Antibiorésistance: un modèle pour une approche One Health intégrant la santé des plantes

François ROGER & Adrien RIEUX

Cirad

UMR ASTRE & UMR PVBMT

Animal, Santé, Territoires, Risques, Ecosystèmes

&

Peuplement Végétaux et Bio-agresseurs en Milieu Tropical

Séminaire du 3 octobre 2018

La santé végétale dans le concept One Health : quelle contribution ?

RFSV Réseau Français pour la Santé Végétale

RMT VegDiag Diagnostic en santé végétale

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Ministère de l'Agriculture de l'Agroalimentaire et de la Forêt

One Health

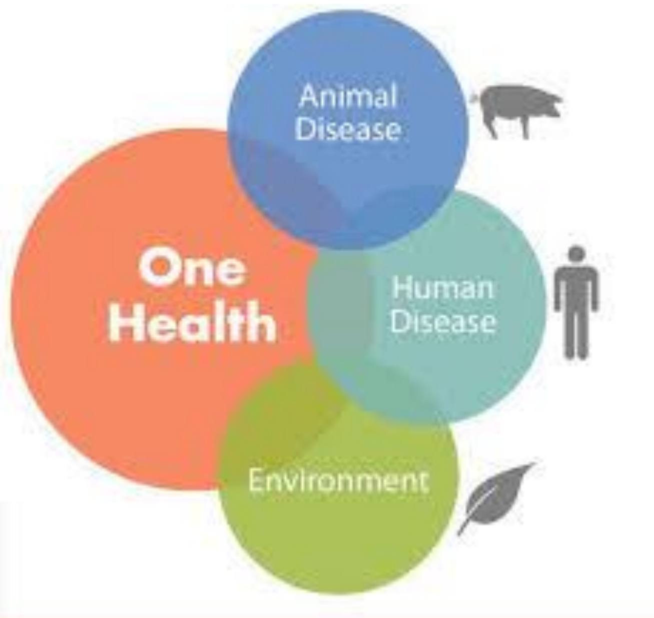
A world capable of preventing, detecting, containing, eliminating, and responding to animal and public health risks attributable to zoonoses and animal diseases with an impact on food security through multi-sectoral cooperation and strong partnerships.

The FAO-OIE-WHO Collaboration

Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces

A Tripartite Concept Note

April 2010



One Health, What else?

		One Health		EcoHealth	Planetary Health	
		Narrow	Wide		Narrow	Wide
Core contributing sciences	Human	Public health	Public health Human medicine Molecular and microbiology Health economics Social sciences	Public health Human medicine Rural and urban development and planning Social sciences Anthropology	Public health Human medicine	Human medicine Economy Energy Natural resources
	Animal	Veterinary medicine	Veterinary medicine	Veterinary medicine	–	Agricultural sciences (including plant and animal production sciences)
	Ecosystem	–	Environmental health Ecology	Conservation and ecosystem management	–	Ecology Other environmental sciences (including climate and biodiversity research) Marine sciences
Knowledge base		Western scientific	Western scientific	Western scientific Indigenous knowledge	Western scientific	Western scientific
Core values	Health	Individual health	Individual and population health	Population health	Individual and population health	Individual and population health
	Groups	Humans Animals	Humans Animals Ecosystems	Humans Animals Ecosystems	Humans	Humans
	Other			Biodiversity Sustainability (for humans, animals, ecosystems)	Sustainability (for humans)	Sustainability (for humans)
Reference		(2, 5, 8, 9)	(4, 7, 8, 11)	(1, 6, 12–15)	(17)	(3)

perspective
Health
n°18August2012
cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

Control of zoonotic diseases in Africa and Asia

The contribution of research to One Health

François ROGER

INFECTION ECOLOGY & EPIDEMIOLOGY
The One Health Journal
co-action PUBLISHING

DEBATE PIECES

One Health and EcoHealth: the same wine in different bottles?

François Roger, DVM, PhD[1]*, Alexandre Caron, DVM, PhD[1], Serge Morand, PhD[1], Miguel Pedrono, PhD[1], Michel de Garine-Wichatitsky, DVM, PhD[1], Veronique Chevalier, DVM, PhD[1], Annelise Tran, PhD[1], Nicolas Gaidet, PhD[1], Muriel Figuié, PhD[2], Marie-Noël de Visscher, PhD[1] and Aurélie Binot, PhD[1]

[1]AGIRs Research Unit, CIRAD, Montpellier, France; [2]MOISA Research unit, CIRAD, Montpellier, France

Responsible Editor: Tanja Strand, Uppsala University, Sweden.

ANTIMICROBIAL RESISTANCE IN SOUTH EAST ASIA

Antimicrobial policy interventions in food animal production in South East Asia

Flavie Goutard and colleagues call for concerted multisectoral measures through stronger policies to combat antimicrobial resistance

Antibiotics and other antimicrobial agents are widely used in food animal production for disease prevention and treatment in animals, to contain disease spread, to prevent contamination of the food chain, and to increase productivity.[1] However, their wide use in humans and animals leads to the emergence of antimicrobial resistance, a general term that encompasses antibiotic resistance.[2] In September 2016, the United Nations recognised the global rise of antimicrobial resistance as a threat to health and human development.[3]

Antimicrobial resistance will increase infectious disease outbreaks, slowing down livestock productivity and disrupting international trade. Recent projections antimicrobial agents, including in animals, but an evaluation of the national animal health systems of about 130 countries, performed by the World Organisation for Animal Health (OIE) using its performance veterinary services pathway tool, showed that more than 110 of them do not yet have appropriate legislation to regulate the import, manufacture, distribution, and use of antimicrobial agents. Even where legislation does exist and is enforced, antibiotics continue to be freely circulated as common goods, and in many countries they are often counterfeited.[5]

Several countries in the region produce meat and aquaculture products for the global market.[6] The World Health Organization South East Asia region (SEAR: each document we extracted information on the topic (drug and medicine production and marketing, drug and medicine use, antibiotic resistance surveillance and monitoring); the competent authority in charge; the type of document (policy or legal document); the objective(s); the key components and limitations. These results were cross checked with additional information on policy implementation and law enforcement found in other non-official documents.[28910] Specific recommendations are based on the reference guides published by WHO, OIE, and FAO.[11-13]

Food animal sector: trends and challenges of antibiotic use

Over recent decades, profound changes

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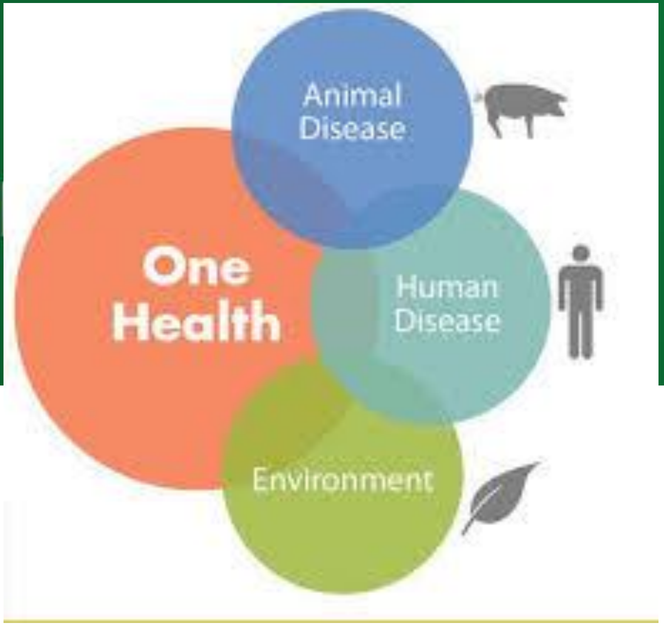
THE LANCET
Planetary Health

COMMENT | VOLUME 2, ISSUE 6, PE238-E239, JUNE 01, 2018

Environment: the neglected component of the One Health triad

Sabiha Y Essack

Open Access • DOI: https://doi.org/10.1016/S2542-5196(18)30124-4



mai 2017 39 perspactive — cirad, LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Avec *Perspective*, le Cirad propose un espace d'expression de nouvelles pistes de réflexion et d'action, fondées sur des travaux de recherche et sur l'expertise, sans pour autant présenter une position institutionnelle.

