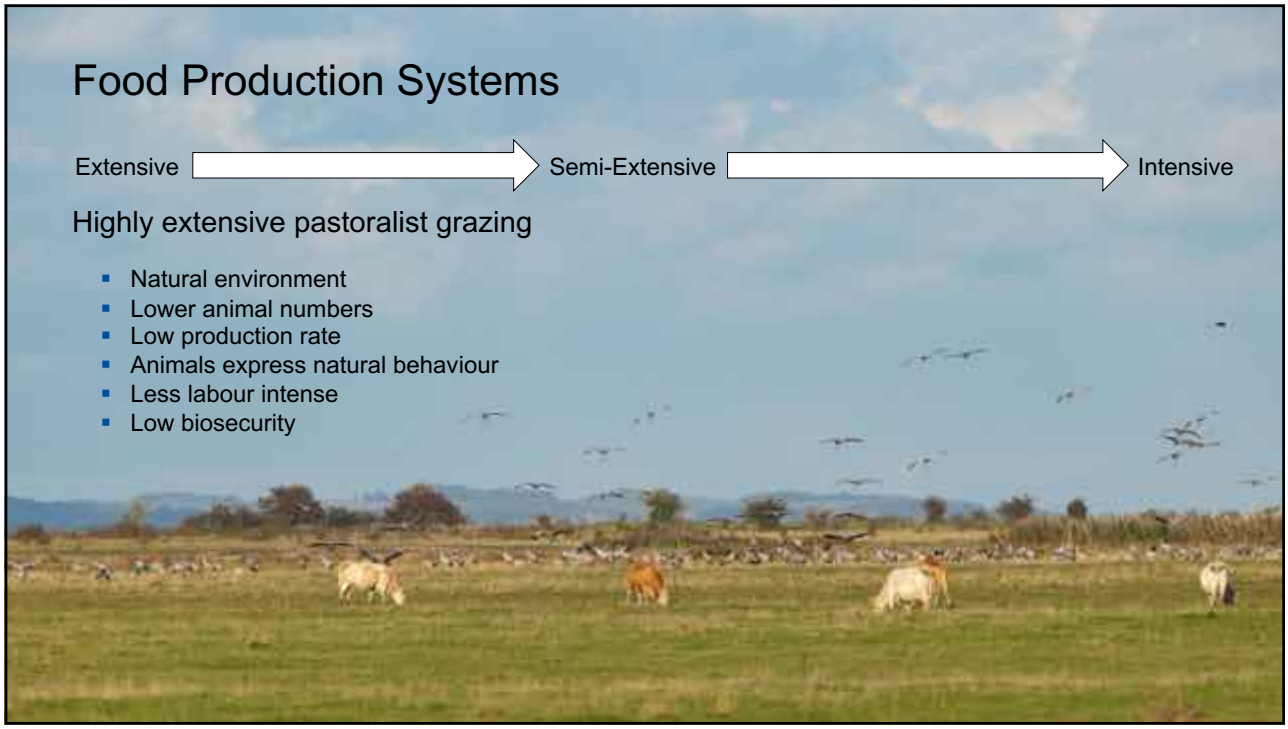
Emerging Infectious Diseases

- The **pandemic risk** from zoonotic livestock diseases must be seen in a global context

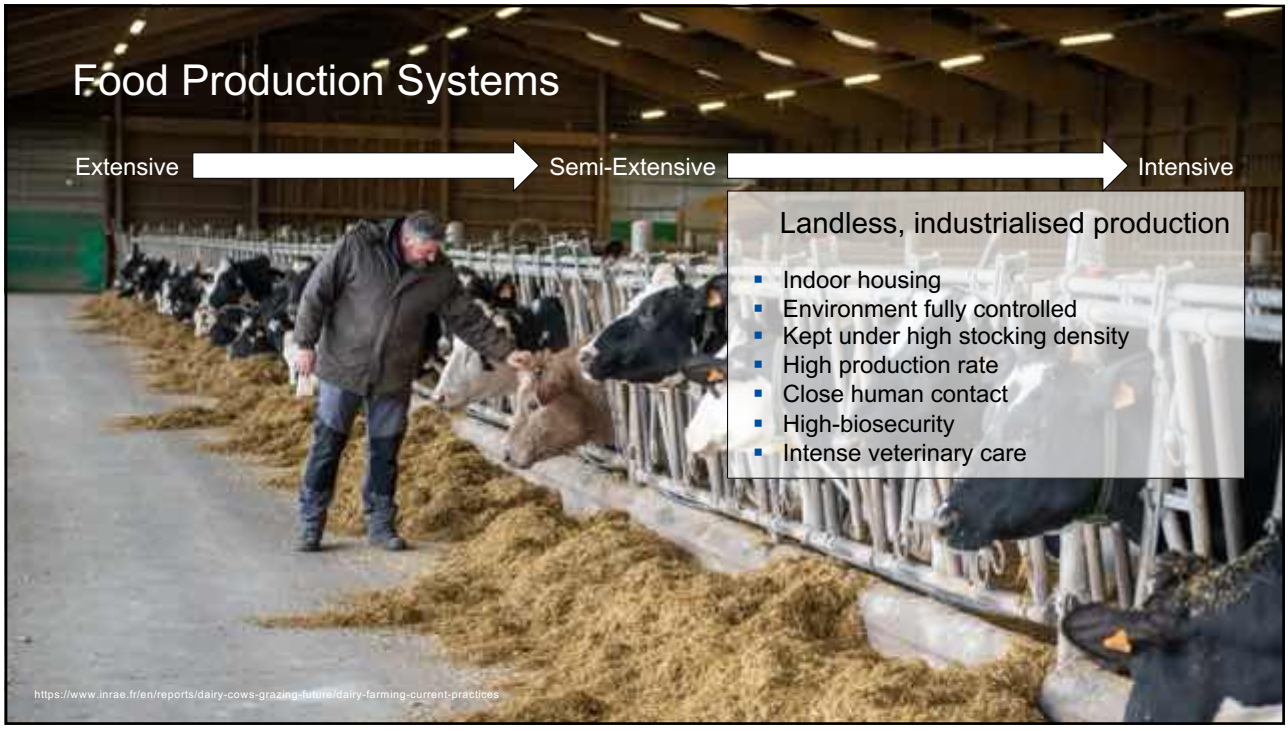
ILRI study shows that zoonotic diseases in livestock cause **2.3 billion human illnesses** and **1.7 million deaths/year**.→

