

Drug resistance: Development, Spread and Consequences in Animal Health

How are Veterinary Products including Antimicrobials are introduced to the Hives.

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SRR/SA AMR Programme officer
Nairobi, Kenya

2 - 4 September 2026



Ministry of Agriculture &
Livestock Development



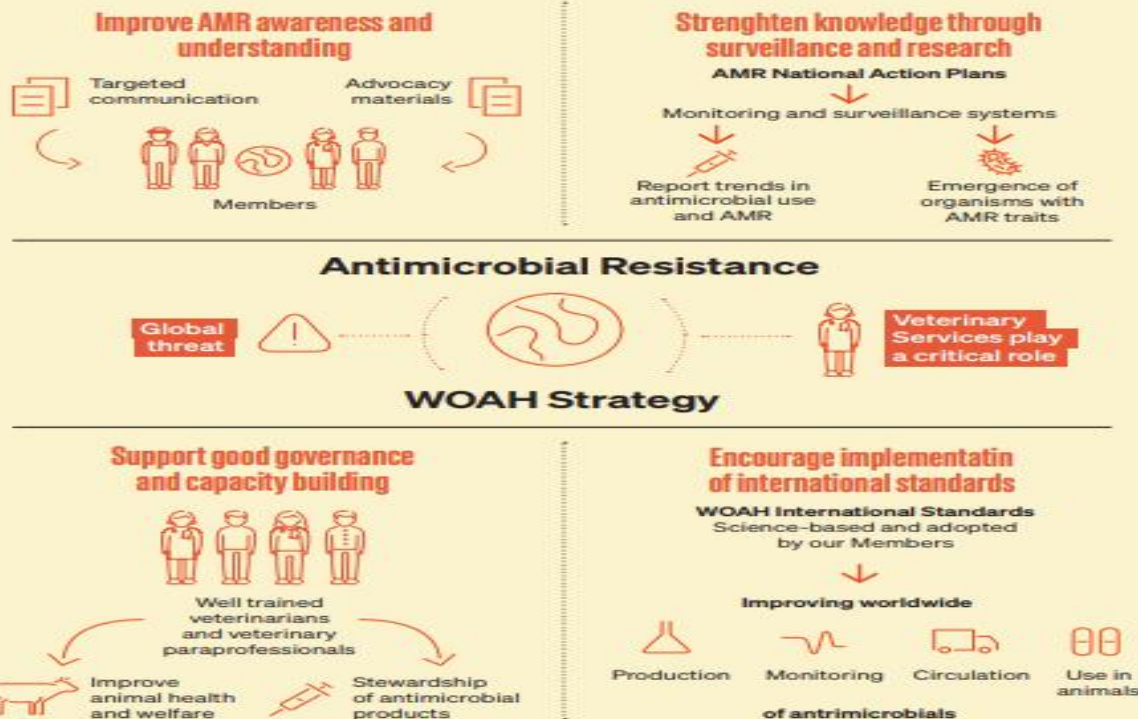
The
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WOAH Strategy on Antimicrobial Resistance (AMR) and the Prudent Use of Antimicrobials

Protecting animal health and welfare by supporting global efforts to combat antimicrobial resistance





AMR consequences in animal health



Ministry of Agriculture &
Livestock Development



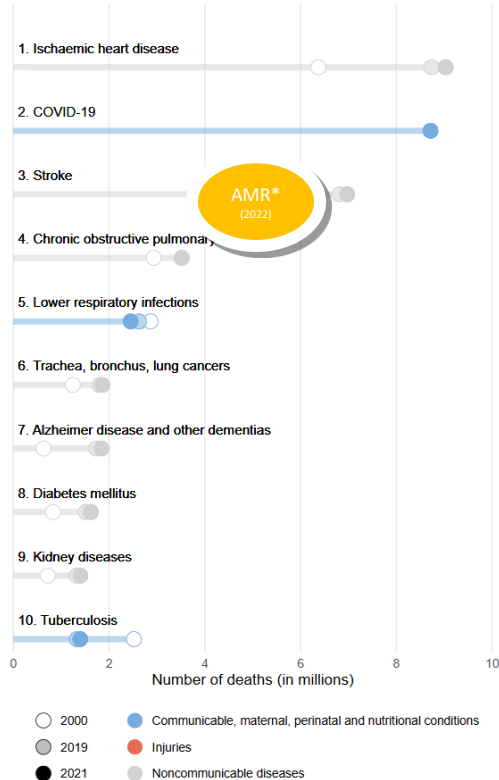
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AMR – Is that a real problem?