Antibiotiques en agriculture : réduire leur usage tout en limitant les risques sanitaires et socioéconomiques au Sud

François ROGER – Christian DUCROT

L'usage massif des antibiotiques en agriculture augmente avec l'essor des élevages intensifs et de la demande en produits animaux. Un phénomène grave en résulte, l'antibiorésistance : des bactéries développent des mécanismes de résistance aux antibiotiques, résistance qui se diffuse dans les populations bactériennes, y compris celles affectant l'homme. L'antibiorésistance a un impact majeur sur la santé publique, et ses effets sur la santé animale et la biodiversité sont encore mal connus. Face à ce fléau, réduire et rationaliser l'usage des antibiotiques est une urgence mondiale, au Nord comme au Sud. Cela requiert des actions intersectorielles impliquant les professionnels et les chercheurs dans de multiples domaines des sciences : les animaux domestiques, la faune sauvage, les plantes, l'homme et l'environnement. Ces actions sont particulièrement complexes à mettre en œuvre dans les pays du Sud.

Principales voies de diffusion de l'antibiorésistance en agriculture ; recherches, actions et politiques à mettre en œuvre.

Les voies de transmission des antibiotiques, de leurs résidus et de l'antibiorésistance sont symbolisées par les flèches d'un disque à l'autre et par le chevauchement des disques.

Les disques représentent tous les compartiments vivants concernés : la production agricole (agriculture, élevage, aquaculture) et ses secteurs de transformation, les éléments de l'environnement, et la population humaine dont l'usage de l'antibiothérapie peut être importante et non contrôlée.

Le Cirad, l'Institut national de la recherche agronomique (Inra, France) et leurs partenaires du Sud et du Nord interviennent dans les quatre domaines : les pratiques, la sensibilisation des acteurs (éleveurs, consommateurs, etc.), les connaissances (études, surveillance) et la gouvernance (politiques sanitaires, action collective).

Schéma inspiré des deux sources suivantes :

– la figure 1 de l'article en accès libre : Thanner S, Drissner D, Walsh F. 2016. Antimicrobial resistance in agriculture. mBio 7(2):e02227-15. http://dx.doi.org/10.1128/mBio.02227-15.

– la figure 1 du document en accès libre : Fao, 2016. Plan d'action de la Fao contre la résistance aux antimicrobiens. 2016-2020. Fao, Rome, 28 p. ISBN 978-92-5-209392-3. http://www.fao.org/documents/card/fr/c/72955b2b-4aaa-4c91-9d5a-56db93adac69/.

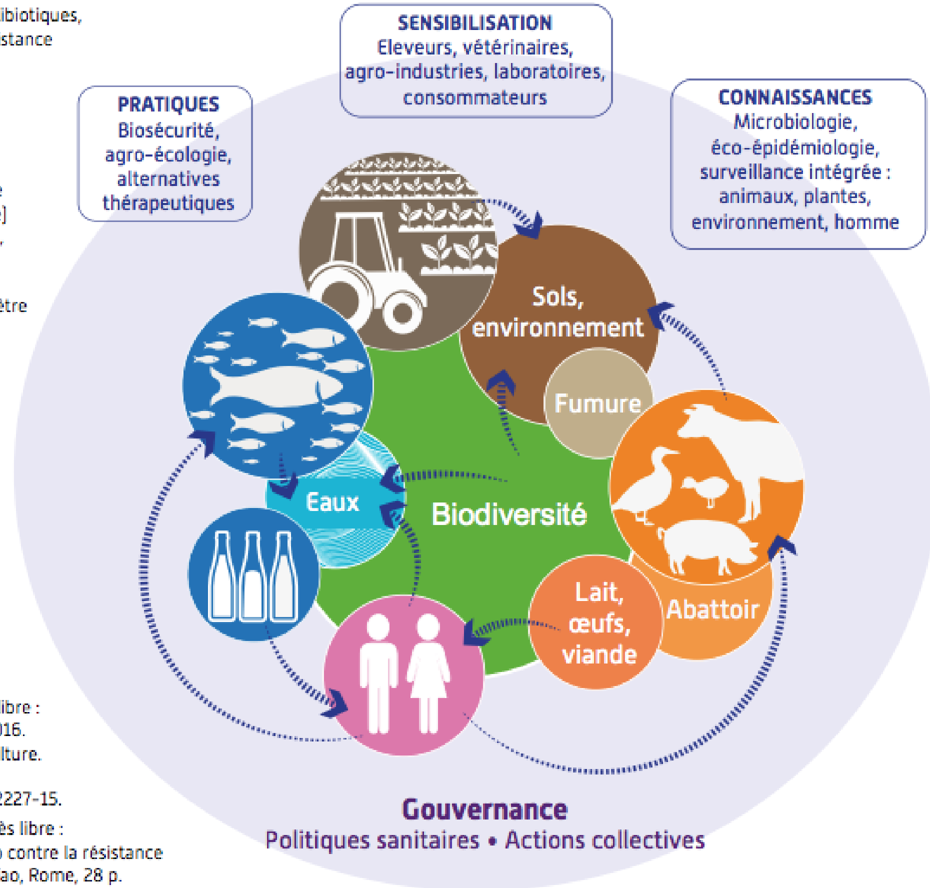


Illustration : Françoise Chirara, UMR Astre

Utilisation excessive des antibiotiques en élevage

Global trends in antimicrobial use in food animals

Thomas P. Van Boeckel[a,1], Charles Brower[b], Marius Gilbert[c,d], Bryan T. Grenfell[a,e,f], Simon A. Levin[a,g,h,1], Timothy P. Robinson[i], Aude Teillant[a,e], and Ramanan Laxminarayan[b,e,j,1]