Gilbert. 2012. Nature

18

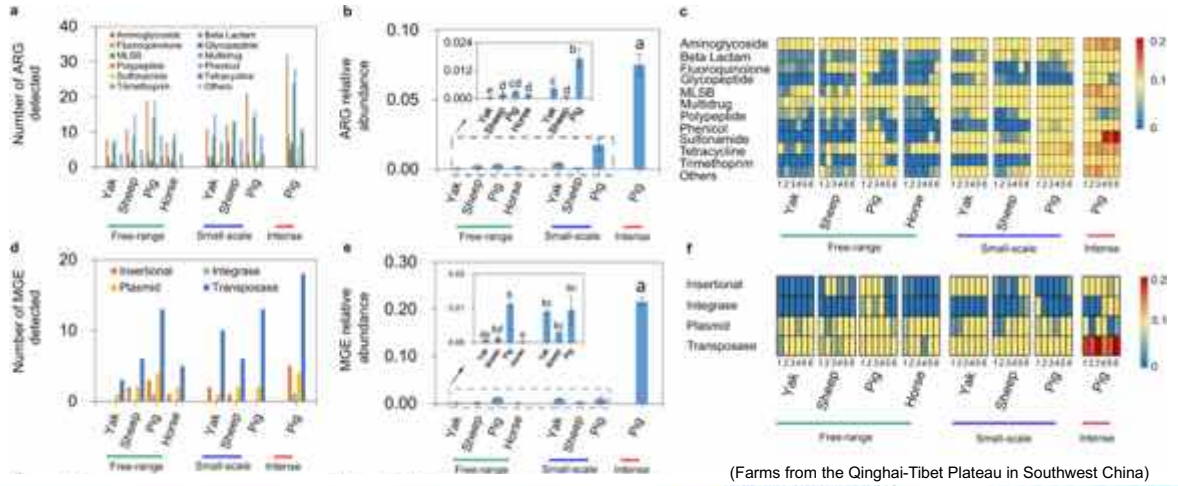

Food Production Systems
Extensive
Semi-Extensive
Intensive
Highly extensive pastoralist grazing
Natural environment
Lower animal numbers
Low production rate
Animals express natural behaviour
Less labour intense
Low biosecurity

19


Food Production Systems
Extensive
Semi-Extensive
Intensive
Landless, industrialised production
Indoor housing
Environment fully controlled
Kept under high stocking density
High production rate
Close human contact
High-biosecurity
Intense veterinary care
https://www.inrae.fr/en/reports/dairy-cows-grazing-future/dairy-farming-current-practices

20

Intensified Livestock Farming Increases Antibiotic Resistance Genotypes and Phenotypes in Animal Feces



(Farms from the Qinghai-Tibet Plateau in Southwest China)

Wang et al. 2023. Nature Communications Earth & Environment

21

Integrated Poultry & Fish Farming

pashudhanpraharee.com/

(…) Chicken raising for meat (broilers) or eggs (layers) can be integrated with fish culture to reduce costs on fertilizers and feeds in fish culture and maximize benefits. Chicken can be raised over or adjacent to the ponds and the poultry excreta recycled to fertilize the fishponds. Raising chickens over the pond has certain advantages: it maximizes the use of space; saves labour in transporting manure to the ponds and the poultry house is more hygienic. No significant differences have been observed on the chickens' growth or egg laying when they are raised over the ponds or on land. In case of the former, the pond embankment could still be utilized for raising vegetables. (…)

22

Integrated Poultry & Fish Farming

pashudhanpraharee.com/

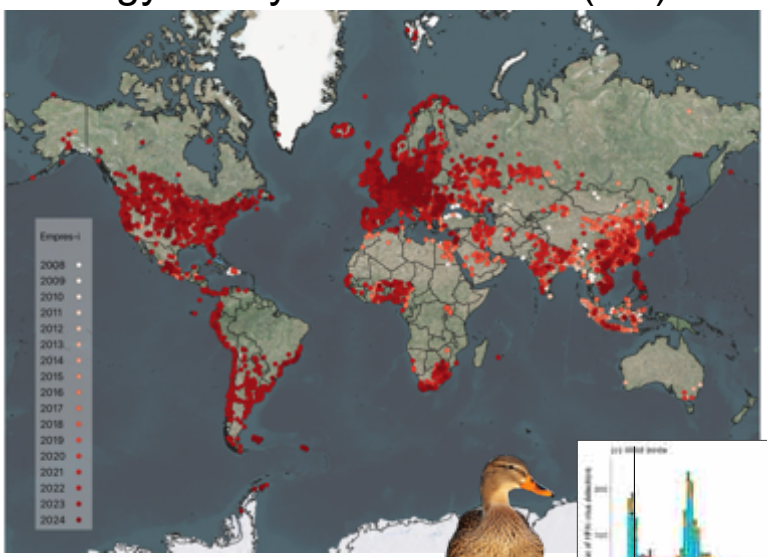
anonymised (06.10.2024)

Animal and human pictograms: Biorender

23

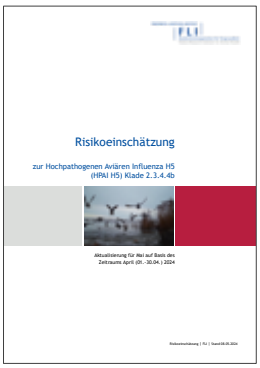
Ecology is Key to Understand (HP)AI

Avian Influenza

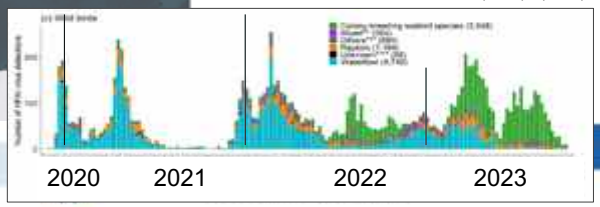


Data source: FAO

https://www.fli.de/

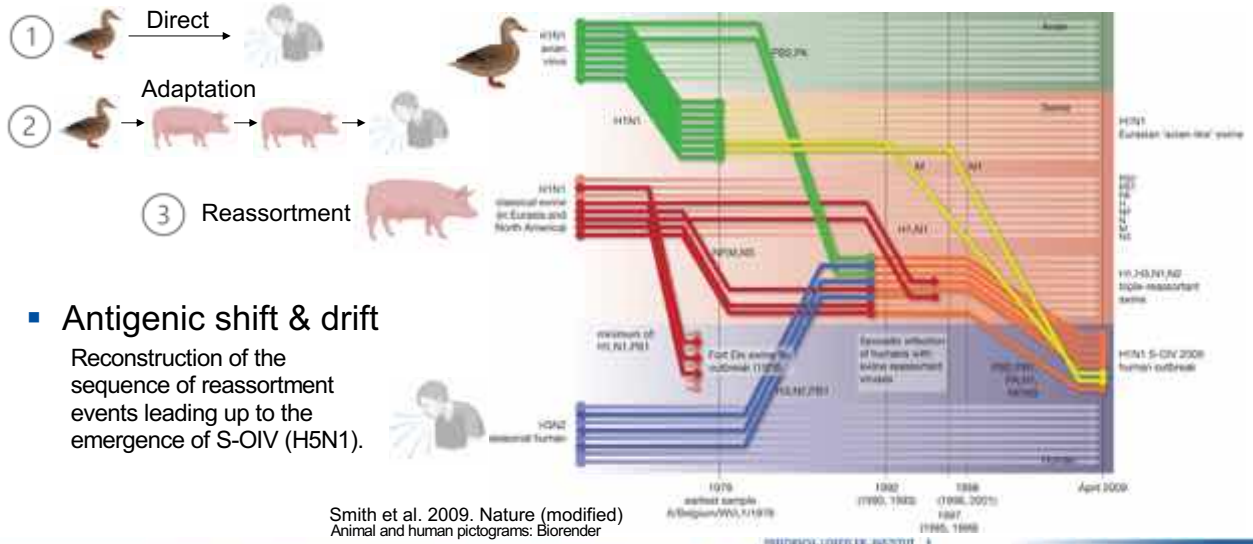


Avian influenza overview June–September 2023. *EFSA J.* **21**, e08328 (2023). (mod.)