Leading causes of death in 2021 globally



Source: <https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>

*Source: <https://www.woah.org/app/uploads/2024/09/ihme-human-health-web-f23924.pdf>

Antimicrobial resistance could result in production losses in the livestock sector equivalent to the **consumption needs of more than 2 billion people annually by 2050.**

- A series of four reports, co-published with the World Bank (Sep.2024)
- Data from more than 200 countries estimating full toll of AMR (humans, livestock and our overall economies)

\$5.2 Trillion
The spillover of resistant pathogens from livestock to humans could **reduce global GDP by \$5.2 trillion from 2025 to 2050.**

\$1.7 trillion
Increased antimicrobial resistance in humans could lower annual global GDP by up to **\$1.7 trillion by 2050.**

39 million
Left unaddressed, antibiotic-resistant infections could lead to more than **39 million human deaths** between 2025 and 2050.

<https://www.woah.org/en/superbugs-could-jeopardise-food-security-for-over-two-billion-people-and-increase-annual-health-care-costs-by-us-159-billion-annually-by-2050-finds-most-extensive-modelling-to-date/>

EcoAMR Series – Economic Impacts of AMR

- A series of four reports, co-published with the World Bank (Sep.2024)
- Data from more than 200 countries estimating full toll of AMR (humans, livestock and our overall economies)



Forecasting the Fallout from AMR: Averting the Health and Economic Impacts through One Health Policy and Investment

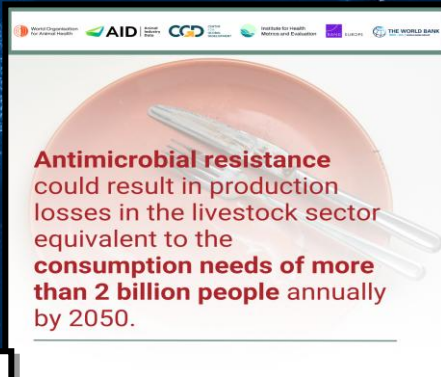
A policy brief from the EcoAMR series

BY 2050...