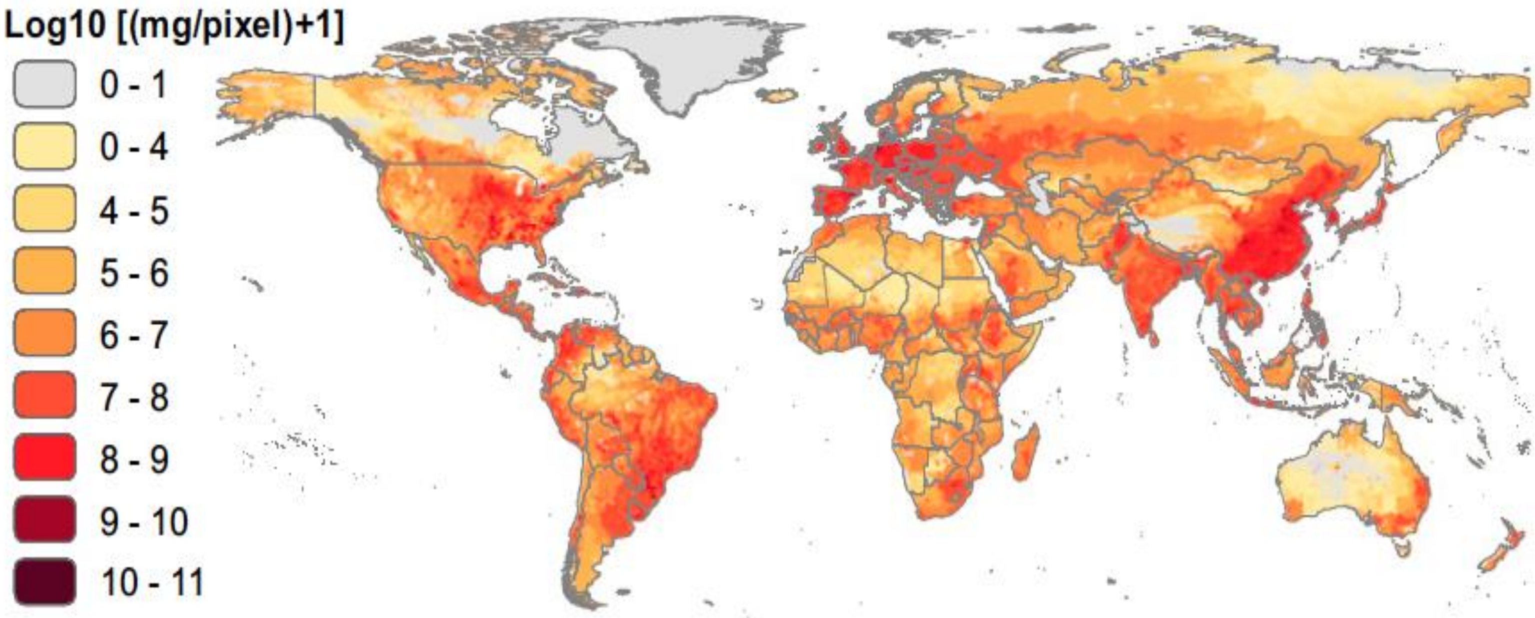
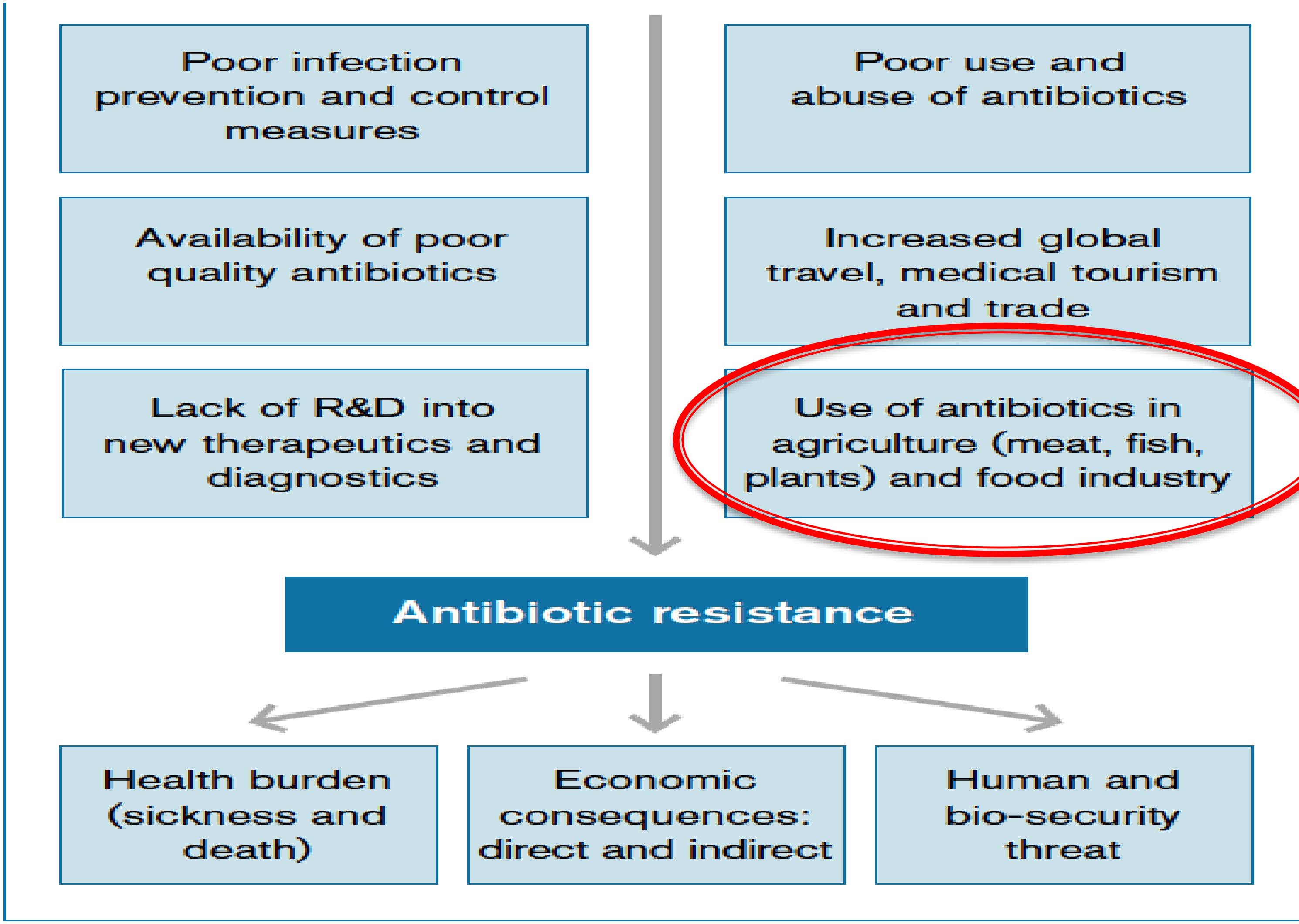


Fig. 3. Global antimicrobial consumption in livestock in milligrams per 10 km^2 pixels (*Top*) and average SD of estimates of milligrams per PCU (*Bottom*).

Driver's and Consequences of Antimicrobial Resistance



Estimates of Burden of Antibacterial Resistance

European Union
population 500m

25,000 deaths per year

2.5m extra hospital days

<u>Overall societal costs</u>
(€ 900 million, hosp. days)
Approx. €1.5 billion per year

Source: ECDC 2007

Thailand
population 70m

>38,000 deaths

>3.2m hospital days

<u>Overall societal costs</u>
US$ 84.6–202.8 mill. direct
>US$1.3 billion indirect

Source: Pumart et al 2012

United States
population 300m

>23,000 deaths

>2.0m illnesses

<u>Overall societal costs</u>
Up to $20 billion direct
Up to $35 billion indirect

Source: US CDC 2013

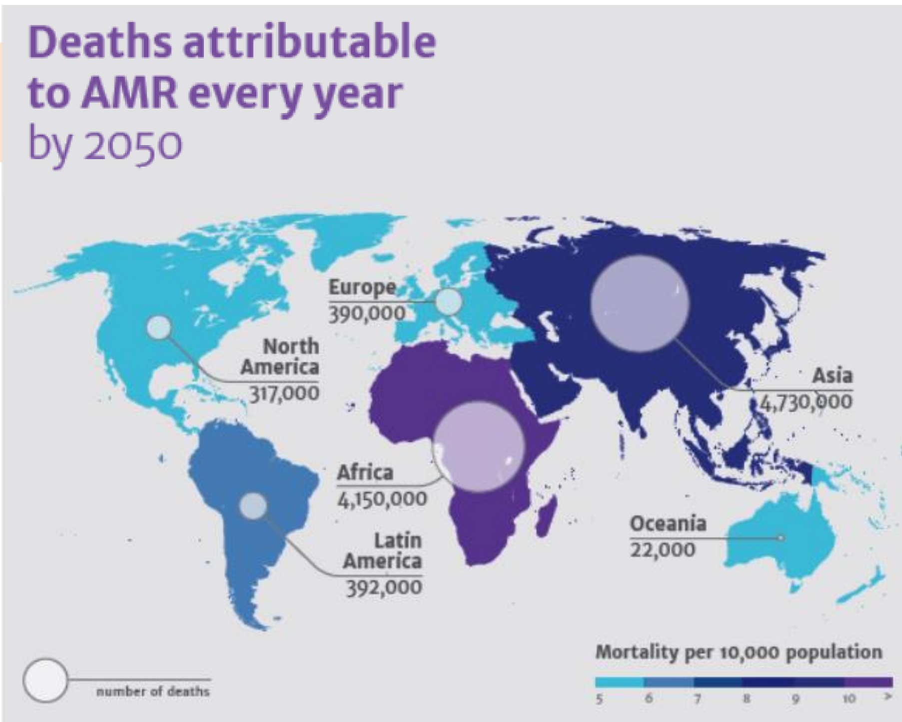
Global information is insufficient to show complete disease burden impact and costs

| Antimicrobial Resistance
Global Report on Surveillance 2014

World Health Organization

MARYN MCKENNA SCIENCE 12.15.14 1:18 PM

THE COMING COST OF SUPERBUGS: 10 MILLION DEATHS PER YEAR



AMR in Plant Agriculture

History and previous uses of antimicrobials on plants

1987
1963

- 10.000 y.a — Agriculture begin in the Fertile Crescent of Mesopotamia
- 5000 y.a — *Sulphur compounds & Pyrethrum used by Sumerians and Chinese to control insects in agriculture
- 2000 y.a — *Other organic chemicals derived from natural sources used in pest control.
- **1800** — *Copper sulphate first used on seed grains to inhibite fungi.
- 1900 — Organo-mercurial used on seeds to control diseases.
- 1928 — **Fleming discovers Penicillin (UK)**
- 1943 — Streptomycin discovery
- **1955** — *Streptomycin first used on apple and pears in USA
- 1960 — * Blasticidin & Kasugamycin discovered in Japan and used on rice
- 1960-70 — * Many new antibiotics tested on crops (US). Most of them were discarded because of high induced phytotoxicity levels
- 1982 — Oxytetracycline replacing Streptomycin in USA
- 1985 — Polyoxin, Jinggangmycin &gongzhulingmycin in China
- 1995 — Gentamicin & Oxolinic Acid introduced in America