24

The HPAI Pandemic Potential



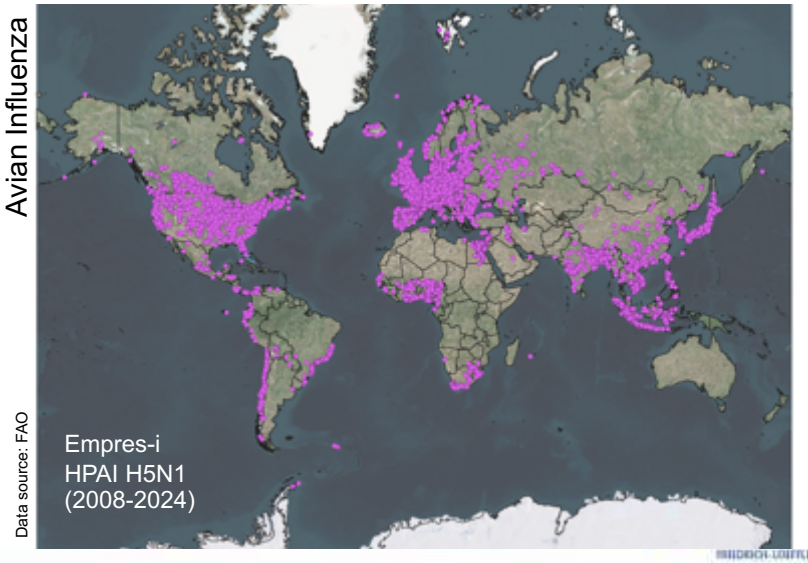
- Antigenic shift & drift

  Reconstruction of the sequence of reassortment events leading up to the emergence of S-OIV (H5N1).

Smith et al. 2009. Nature (modified)
Animal and human pictograms: Biorender

25

Ecology is Key to Understand (HP)AI

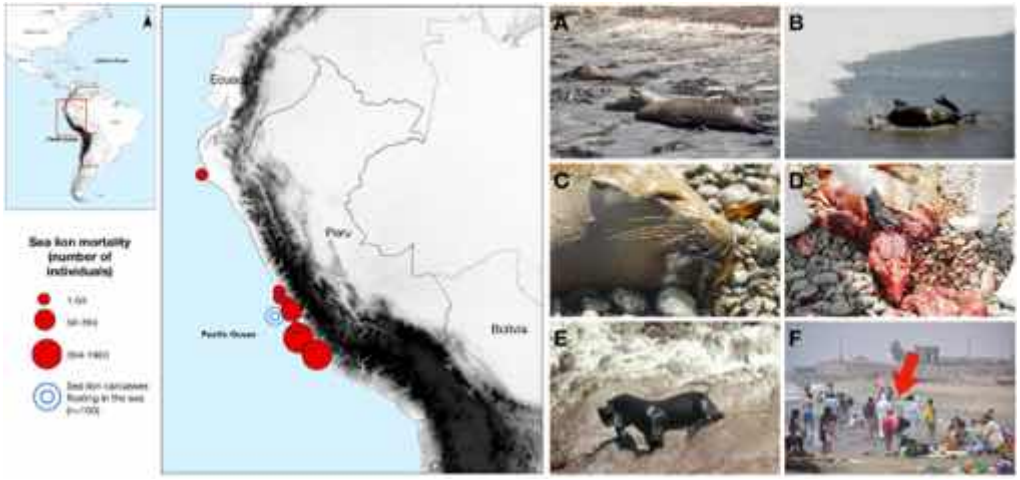



First birds, now mammals: how H5N1 is killing thousands of sea lions in Peru

The Guardien, 21.03.2023

26

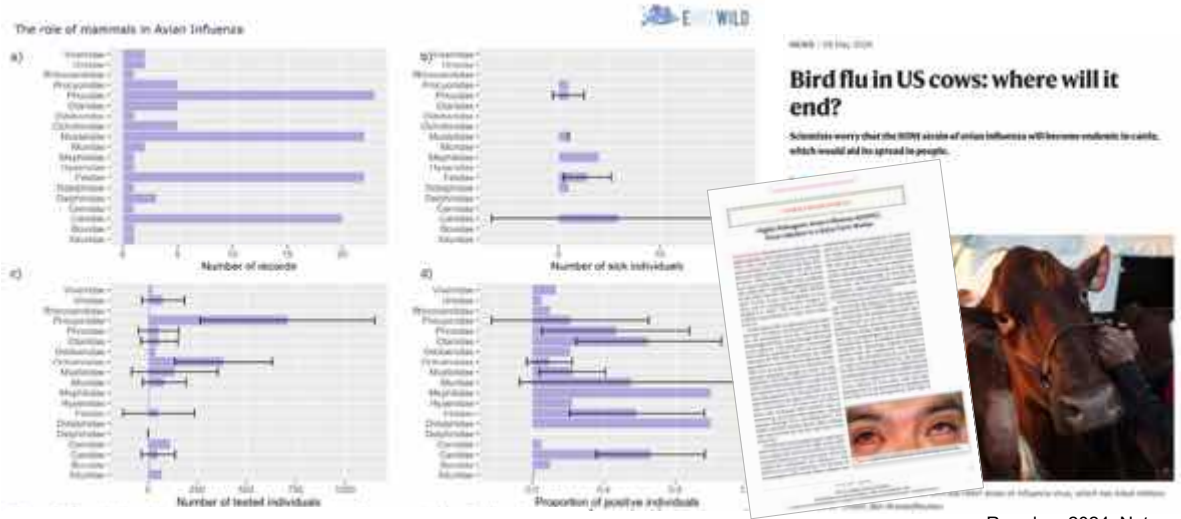
Mass Mortality of Marine Mammals Associated to HPAI (H5N1) in South America



Gamarra-Toledo et al. 2023. bioRxiv

27

The Role of Mammals in Avian Influenza: a Review



ENetWild Consortium et al. 2024. EFSA Supporting Publication

Uyeki. 2024. NEJM

Reardon. 2024. Nature

28

HPAI – The Ecological Disaster Is Near

Northern Gannet breeding colony in Scotland, UK

FAO Scientific Task Force on AI in Wild Birds, Statement – July 2023

In 2023 HPAI reached Antarctica

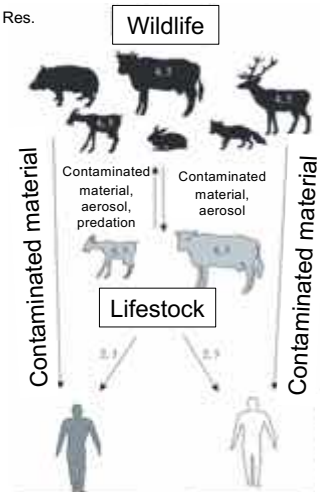
https://www.bas.ac.uk/media-post/penguins-test-positive-for-avian-flu-on-south-georgia/

©FLI

29

Zoonotic Tuberculosis

Biet et al. 2005. Vet. Res.