- From reports, human health care costs from antimicrobial resistance (AMR) could rise to **US\$ 109 billion** per year globally.
- But investments in drug innovation and health care improvements can reduce these costs to **US\$ 97 billion** per year globally, leaving the extra from the 2024 baseline. The extra of **US\$ 12 billion** (12% of the total) is the extra from the 2024 baseline to the 2050 baseline, and the extra of **US\$ 12 billion** (12% of the total) is the extra from the 2024 baseline to the 2050 baseline.
- Investment in AMR in human health care could reduce global GDP by **US\$ 109 billion** per year.
- But achieving global 30% reduction in antimicrobial use (AMU) within the next five years could reduce GDP by **US\$ 109 billion** per year globally, leaving the extra from the 2024 baseline. The extra of **US\$ 12 billion** (12% of the total) is the extra from the 2024 baseline to the 2050 baseline, and the extra of **US\$ 12 billion** (12% of the total) is the extra from the 2024 baseline to the 2050 baseline.
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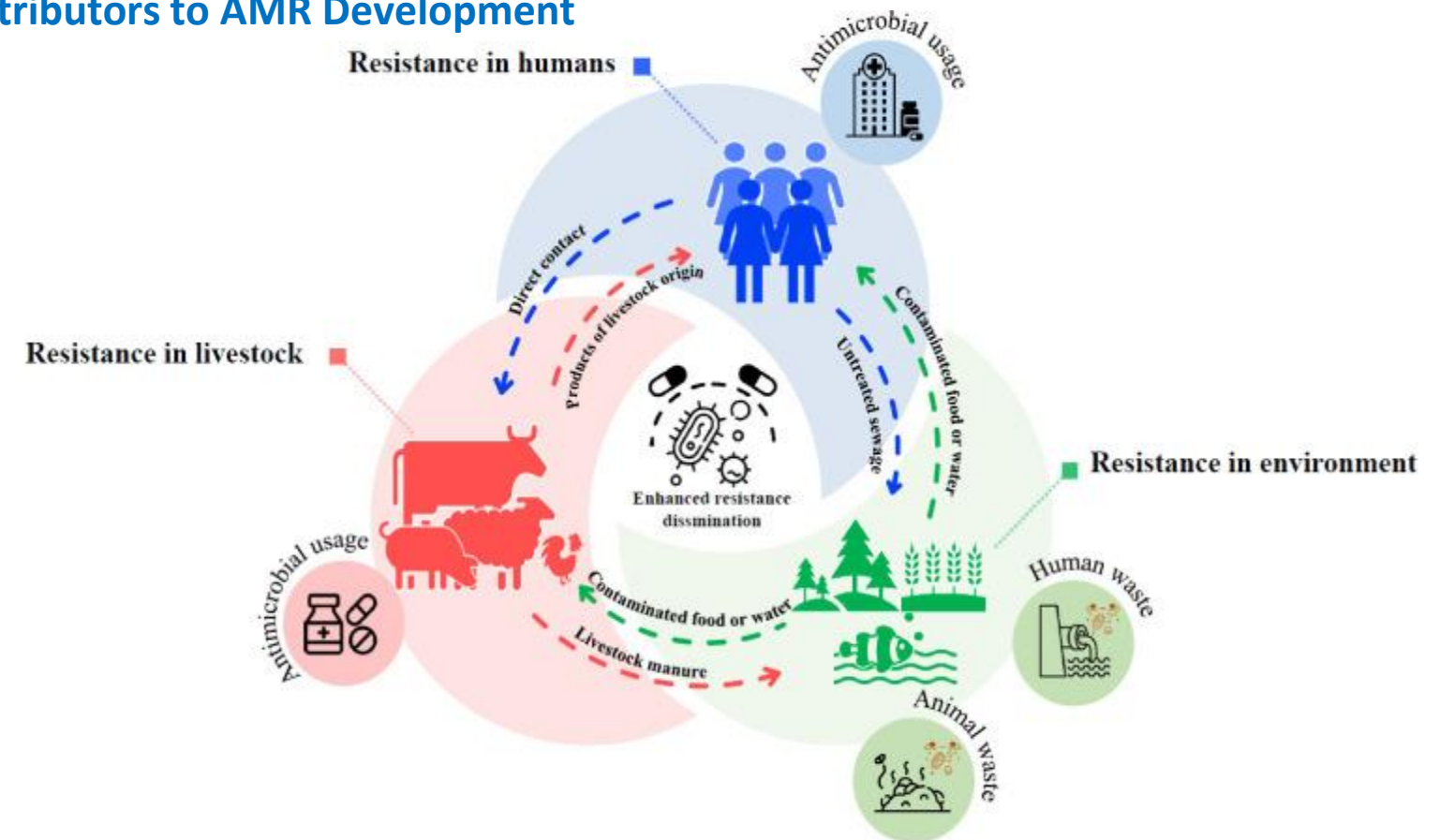
IN 2022 ALONE...

- A total of **3.12 million** human deaths were attributable to AMR in 2022.