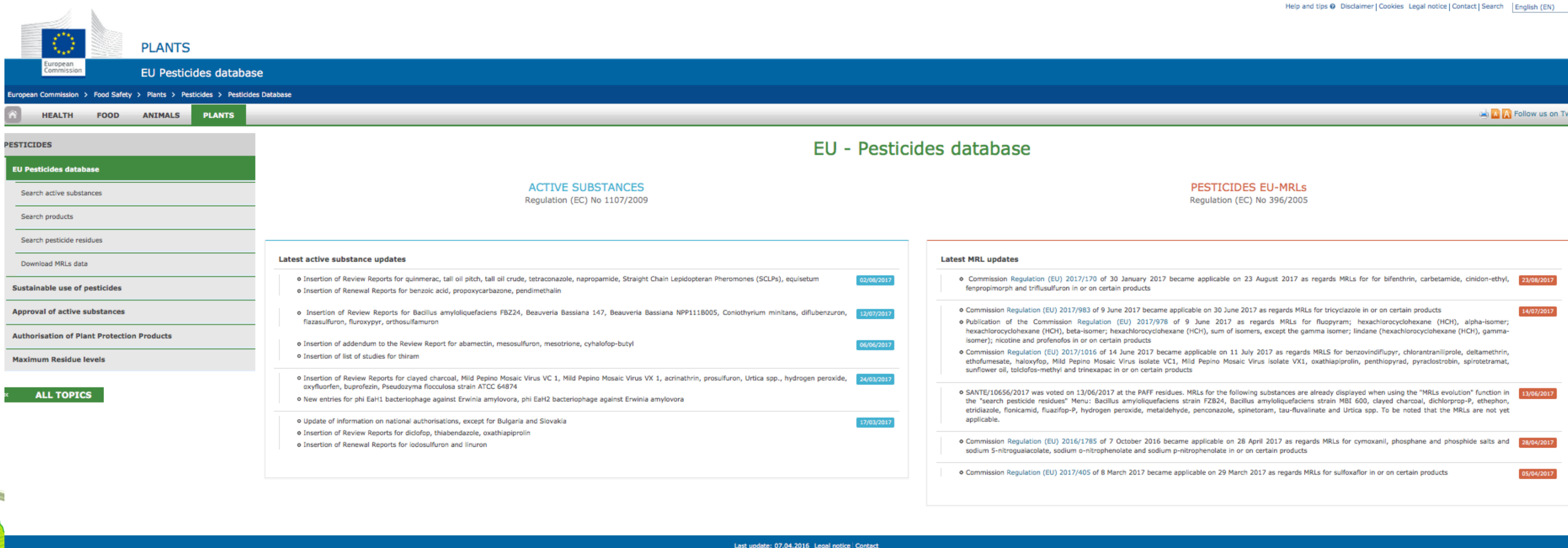
AMR in Plant Agriculture

Legislation & use

Europe:

- Use of antibiotics on crops is forbidded
- Most metals (copper, iron, zinc…) allowed

http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/



AMR in Plant Agriculture

Legislation & use

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United states of America

- Streptomycine & Oxytetracycline and Metals allowed

AMR in Plant Agriculture

Legislation & use

Table 1. Antibiotics registered for use in plant agriculture in the United States.

Crop use, crop	Disease	Disease agent	Registered treatment: Streptomycin[a,b]	Registered treatment: Oxytetracycline[b,c]
Terrestrial food and/or feed crop use				
Apple	Fire blight	*Erwinia amylovora*	F	F
Bean	Halo blight	*Pseudomonas syringae* pv. *phaseolicola*	S	—
Celery	Bacterial blight	*Pseudomonas cichorii*	F*	—
Crabapple	Fire blight	*E. amylovora*	F	—
Nectarine	Bacterial leaf and fruit spot	*Xanthomonas campestris* pv. *pruni*	—	F
Peach	Bacterial leaf and fruit spot	*X. campestris* pv. *pruni*	—	F
Pear	Fire blight	*E. amylovora*	F	F
Pepper	Bacterial spot	*X. campestris* pv. *vesicatoria*	F*	—
Potato	Bacterial soft rot	*E. chrysanthemi, E. carotovora* subspecies *carotovora*	S	—
	Blackleg	*E. carotovora* subspecies *atroseptica*	S	—
Quince	Fire blight	*E. amylovora*	F	—
Tomato	Bacterial spot	*X. campestris* pv. *vesicatoria*	F* and S	—
Nonfood crops				
Sugar beets (grown for seed)	Bacterial rot/blight	*Erwinia* species	S	S
Tobacco	Wildfire	*Pseudomonas syringae* pv. *tabaci*	F* and S	—
Ornamental herbaceous plants, shrubs, and vines, and greenhouse ornamentals				
Anthurium	Bacterial blight	*X. campestris* pv. *dieffenbachiae*	F	—
Cotoneaster	Fire blight	*E. amylovora*	F	F
Chrysanthemum	Bacterial wilt	*E. chrysanthemi, E. carotovora* subspecies *carotovora*	F	C
Crabapple, flowering	Fire blight	*E. amylovora*	F	—
Elm	Lethal yellows	*Phytoplasma*	—	I
Dieffenbachia	Bacterial stem rot	*Erwinia* species	F	—
Hawthorn	Fire blight	*E. amylovora*	F	—
Palm	Lethal yellows	*Phytoplasma*	—	I
Philodendron	Bacterial leaf spot	*X. campestris* pv. *dieffenbachiae*	F	F
Pyracantha	Fire blight	*E. amylovora*	F	—
Quince, flowering	Fire blight	*E. amylovora*	F	—
Roses	Crown gall	*Agrobacterium tumefaciens*	F	—

NOTE. F, foliar; F*, foliar, seedling stage only; S, seed, seed piece, or bed treatment; C, cutting; I, internal injection.
[a] Adapted from 1992 US Environmental Protection Agency (EPA) Reregistration Eligibility document [7].
[b] Data from [8, 9].
[c] Adapted from 1993 US EPA Reregistration Eligibility document [10].

Vidaver 2012

AMR in Plant Agriculture

Legislation & use

Europe:

- Use of antibiotics on crops is entirely forbidded
- Most metals (copper, iron, zinc…) allowed

United states of America

- Streptomycin & Oxytetracyclin and Metals allowed

Latin America: Streptomycin, Oxytetracyclin
+ Gentamicin and metals

AMR in Plant Agriculture

Legislation & use

Table 2. Use of the antibiotic agent gentamicin in food crops by country.

Country, crop	Disease	Disease agent
Chile		
Tomato	Bacterial canker	*Clavibacter michiganensis* subspecies *michiganensis*
Pear	Fire blight	*Erwinia amylovora*
Central America (Costa Rica, Honduras, Guatemala, El Salvador)		
Potato	Blackleg	*Erwinia carotovora* subspecies *atroseptica*
	Bacterial wilt	*Ralstonia solanacearum*
Tomato	Bacterial speck	*Pseudomonas syringae* pv. *tomato*
Chili	Bacterial spot	*Xanthomonas campestris* pv. *vesicatoria*
Cauliflower and broccoli	Bacterial soft rot	*Erwinia* species
Cabbage	Bacterial black rot	*X. campestris* pv. *campestris*
Mexico		
Potato	Black leg	*E. carotovora* subspecies *atroseptica*
Apple, pear, and ornamentals	Fire blight	*E. amylovora*
Tomato and chili	Bacterial spot	*X. campestris* pv. *vesicatoria*
Agave	Bland rottenness of the heart of agave	*Erwinia* species
Watermelon	Bacterial spot	*Xanthomonas* species

NOTE. The gentamicin used is Agry-gent (Quimica Agronomica de Mexico, Rhode Island No. 4908, Residencial Campestre, C.P. 31238, Chihuahua, Chihuahua, Mexico).