Vertical and horizontal transmission

Vertical and horizontal transmission

Aerosol, ingestion derivate products

30

Zoonotic Tuberculosis

Example I: South-Central Spain

Significant risk factors for zoonotic TB

- Extensive production system
- High number of fenced big game estates ≤2km near to farm (reservoir system)
- High number of open game estates in vicinity
- Large farm size (spatial overlap with reservoir systems)
- High number of hunted deer (proxy for deer density)

Multispecies reservoir system ⟶

Farm-level risk factors for the occurrence, new infection or persistence of tuberculosis in cattle herds from South-Central Spain

Picture: Seano et al. 2020. Pathogens

31

Food Production Systems

- Complex systems within a greater ecological landscape

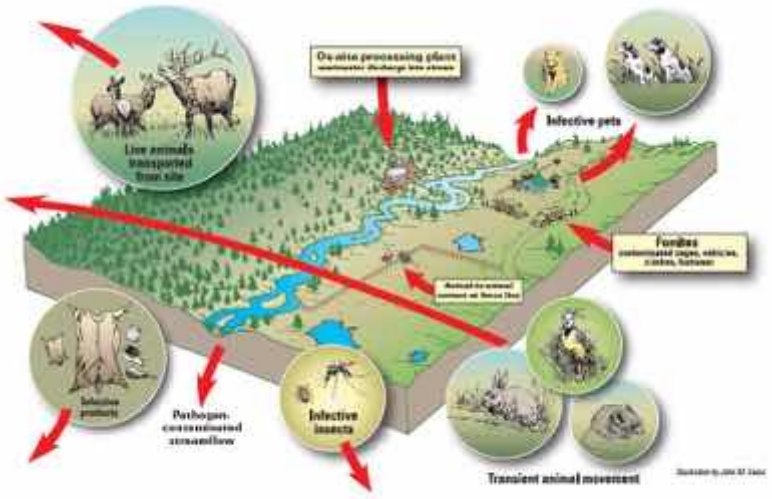


Illustration by J.M. Evans

32

Food Production Systems

- Complex systems within a greater ecological landscape
- Environmental impacts **before** and **after the farm gate** have **an indirect impact** on zoonotic disease emergency

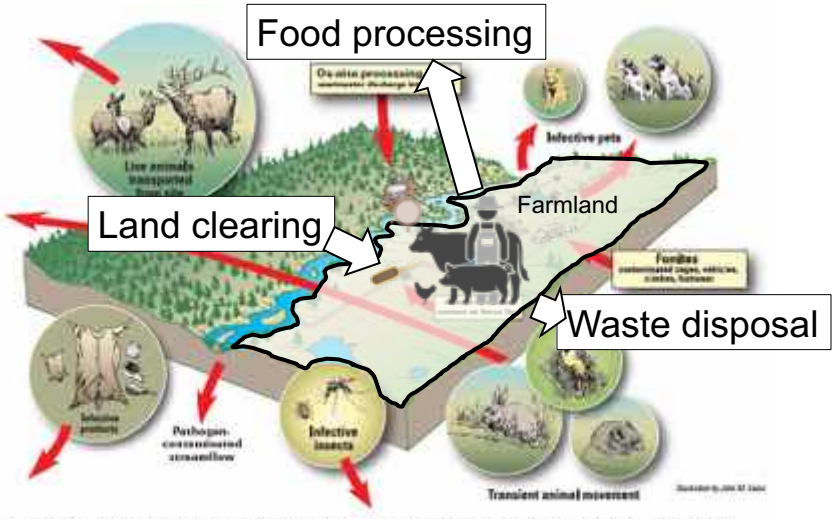


Illustration by J.M. Evans, modified with BioRender.com

33

Intensive Animal Management Strategies

Evidence of zoonotic disease emergence

Elevated risks

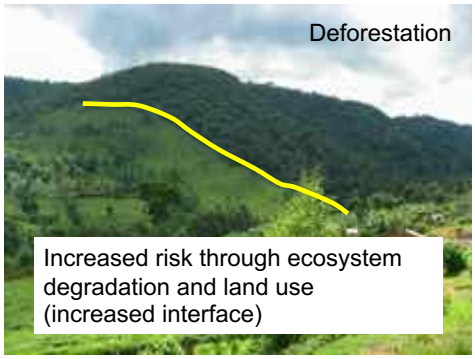
- Indoor production and confinement
- Genetic homogenisation
- Subtherapeutic and growth-promoting antibiotic use
- Long-distance transportation
- Physiological stress from crowding, confinement, and conflict (e.g., gestation crates, veal crates, and battery cages)
- Temporary/seasonal and transient human labour
- Concentrated animal waste

Hayek. 2022. Science Advances (Review)

Commercial poultry farming, Ghana

34

Intensive Animal Management Strategies



Bwindi Impenetrable Forest, Uganda

Evidence of reduced land and resource needs

Neutral or reduced risks

- Improving veterinary care and reducing mortality
- Improving animal husbandry management (e.g., lower reproductive age)
- Integrating crop and livestock production

In ruminants:

- Optimizing grazing densities
- Improving forage quality
- Amending and restoring degraded pastures

Hayek. 2022. Science Advances (Review)

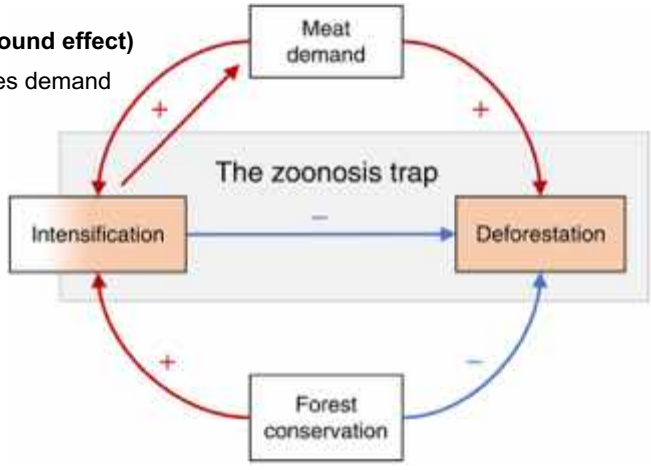
35

Intensive Animal Management Strategies

Jevon's paradox (rebound effect)