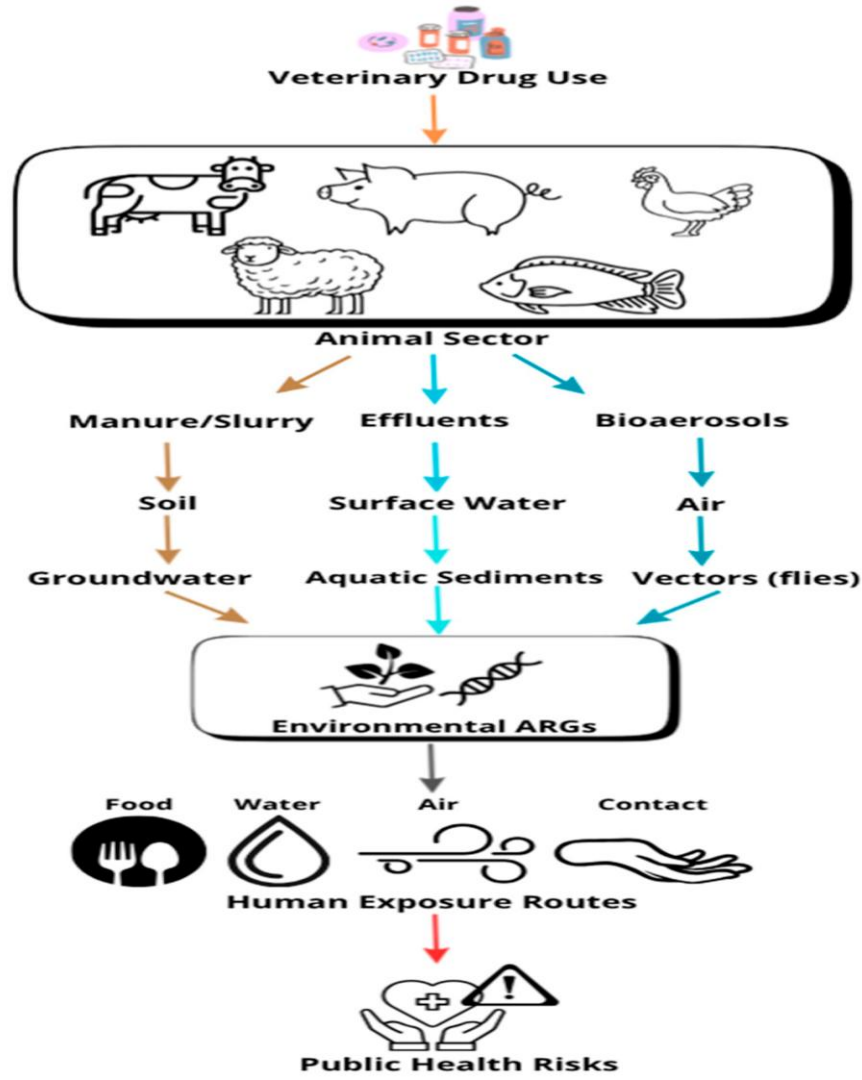


Statistical analysis suggests that countries using antimicrobials for growth promotion in livestock have an estimated average of 45% higher antimicrobial use per kilogram of animal biomass than countries that do not use growth promoters. This estimate accounts for all classes of antimicrobials except ionophores. As previously reported by WOA, the use of antimicrobials as growth promoters is still a practice among 20% of its Members, with 75% of those being in the regions of the Americas, and in Asia and the Pacific.

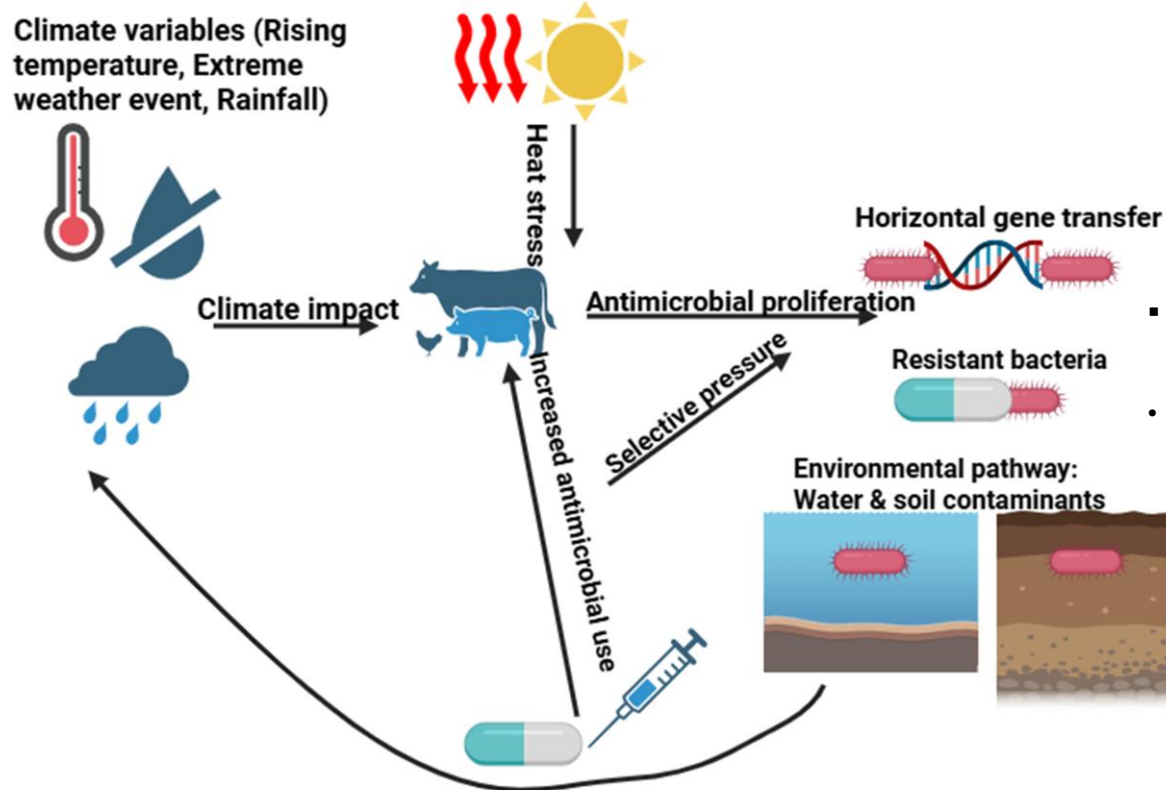
This figure illustrates the interplay between livestock, humans, and the environment as contributors to AMR Development