Vidaver 2012 Clinical Infectious Diseases

AMR in Plant Agriculture

Legislation & use

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United states of America

- Streptomycin & Oxytetracyclin and Metals allowed

Latin America: Streptomycin, Oxytetracyclin
+ Gentamicin and metals

Asia : Streptomycin, Oxytetracyclin, Gentamicin + metals
+ Kasugamycin: rice blast disease
+ Midiomycin on cucumber, tomato, pear, apple, garlic, onion (blight diseases)
+ Gongzhulingmycin on sorghum
+ Oxytetracyclin on citrus (HLB)

………..

AMR in Plant Agriculture

Legislation & use

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United states of America

- Streptomycin & Oxytetracyclin and Metals allowed

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Asia : Streptomycin, Oxytetracyclin, Gentamicin + metals

+ Kasugamycin: rice blast disease
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+ Gongzhulingmycin on sorghum
+ Oxytetracyclin on citrus (HLB)

………..

Africa : ???

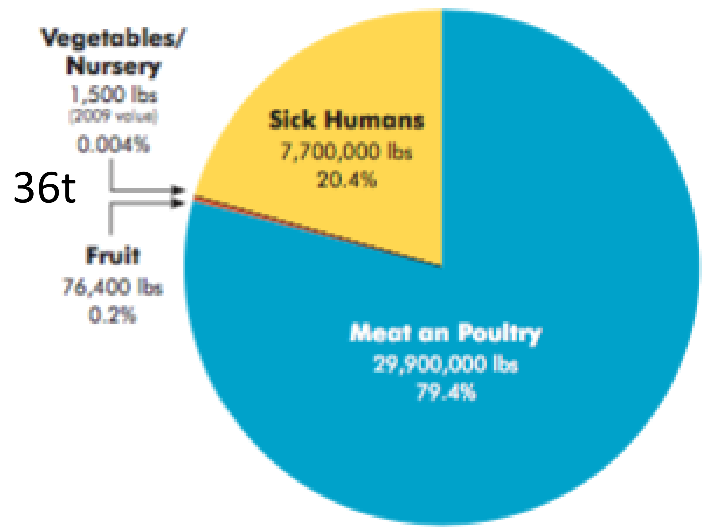
AMR in Plant Agriculture

Quantity applied

- Reliable data only for USA

TABLE 1: **Use of Antibiotics on Fruit in the U.S. in 2015 according to USDA NASS** (www.nass.usda.gov)

	Streptomycin				Oxytetracycline			
Crop	Percentage of Acres Treated	Acres Treated	Pounds per Acre per year	Total Active Ingredient Per year (lb)	Percentage of Acres Treated	Acres Treated	Pounds per Acre Per Year	Total Active Ingredient Per year (lb)
Apple	26	68,581	0.49	33,600	11	30,000	0.27	8,100
Pear	16	7,346	0.39	2,900	30	14,200	0.5	7,100
Peaches					5	4,103	0.39	1,600
Total				**36,500**				**16,800**



- Need for similar data in ASIA !!!

AMR in Plant Agriculture

Emergence of AMR

ANNUAL REVIEWS

Annual Review of Phytopathology

Antibiotic Resistance in Plant-Pathogenic Bacteria

George W. Sundin[1] and Nian Wang[2]

[1]Department of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing, Michigan 48824, USA; email: sundin@msu.edu

[2]Citrus Research and Education Center, Department of Microbiology and Cell Science, Institute of Food and Agricultural Sciences, University of Florida, Lake Alfred, Florida 33850, USA

Table 2 Reports of antibiotic resistance in plant-pathogenic bacteria

Antibiotic	Organism	Location	Genetic mechanism	Reference
Kasugamycin	*Acidovorax avenae* ssp. *avenae*	Japan	*aac(2′)-IIa*	138
	Burkholderia glumae	Japan	*aac(2′)-IIa*	138
Oxolinic acid	*Erwinia amylovora*	Israel	Probable chromosomal mutation	53
	Burkholderia glumae	Israel	Probable chromosomal mutation	53
		Japan	Probable chromosomal mutation	41
Streptomcyin	*E. amylovora*	California, USA	Chromosomal mutation	97
		California, USA	*rpsL* mutation	14
		Michigan, USA	*rpsL* mutation	14
		Oregon, USA	*rpsL* mutation	14
		Washington, USA	*rpsL* mutation	14
		New Zealand	*rpsL* mutation	14
		California, USA	*strAB* on plasmid RSF1010	80
		California, USA	Tn*5393*a	32
		Michigan, USA	Tn*5393* on pEa34	13
		Michigan, USA	Tn*5393* on pEa29	63
		New York, USA	Tn*5393* on pEa29	119
	Pseudomonas syringae			
	P. syringae	Oregon, USA	*strAB*[a]	93
	P. syringae pv. *actinidiae*	Japan	Tn*5393*a	39
		Japan	*rpsL* mutation	
	P. syringae pv. *papulans*	New York, USA	*strAB*[b]	75
		Michigan, USA	*strAB*[b]	52
	P. syringae pv. *syringae*	Oklahoma, USA	Tn*5393*a	111
	X. axonopodis pv. vesicatoria	Argentina	Tn*5393*b	113
	X. citri subsp. *citri*	Korea	*strB*[c]	48
	X. oryzae pv. *oryzae*	China	*aadA1*	134

[a]Presence of the *strAB* genes was determined by hybridization, but structural genes of Tn*5393* were not screened for.
[b]The probe SMP3 was utilized to detect streptomycin resistance; this probe contains portions of the *strA* and *tnpR* genes from Tn*5393*a.
[c]Presence of the *strB* gene was determined by PCR but *strA* or structural genes of Tn*5393* were not screened for.

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VegDiag Diagnostic en santé végétale

RÉPUBLIQUE FRANÇAISE — MINISTÈRE DE L'AGRICULTURE DE L'AGROALIMENTAIRE ET DE LA FORÊT

AMR in Plant Agriculture

Synergy between resistance to heavy-metals and antibiotics

Presence of Cu & Zn (soil, water) increase the probability of acquiring antibiotics resistance

- Same physiological processes (e.g. efflux pumps)

- [Cu] & [Zn] cause plant stress which has been shown to increase mutation and conjugation rates

Trends in Microbiology

CellPress REVIEWS

Review

At the Nexus of Antibiotics and Metals: The Impact of Cu and Zn on Antibiotic Activity and Resistance

Keith Poole[1,*]

Environmental influences on antibiotic activity and resistance can wreak havoc with *in vivo* antibiotic efficacy and, ultimately, antimicrobial chemotherapy. In nature, bacteria encounter a variety of metal ions, particularly copper (Cu) and zinc (Zn), as contaminants in soil and water, as feed additives in agriculture, as clinically-used antimicrobials, and as components of human antibacterial responses. Importantly, there is a growing body of evidence for Cu/Zn driving antibiotic resistance development in metal-exposed bacteria, owing to metal selection of genetic elements harbouring both metal and antibiotic resistance genes, and metal recruitment of antibiotic resistance mechanisms. Many classes of antibiotics also form complexes with metal cations, including Cu and Zn, and this can hinder (or enhance) antibiotic activity. This review highlights the ways in which Cu/Zn influence antibiotic resistance development and antibiotic activity, and in so doing impact *in vivo* antibiotic efficacy.

Trends

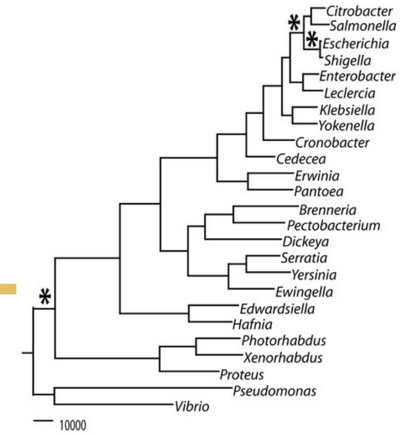
The environment can influence both antibiotic activity and bacterial susceptibility to antibiotics, and understanding the impact of environmental factors is key to predicting *in vivo* antibiotic efficacy.