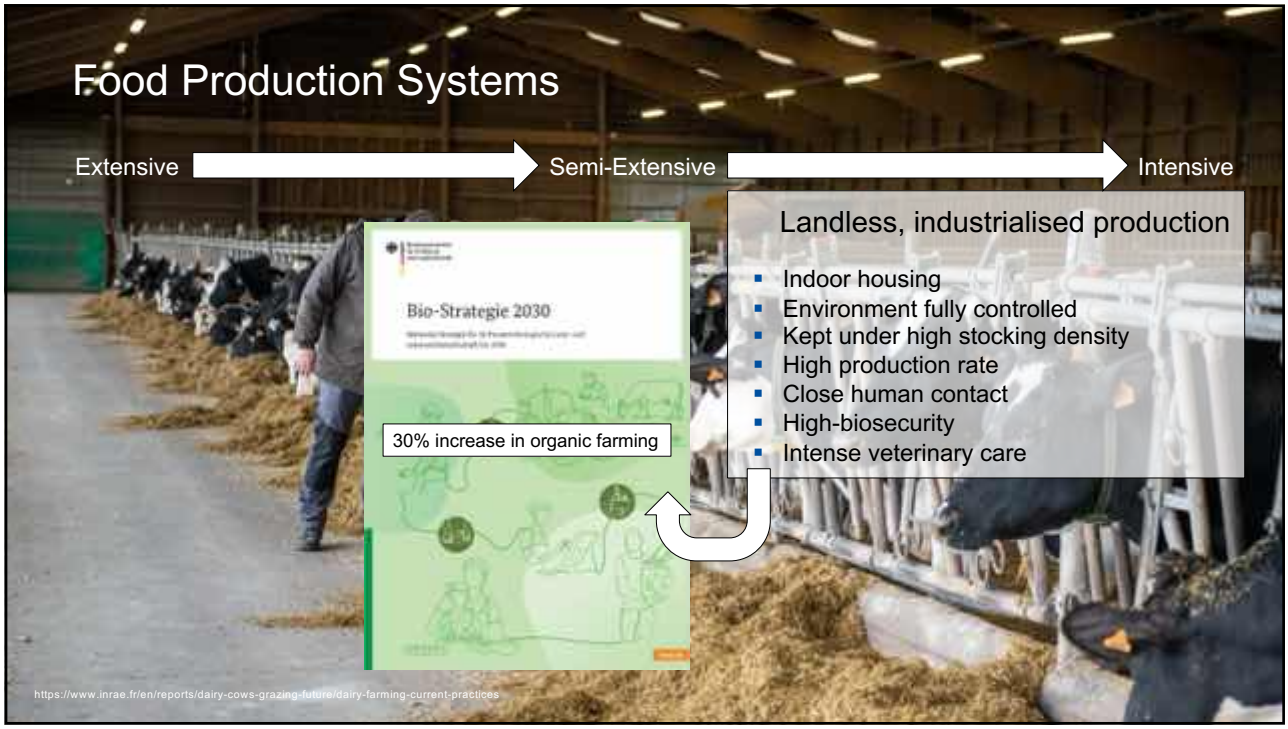
- Intensification creates demand

(lower costs beget more consumption & production)



Hayek. 2022. Science Advances (Review)

36



37

Organic Farming – What to expect when we enlarge the interface?

Photos: Klaus Depner

Characteristic aspects of organic farming

- Outdoor rearing (→ increased contact with wildlife)
- Limited use of curative and preventive conventional medicine (→ increased susceptibility)
- Organic feed (→ risk of contamination)
- Incorporation of biological cycles within the farm (→ risk of recirculating infectious diseases)
- Increased land use

Kijlstra, A. & Eijck, I. A. J. M. 2006. J Life Sci

38

Organic Farming – What to expect when we enlarge the interface?

The global South as an information source for impact assessment

- ✓ Outdoor rearing
- ✓ Limited use of curative and preventive conventional medicine
- ✓ Organic feed
- (✓) Incorporation of biological cycles within the farm
- ✓ Increased land use

39

Syndemic [syn - dem - ic]

i0.wp.com

- Dangerous interaction of two or more diseases in a population
- Leads to worse health outcomes

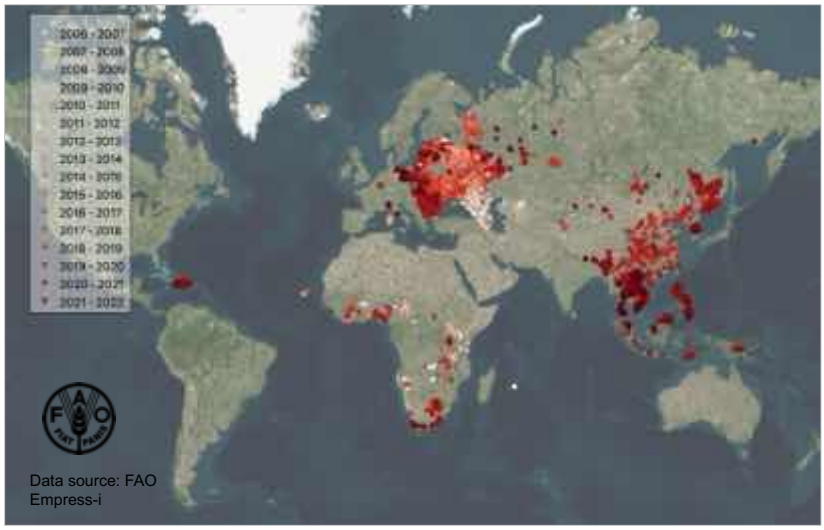
Classical examples in human health

- ❖ Flu and bacterial infection
- ❖ HIV & tuberculosis
- ❖ Syphilis & HIV

Under the One Health approach we should also include non-zoonotic diseases!

40

African Swine Fever – The Forgotten 'Pandemic'



e.g. Viet Nam (2019)

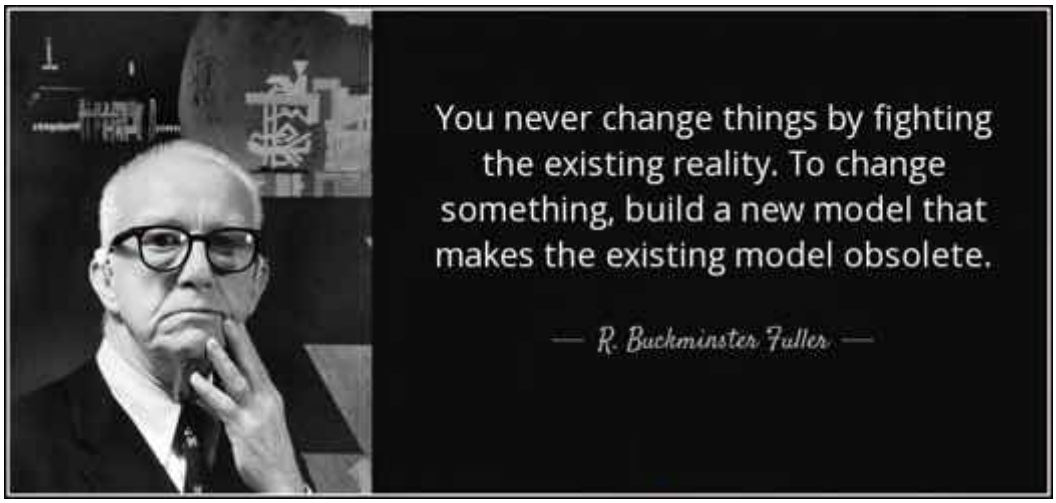
41

The Socio-ecological and Economical Context

- Farmers are globally aware of livestock diseases
- After reporting an outbreak and subsequent depopulation
  - Only global North gets financial compensation for depopulation
- Consequences
  - Lack of reporting
  - Market sale of sick animals and products (further spread of disease)
  - Increases risk behaviour (e.g., bushmeat consumption)
  - No access to health care