Environmental dissemination pathways of ARGs from food-animal production within the OH framework



- Flooding,
- Drought,
- Sea level rise
- Coastal erosion



- Human waste (e.g. municipal, hospital, industrial)
- Animal waste (e.g. livestock) can contain high levels of antimicrobial compounds and resistant microorganisms

Gaddafi et al.2026

Antimicrobial Resistance From Farm to Home

A AMR Evolution

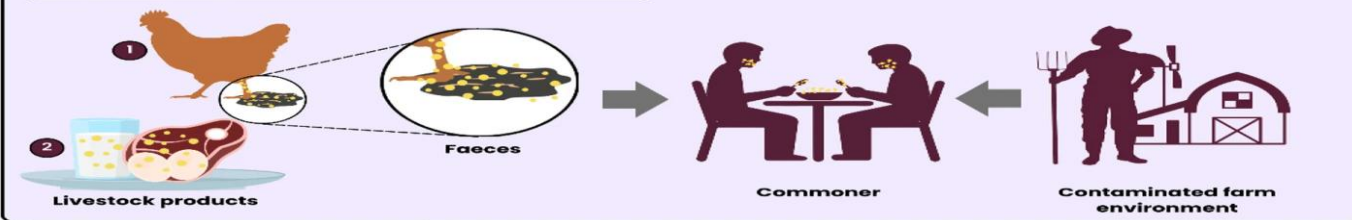
Livestock vs Antibiotics interface



B Role of Gut Microbiome



C Propagation of AMR to Humans



D Impact on Humans



A Comprehensive Narrative Review on the Hazards of Bee Honey Adulteration and Contamination



PESTICIDES

- Acaricides
- Organic acids
- Insecticides
- Fungicides
- Herbicides



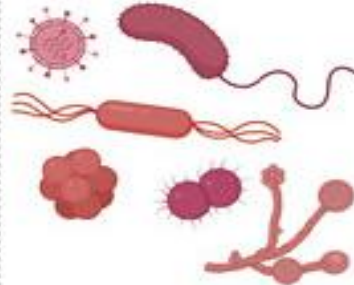
ANTIBIOTICS

- Streptomycin
- Erythromycin
- Lincomycin
- Sulfonamide
- Chloramphenicol



MICROORGANISM

- *Bacillus cereus*
- *Candida parapsilosis*
- *Clostridium botulinum*



HEAVY METALS

- Aluminium (Al)
- Arsenic (As)
- Cadmium (Cd)
- Iron (Fe)
- Lead (Pb)
- Mercury (Hg)
- Nickel (Ni)



AMR vs Honeybees

- Recent analysis results reveal that the gut of honeybee serves as a reservoir of AMR genes,
 - Probably due to
 - ✓ Antibiotics application history in beekeeping
 - ✓ Horizontal gene transfer from the highly polluted environment
- These AMR genes accumulate in the honeybee gut,
 - ❖ Could be transferred to the pathogen, even having the potential to spread during pollination , tending, social interactions.
 - ❖ Newly acquired resistance traits may cause fitness reduction in bacteria whereas facilitating adaptive evolution as well.

Hu *et al.* 2013



World Organisation
for Animal Health

Why Antibiotic Use in Honeybees Matters?