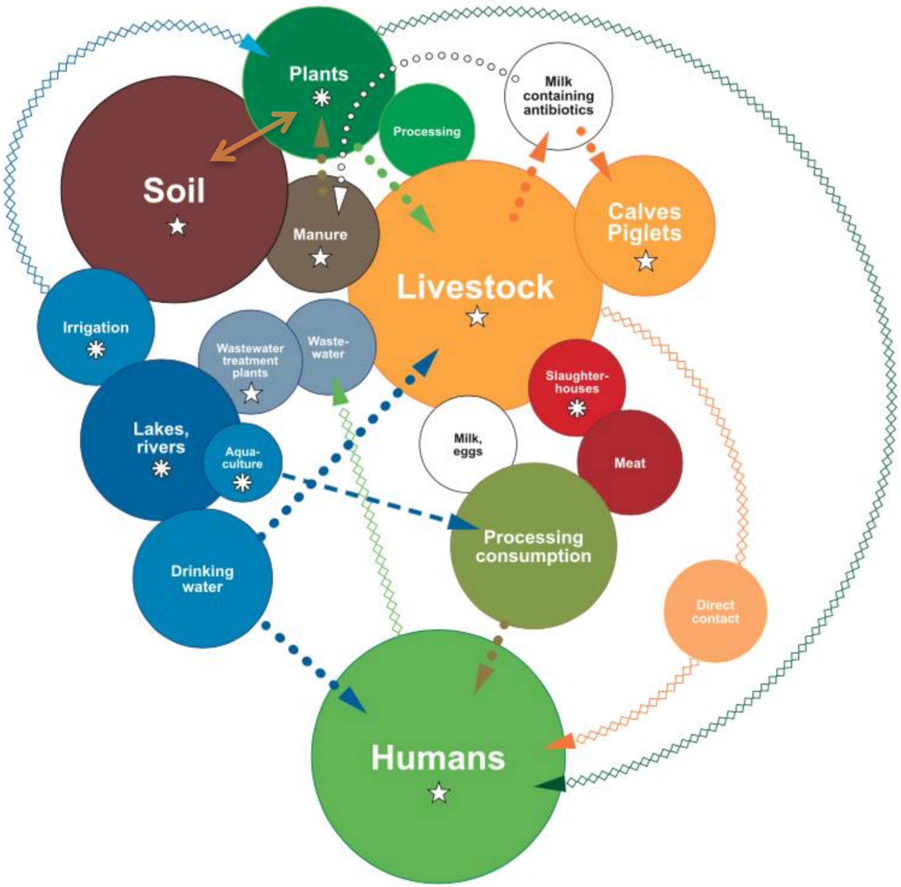
Metal cations are common environmental stressors that perturb bacteria, activating metal-protective stress responses and growth states that also protect against and provide resistance to antibiotics.

Metal (Cu and Zn) and antibiotic resistance genes co-occur in animal

AMR in Plant Agriculture

Interaction between reservoirs at the global scale





IG 1 Pathway map of AMA and AMR dissemination within agriculture, the environment, and the food processing industry. Movement of AMA or AMR is ndicated by overlapping circles and arrows, respectively; different colors define different groups of reservoirs. Stars indicate the hot spots of ARG and ARB with igh bacterial densities, nutrient availability, and selective pressure in the digestive tract of livestock and humans, in manure storage facilities, wastewater eatment plants, and in the rhizosphere. Asterisks indicate possible hot spots of ARG and ARB in water, sediments, and biofilms in aquaculture, rivers, lakes, and rigation systems, as well as in slaughterhouse facilities and on plant surfaces.

Thanner et al. 2016, *mBio*

- Multiple interactions between plants and the other reservoirs

=> Potential diffusion source

- Genetic proximity between bacteria living in different reservoirs

- Plasmid transfer (TcR+) between enterobacteria living on plant and human in the lab

- Use of same antibiotics in different reservoirs (Streptomycin, Gentamicin…)

=> Potential selective pressure source

AMR in Plant Agriculture

Emergence of AMR

Emergence in the plant compartiment *vs* transmission from another compartiment

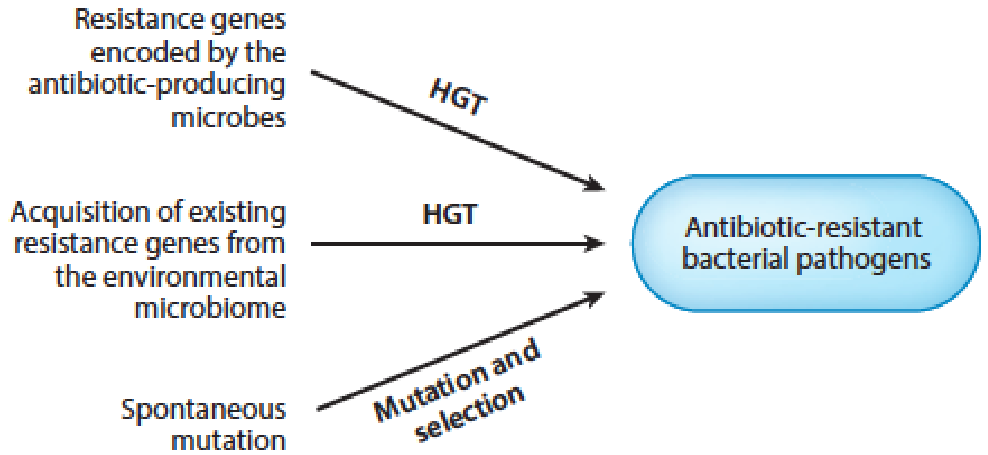
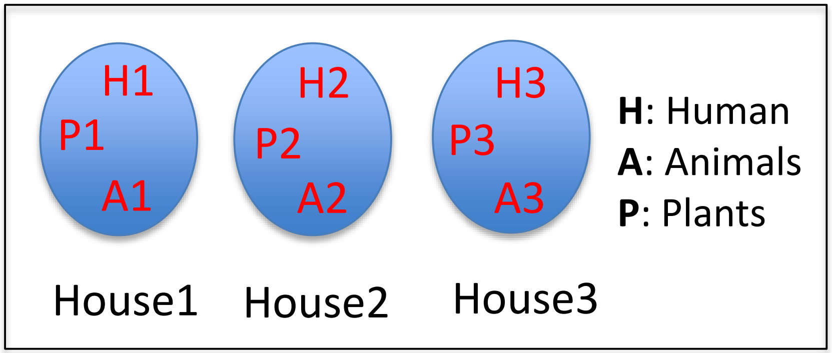


Figure 1

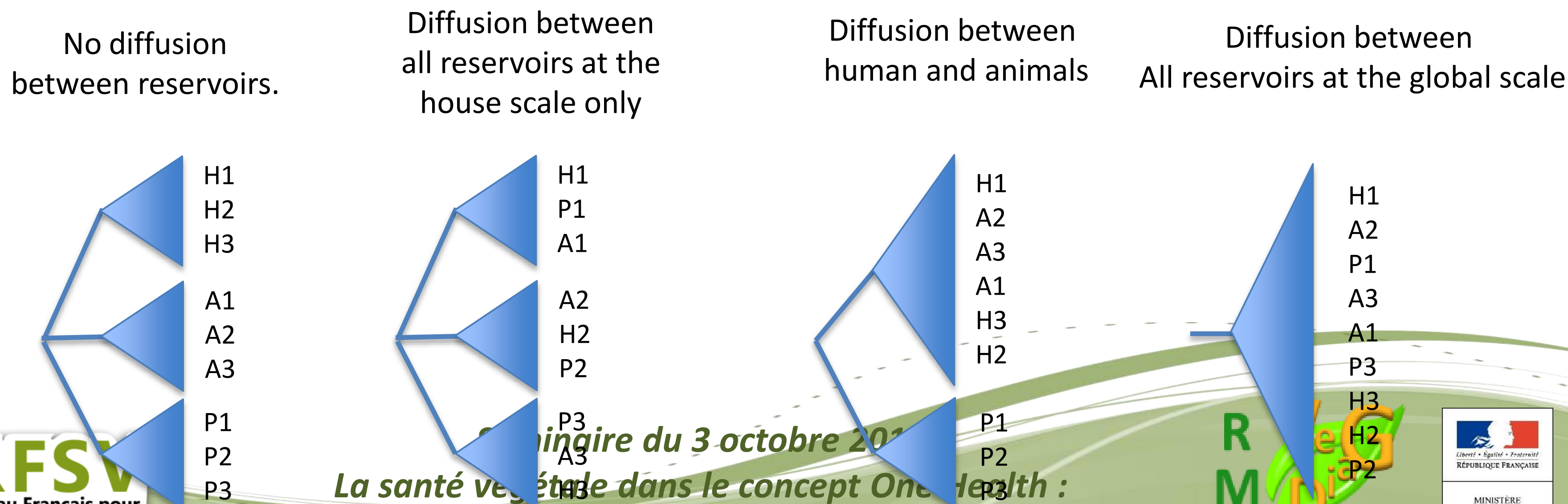
Schematic illustration of the origin of antibiotic-resistant bacterial pathogens. Abbreviation: HGT, horizontal gene transfer.