42

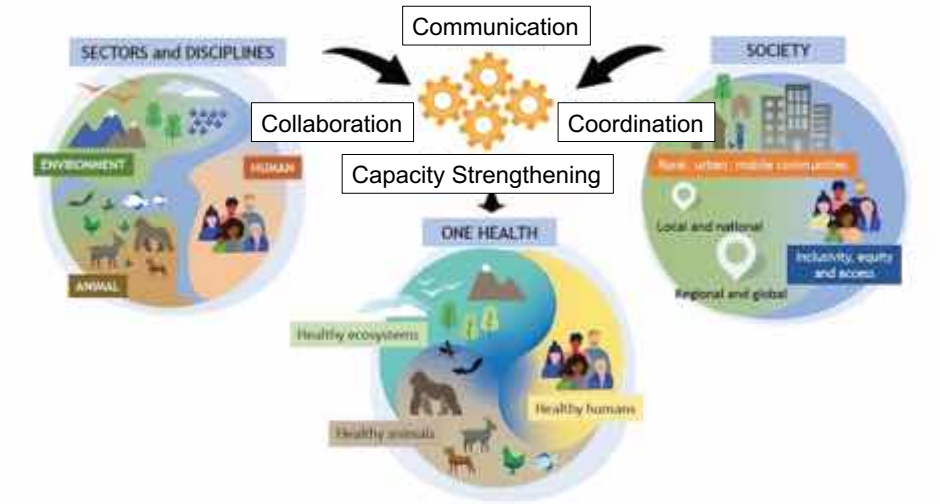
One Health as a New Model



AZ Quotes

43

The Four Cs of One Health



OHHLEP (2021)

44

Communication

Authenticity and credibility

One Health is an ethical dilemma: Respect for all and harm for none?

- Conflicting interests
  - ❖ not always possible to act in the best interests of all
- Generally anthropocentric viewpoint
- How do we reach all levels of society?

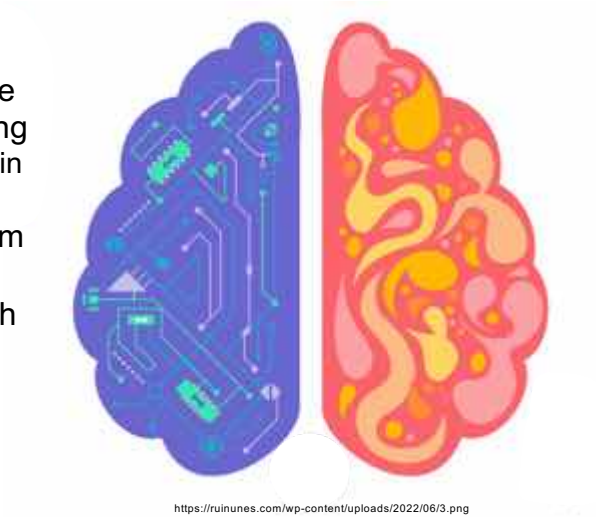
https://www.zeit.de/2014/21/tierversuche-versuchstiere-maeuse-ratten

https://www.sueddeutsche.de/bayern/bayern-vogelgrippe-bse-tierseuchen-1.6000365?reduced=true

45

Collaboration

- One Health does not mean everyone or every institution is doing everything
  - ❖ We need specialists and generalists in all sectors
- Reversing conservative systems from competitive to collaborative
- Appreciation of the different research disciplines and depths
- Respectful and ethically correct
- Listen to the needs of your partner
  - ❖ Context specific



https://ruinunes.com/wp-content/uploads/2022/06/3.png

46

Tools to foster intersectoral collaboration

International Health Regulations (IHR)-Public Veterinary Service (PVS) National Bridging Workshop (NBW)

- Brings together stakeholders from the animal health and human health services within a given country

Impressions of the pilot rabies NB workshops (Ghana and Bali):



47

Coordination

One Health Lighthouse Projects

- Local, regional and global showcase projects that demonstrate the positive effect of One Health
- Not only in the academic world
- Innovative thinking (out of the box)
- The motivation to change something (crossing borders)

48

Institute of International Animal Health/One Health [est. 2020]
Mandate and Mission

§27 (8) Tiergesundheitsgesetz (German Animal Health Law)

- Reinforcing German commitment and visibility in infectious disease prevention abroad
- Capacity strengthening and technical support for international partners

49

Justus Liebig University of Giessen

Bildquelle: Roland Duss

Universität Gießen und Friedrich-Loeffler-Institut berufen PD Sascha Knauf auf die Professur für One Health

(03.07.2023) PD Sascha Knauf, Ph.D., kommissarischer Leiter des Instituts für Internationale Tiergesundheit/One Health (IITG) am Friedrich-Loeffler-Institut, wurde zum 30. Juni 2023 auf die Professur für One Health mit dem Schwerpunkt Internationale Tiergesundheit an der Justus-Liebig-Universität Gießen (JLU) berufen.

https://vet-magazin.de/

W3 Professur für One Health/Internationale Tiergesundheit, Fachbereich 10 (Veterinärmedizin)

Nur die JLU hat alle One Health relevanten Fachbereiche unter einem Dach!

50

Capacity Strengthening

The inequity in One Health

- Many countries in the tropics are committed to the One Health thinking (*more than countries in the Northern Hemisphere*)
- Uneven distribution of resources
  - ❖ Imbalance of the health system
- Cross-sectoral collaboration only possible when all partners have basic equipment and training

Livestock Health 'Data Hub', Zanzibar 2022

51

Capacity Strengthening

In addition to our world-wide flexible support

- Establishment of two field presences (Africa and Asia)
- Equal partnership (involving all FLI institutes)
- Basic and applied sciences
- Sustainable training and education (Training-of-trainers, ToT)
- Local relevant – globally significant
- **One Health (Animal – Human – Environment)**

52

Zanzibar

CC BY-SA 4.0 (Wikipedia)

Livestock type	Number of livestock
Cattle	166,047
Goat	55,575
Sheep	2,769
Pig	0
Poultry	2,903,221