AMR in Plant Agriculture

How testing the diffusion of AMR between reservoirs



1) Sampling at different scales
2) Isolating resistant bacteria
3) Extracting + sequencing DNA
4) Investigating the phylogenetic relationships of the genes providing resistance to antibiotics:



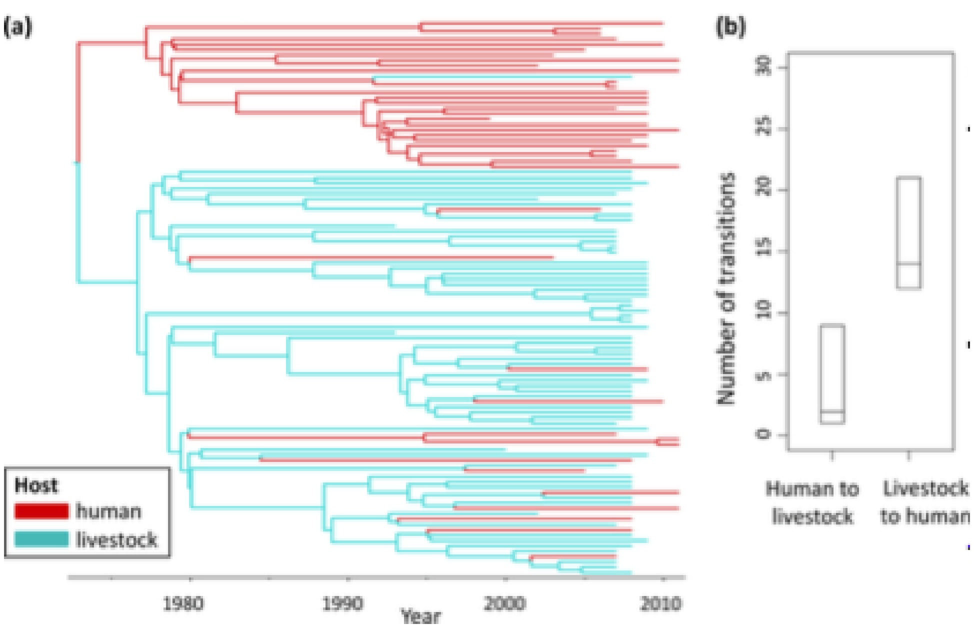
AMR in Plant Agriculture

How testing the diffusion of AMR between reservoirs: a case study

Time-Scaled Evolutionary Analysis of the Transmission and Antibiotic Resistance Dynamics of *Staphylococcus aureus* Clonal Complex 398

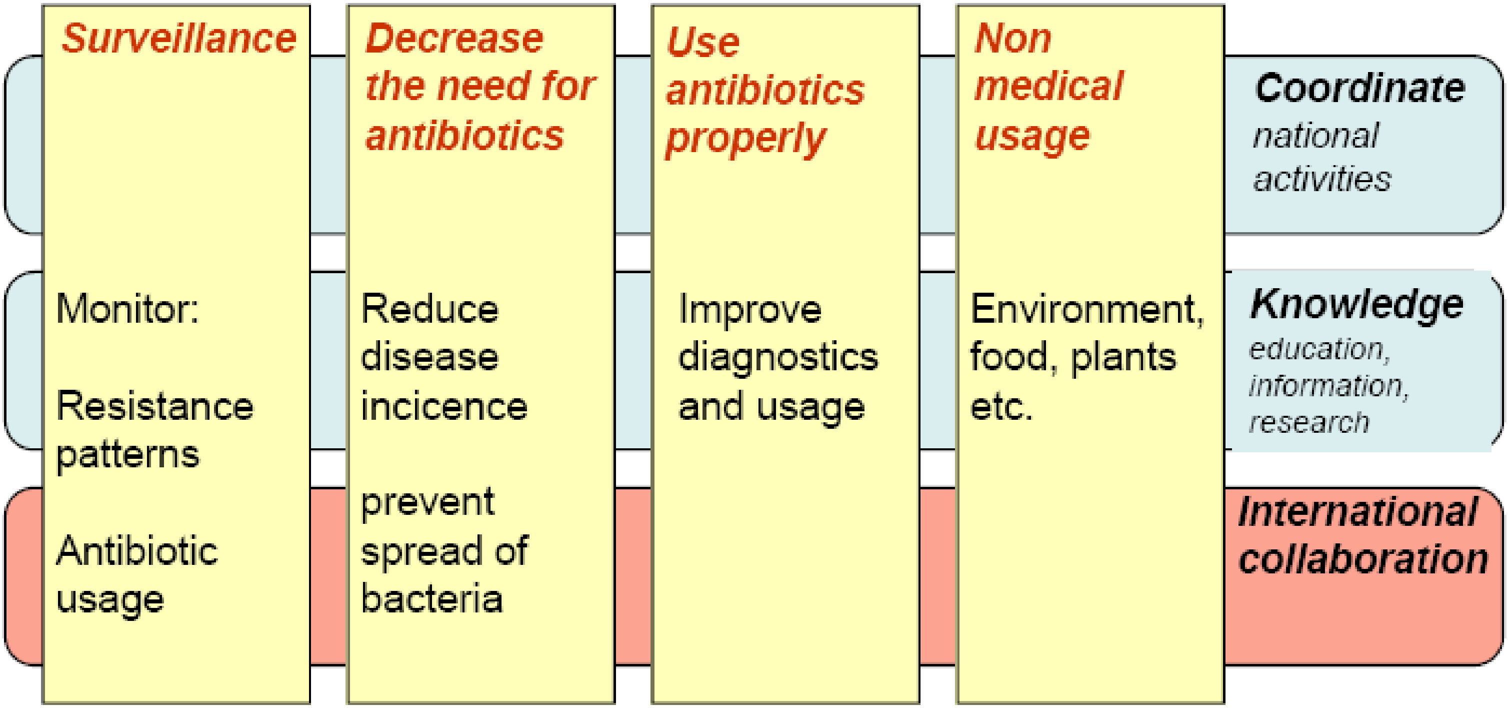
M. J. Ward,[a] C. L. Gibbons,[a] P. R. McAdam,[b] B. A. D. van Bunnik,[a] E. K. Girvan,[c] G. F. Edwards,[c] J. R. Fitzgerald,[b] M. E. J. Woolhouse[a]

Centre for Immunity, Infection and Evolution, School of Biological Sciences, University of Edinburgh, Edinburgh, United Kingdom[a]; The Roslin Institute and Edinburgh Infectious Diseases, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Midlothian, United Kingdom[b]; Scottish MRSA Reference Laboratory, National Health Service Greater Glasgow and Clyde, Glasgow Royal Infirmary, Glasgow, United Kingdom[c]