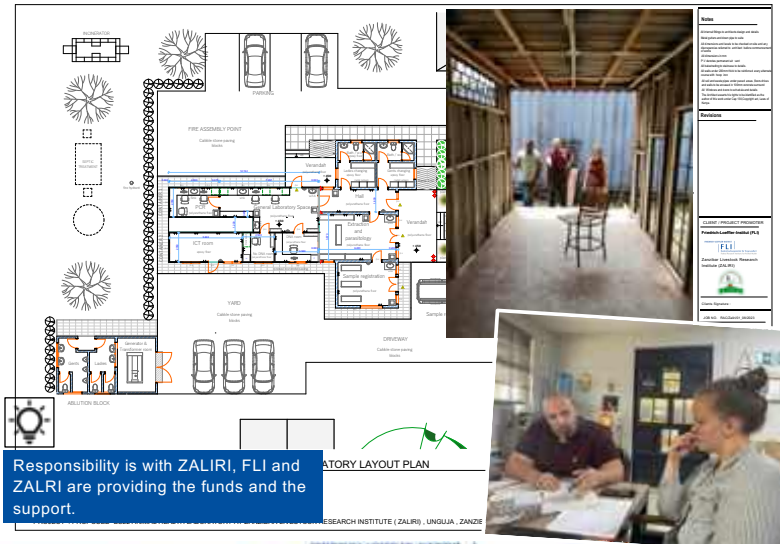
Total numbers of livestock by type in Zanzibar, created from Zanzibar household budget survey 2019-20, Y. Hikita (2023)

Area – 2,461 km²

Population – 1.5 Mio (2012)

53

Grande Challenges - Setting Up The Infrastructure



Responsibility is with ZALIRI, FLI and ZALRI are providing the funds and the support.

54

1st FLI-Field School

"Healthy Livestock - Healthy People" 27.11.-01.12.2023

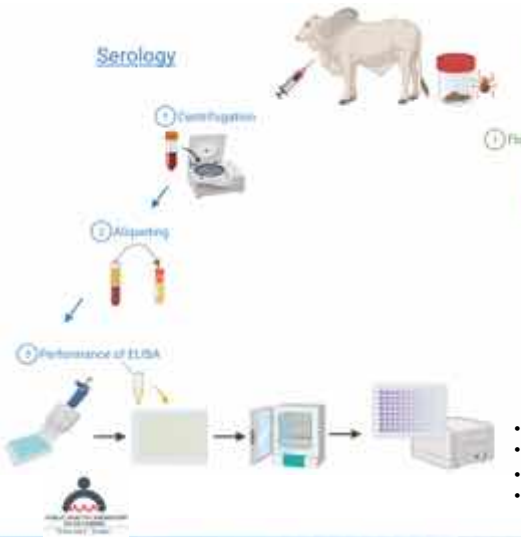
- Highly recognised by the Revolutionary Government of Zanzibar (Preseident of Zanzibar)
- Opening speech by Hon. Shamata Shaame Khamis (Minister, Ministry of Agriculture, Irrigation, Natural Resource and Livestock)
- Training-of-Trainer (ToT) approach

Learning objective

- Recognizing sick animals
- Herd health
- Case definitions
- Differential diagnoses
- Knowledge of correct and high quality sampling
- Overview of livestock diagnostics
- Interpretation of the results

55

Zanzibar Cattle Health (PhD Study J. Wiethoff)



- ID Screen® Rift Valley Fever Competition Multi-species
- ID Screen® Brucellosis Serum Indirect Multi-species
- ID Screen® Q Fever Indirect Multi-species
- Linnodee Bovine Leptospira Hardjo ELISA kit

56

Step-wise Growth Of The One Health Family On Zanzibar

High-Level Meetings – High Support

Zanzibar Ministry of Blue Economy and Fisheries
(Principal Secretary Level)

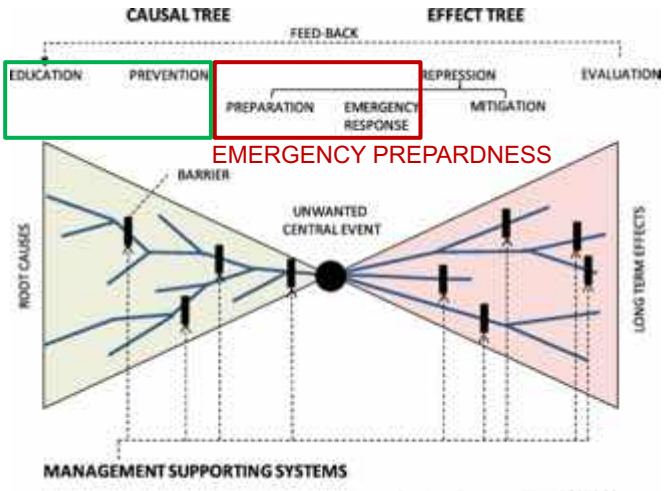
Zanzibar Ministry of Tourism and Heritage
(Director Level)

One Health – One Ocean
Zanzibar Ocean Museum

Deutsches Meeresmuseum Stralsund

57

Root Causes And Long-Term Effects

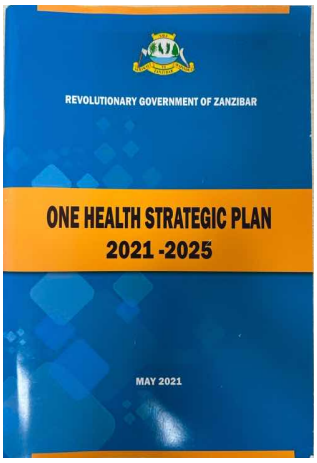


Bow-tie model and the safety hierarchy

Lindout, P. et al. 2017. Safety Sci

58

What we can learn from the Global South



- Transforming traditional systems into intersectoral transdisciplinary workspaces
- National One Health Strategic Plans
- Information about emerging and re-emerging pathogens
- Data needed to evaluate the One Health approach

59

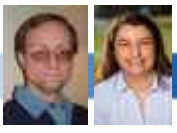
Integrated Wildlife Disease Surveillance In Europe

ENETWILD-2

Integrated wildlife disease surveillance that combines data from disease surveillance, and the monitoring of wild populations and the biotic components of the ecosystem (adapted from Cardoso 2022).

- E*Net*Wild-*2* Consortium

C. Staubach C. Sauter-Louis

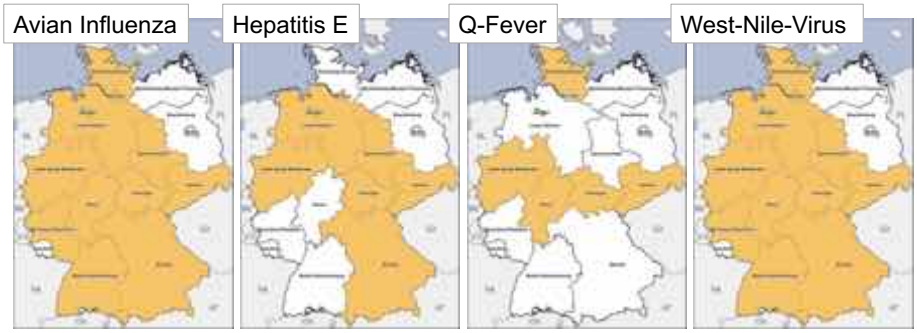


60

One Health for Surveillance

Setting up a coordinated surveillance under the One Health approach (OH4Surveillance) in Europe

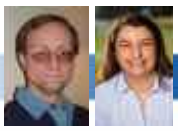
Avian Influenza | Hepatitis E | Q-Fever | West-Nile-Virus



Funded by the European Union
EU4H Project Grant

efsa

- Harmonized at international level
- Standardized procedures
- Widening of the scope



61

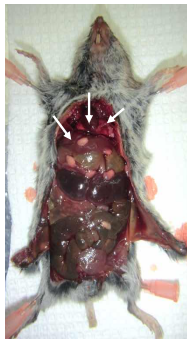
BEPREP

Funded by the European Union
2022 -2027

Identification of Best Practice for Biodiversity Recovery and Public Health Interventions to Prevent Future Epidemics and Pandemics

- Nature restoration targeting biodiversity recovery - isolated or in combination with public health interventions - has been identified as a major disease risk mitigation tool.

❖ Spatially and temporally replicated field studies and experiments
❖ 12 case study areas in Europe and the tropics



→ Identify causal mechanisms of infection dynamics and generate knowledge how to interrupt infection pathways.

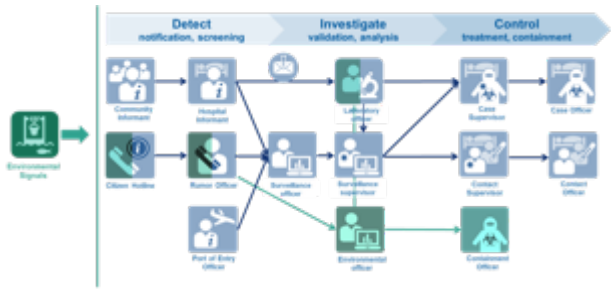
62

Surveillance, Outbreak Response Management and Analysis System

SORMAS goes One Health

Water-based Outbreak Prediction in Peri-Urban Africa
(IITG-HZI joint project)

KCCR



Curtesy to J. Dörrbecker and the SORMAS Team (HZI)

09/2021 Kumasi, Ghana

HZI HELMHOLTZ Zentrum für Infektionsforschung

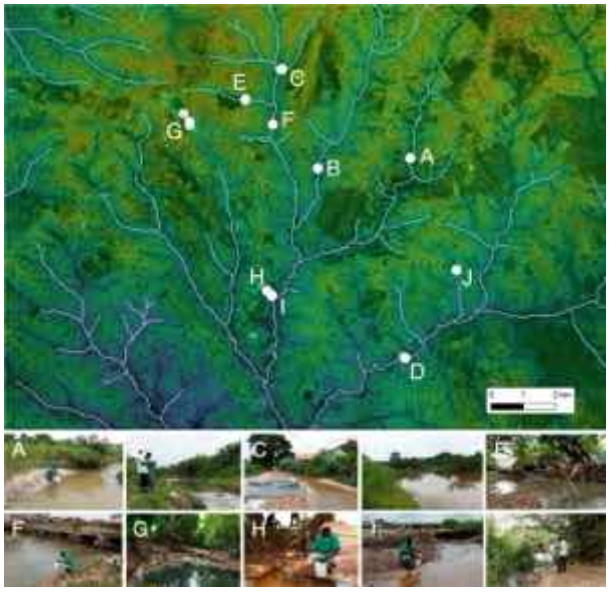
FLI

63

Water Sources

Kumasi, Ghana

- 2 L surface water/site per week
- 7 weeks sampling



Knauf et al. in prep.

UNIVERSITÄT GREIFSWALD

KCCR

- Antibiotic-resistant Enterobacteriaceae resistant to third-generation cephalosporins (ESBL-producers)
- High-risk clonal *Escherichia coli* lineages that are usually multi-drug resistant and highly virulent for humans and animals

Eger et al. 2024. JAC-Antimicrob Restist

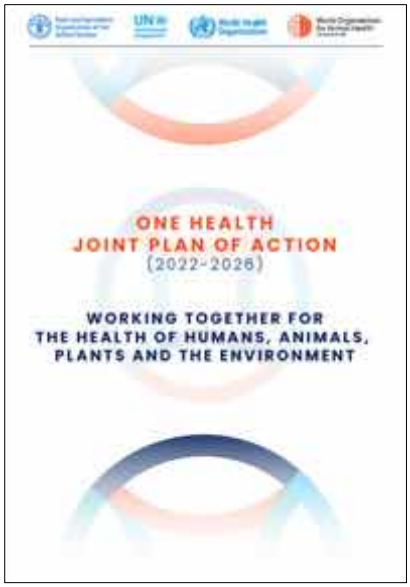
HZI HELMHOLTZ Zentrum für Infektionsforschung

FLI

64

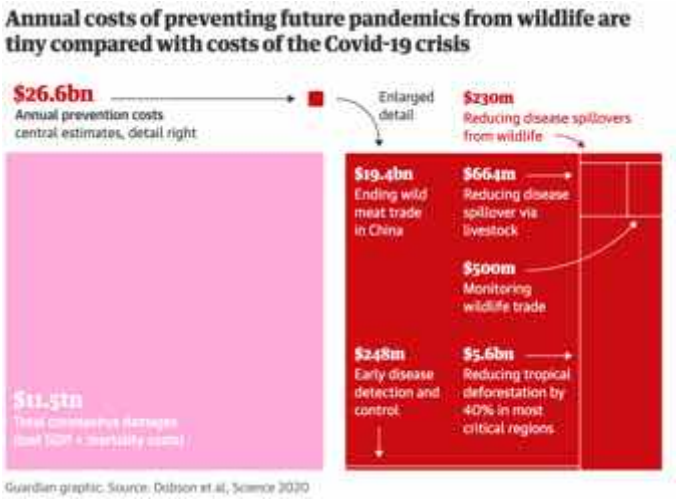
Quadripartite's One Health Joint Plan of Action

Action track 1: Enhancing One Health capacities to strengthen health systems
Action track 2: Reducing the risks from emerging and re-emerging zoonotic epidemics and pandemics
Action track 3: Controlling and eliminating zoonotic, neglected tropical and vector-born diseases
Action track 4: Strengthening the assessment, management and communication of food safety risks
Action track 5: Curbing the silent pandemic of Antimicrobial Resistance (AMR)
Action track 6: Integrating the environment into One Health



65

The COVID19 aftermath



Dobson et al. 2020. Science

66

Conclusion

- There is no magic in One Health
- Lead by example
- On the local, regional and global level
- Don't allow One Health to become a 'new' silo
- Be committed to 'Good Scientific Practice'
- One Health is politically supported (the momentum is now)

Bundesministerium für Ernährung und Landwirtschaft

Wir sind ein One Health Ministerium
– Prof. Dr. Dr. Schick

67

The Way We Design the Interface Will Impact The UN-SDGs

aer.eu

68

Never Stop Exploring.
One Health – For Good and For All.
FLI.

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JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

FRIEDRICH-LOEFFLER-INSTITUT since 1910 FLI Bundesforschungsinstitut für Tiergesundheit Federal Research Institute for Animal Health

69