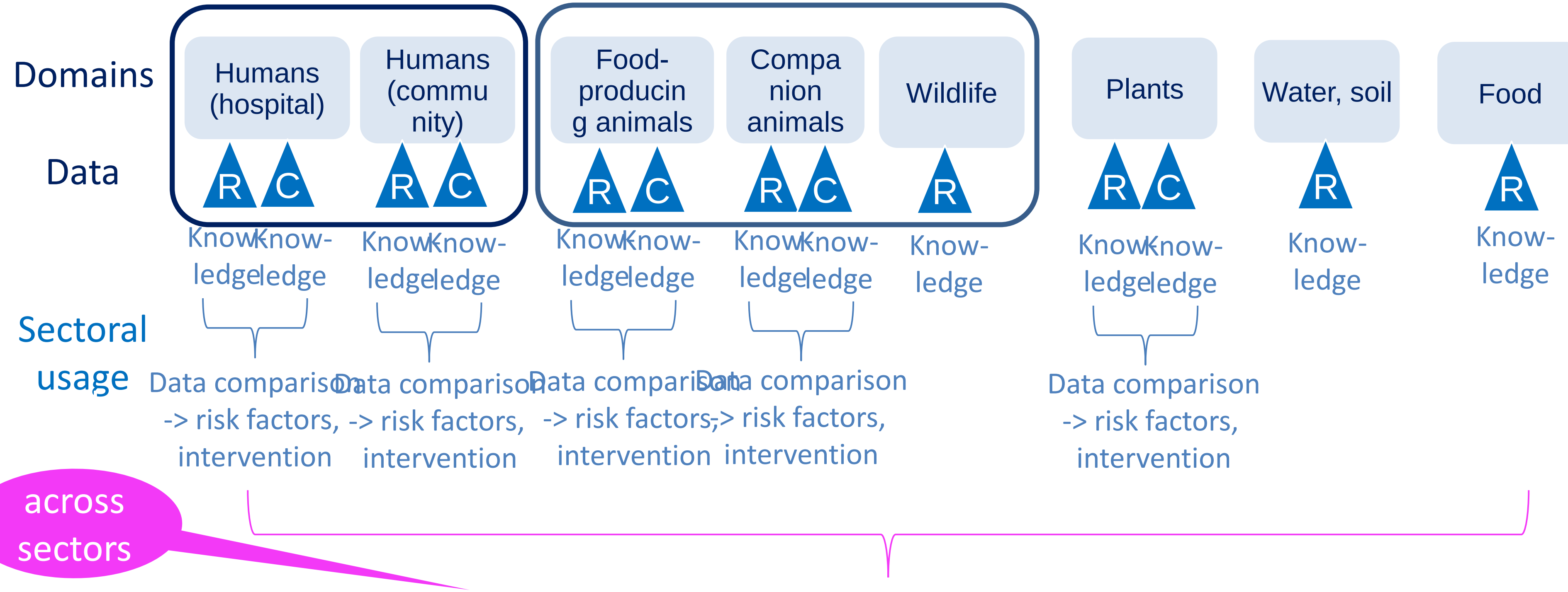


- Diffusion of methicillin resistance between human and livestock (cattle) reservoirs in Scotland
- In both directions, although livestock to human flows are more frequent
- Global origin of the epidemic not found here. More data (including from other environments) is needed…

Addressing antimicrobial resistance



A conceptual framework for One surveillance of ABR



Inter-sectoral usage

Data comparison

-> Knowledge: global mapping, link between resistance genes, transmission pathways within and between domains, source attribution

-> Intervention impact

R Resistances data

C Consumption data

Adapted from Queenan et al, 2016

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MINISTÈRE DE L'AGRICULTURE DE L'AGROALIMENTAIRE ET DE LA FORÊT

policy brief

GREASE

December 2017

Moving towards a One Health surveillance system for antibiotic resistance in Vietnam

Marion BORDIER, NGUYEN Thi Dien

Executive summary

Antibiotic resistance (ABR) is a global health threat that calls for the implementation of an inter-disciplinary and inter-sectoral surveillance system, in line with the One Health (OH) concept. The international community is strongly advocating the implementation of OH surveillance system for ABR at country level. In this context, the Vietnamese authorities have developed an inter-ministerial strategy (2013) to combat the phenomenon, including a surveillance system for ABR, that targets hospitals, community, food-producing animals and retailed food. However, those in charge of surveillance tasks are having trouble implementing the inter-sectoral and inter-disciplinary collaborations promoted at policy level. To elucidate the rationale behind success or unsuccessful collaborations and in order to suggest solutions to overcome identified obstacles, we interviewed all categories of actors involved in the national strategy. We have identified seven factors that may impede the development of the collaborations required by the OH approach: the current governance and operational framework, a divergent institutional culture, the level of knowledge, technical capacities, availability of resources, conflicting commercial interests and the international partners' influence. To overcome these barriers, we propose a new model for the governance of ABR surveillance that may open the way to a more effective and sustainable OH surveillance system in Vietnam.

- New surveillance methodologies are needed to account for the mobility of resistance genes in humans, animals and plants, environment.
- Antibiotic levels in environment needs to be monitored and controlled including on plants/environment
- Sanitation and clean water are key elements in control
- Unnecessary pollution of antibiotics can be avoided
  - Methods to remove antibiotics and important resistance genes from environment needs to be developed
  - Biodegradable antibiotics
- Behavior change of health work force and general public

→ Time for ONE HEALTH

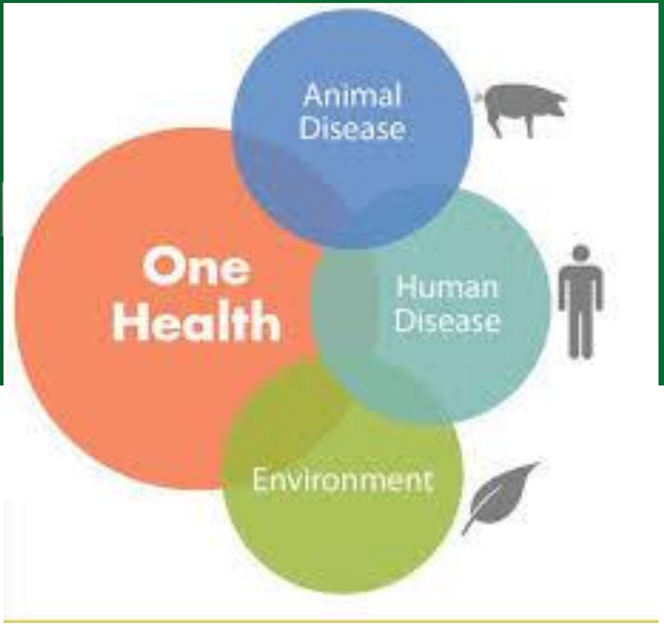
THE LANCET
Planetary Health

COMMENT | VOLUME 2, ISSUE 6, PE238-E239, JUNE 01, 2018

Environment: the neglected component of the One Health triad

Sabiha Y Essack

Open Access • DOI: https://doi.org/10.1016/S2542-5196(18)30124-4



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Volume 110, Issue 7

Antibiotic resistance is the quintessential One Health issue

T. P. Robinson, D. P. Bu, J. Carrique-Mas, E. M. Fèvre, M. Gilbert, D. Grace, S. I. Hay, J. Jiwakanon, M. Kakkar, S. Kariuki, ... Show more

Transactions of The Royal Society of Tropical Medicine and Hygiene, Volume 110, Issue 7, 1 July 2016, Pages 377–380, https://doi.org/10.1093/trstmh/trw048

Published: 05 August 2016 **Article history** ▾

Conclusion

- Modèle AMR pour Homme-Animal-Plantes/Environnement
  - d'autres modèles : E. coli ?

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***Escherichia coli* population structure and antibioresistance at a buffalo/cattle interface in southern Africa**

Mathilde Mercat, Olivier Clermont, Méril Massot, Etienne Ruppe, Michel de Garine-Wichatitsky, Eve Miguel, Hugo Valls Fox, Daniel Cornelis, Antoine Andremont, Erick Denamur, Alexandre Caron

DOI: 10.1128/AEM.03771-15

- Plus largement sur OH et environnement :
  - Intégration de drivers e.g; climatiques
  - et approches socio-économiques nécessaires
  - ? Etudes épidémiologiques sur données agrégées : corrélations entre santé des plantes et santé humaine

Les études « écologiques » (en épidémiologie quantitative) sont des études d'observation visant à détecter ou identifier des variations de l'occurrence d'une maladie dans l'espace ou dans le temps, et à relier ces variations à des facteurs environnementaux ou sociaux (le plus souvent). Ces études utilisent des données agrégées et non des données individuelles (biais fréquents …).

Séminaire du 3 octobre 2018
La santé végétale dans le concept One Health :
quelle contribution ?

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- Noellie Gay, CIRAD (ARS Réunion)