**Residues in honey and
other bee products.**

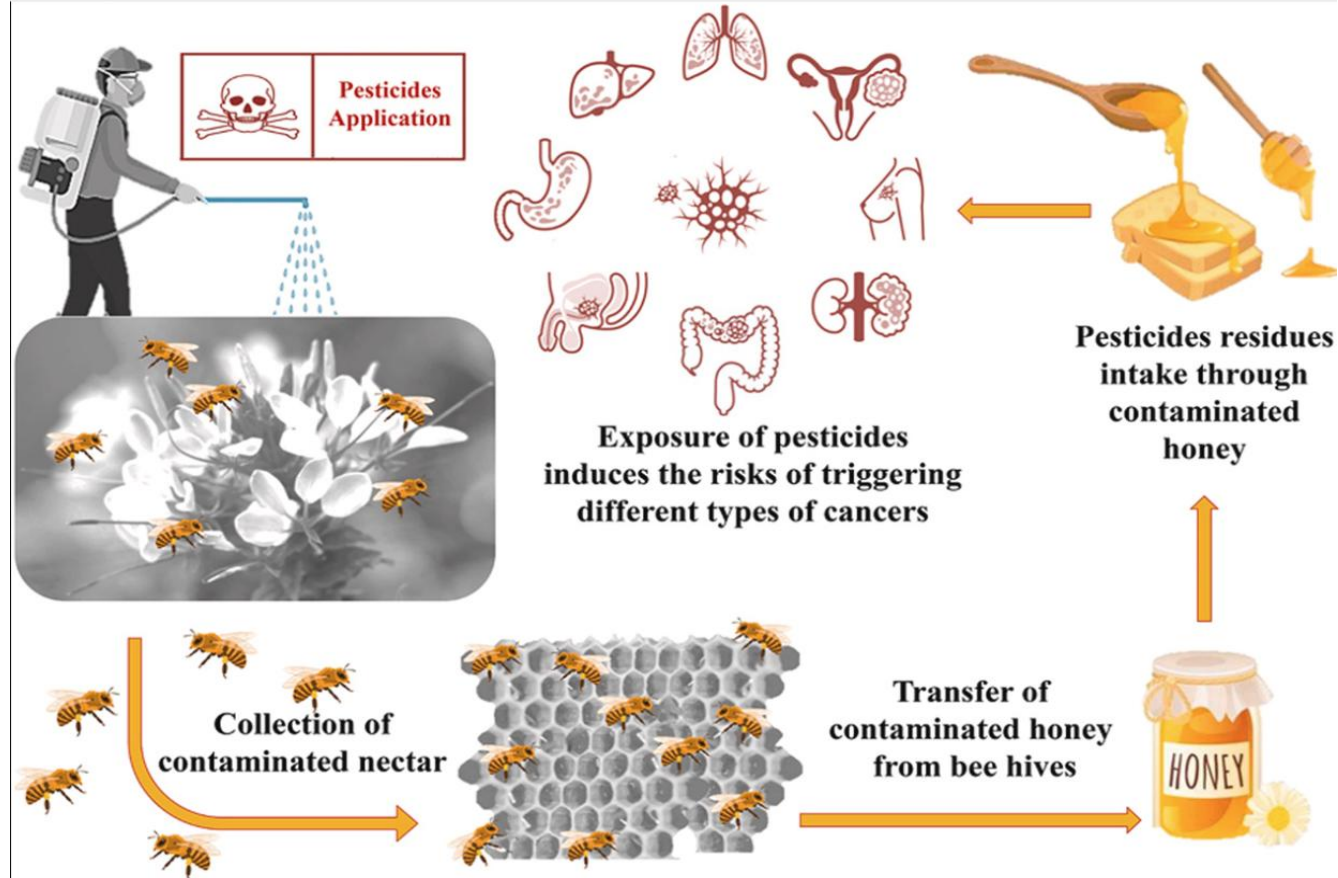


**Disruption of the
natural microbiota of
honeybees.**

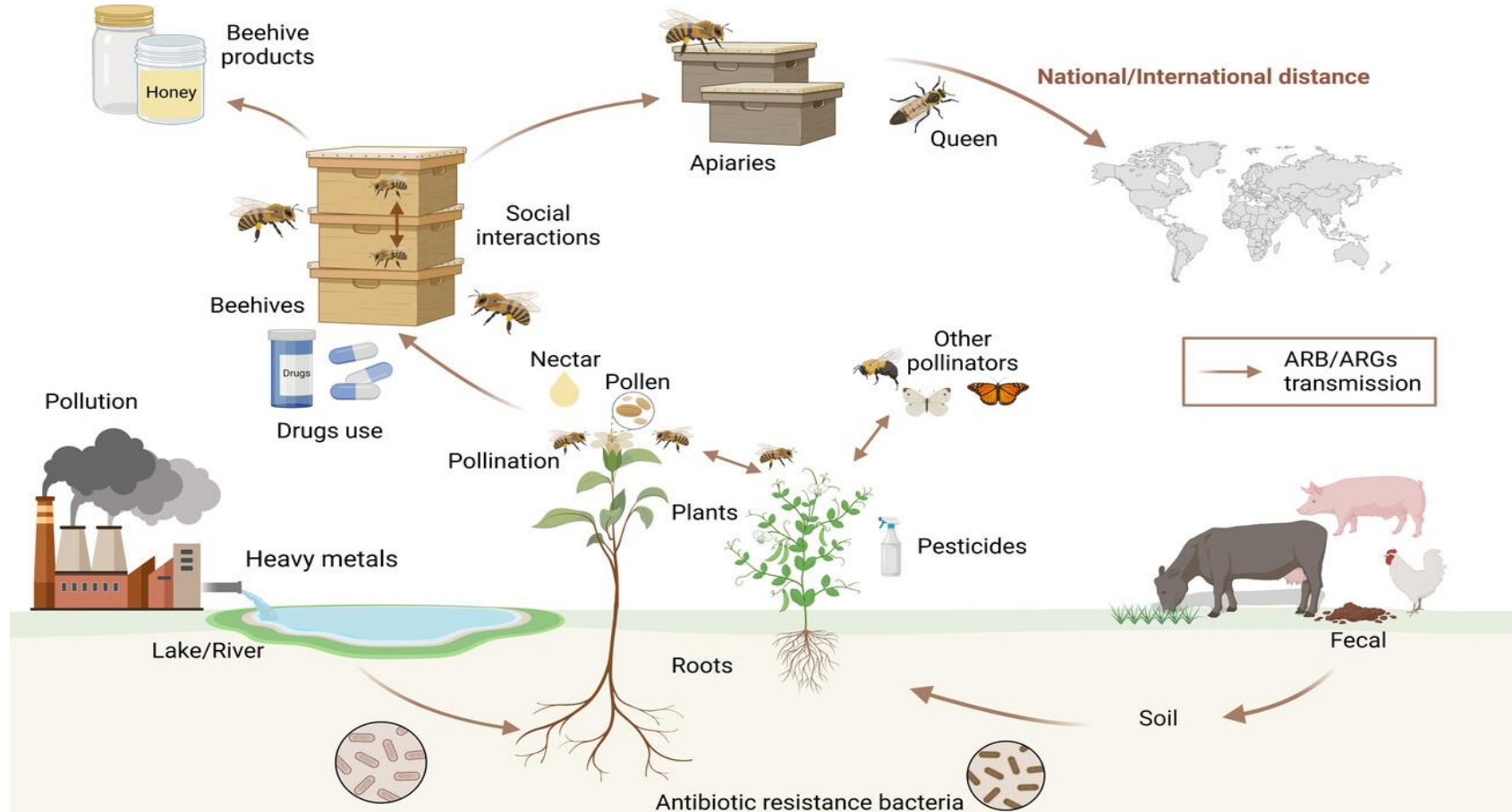


**Emergence and spread of
antimicrobial resistance.**

Exposure to pesticide residues in honey and its potential cancer risk assessment



The potential transmission routes of AMR bacteria and associated AMR genes mediated by honeybees and speculative factors affecting the horizontal gene transfer.



Antimicrobial Resistance Mitigation into Beekeeping Practices

- Agricultural and apicultural practices expose honeybees to a range of pesticides that have the potential to negatively affect their
 - physiology, neurobiology, and behavior.
- **These effects extend to the honeybee gut microbiome,** which serves important functions for honeybee health.
- **Gut microbial community plays an important role in the regulation of insect health**

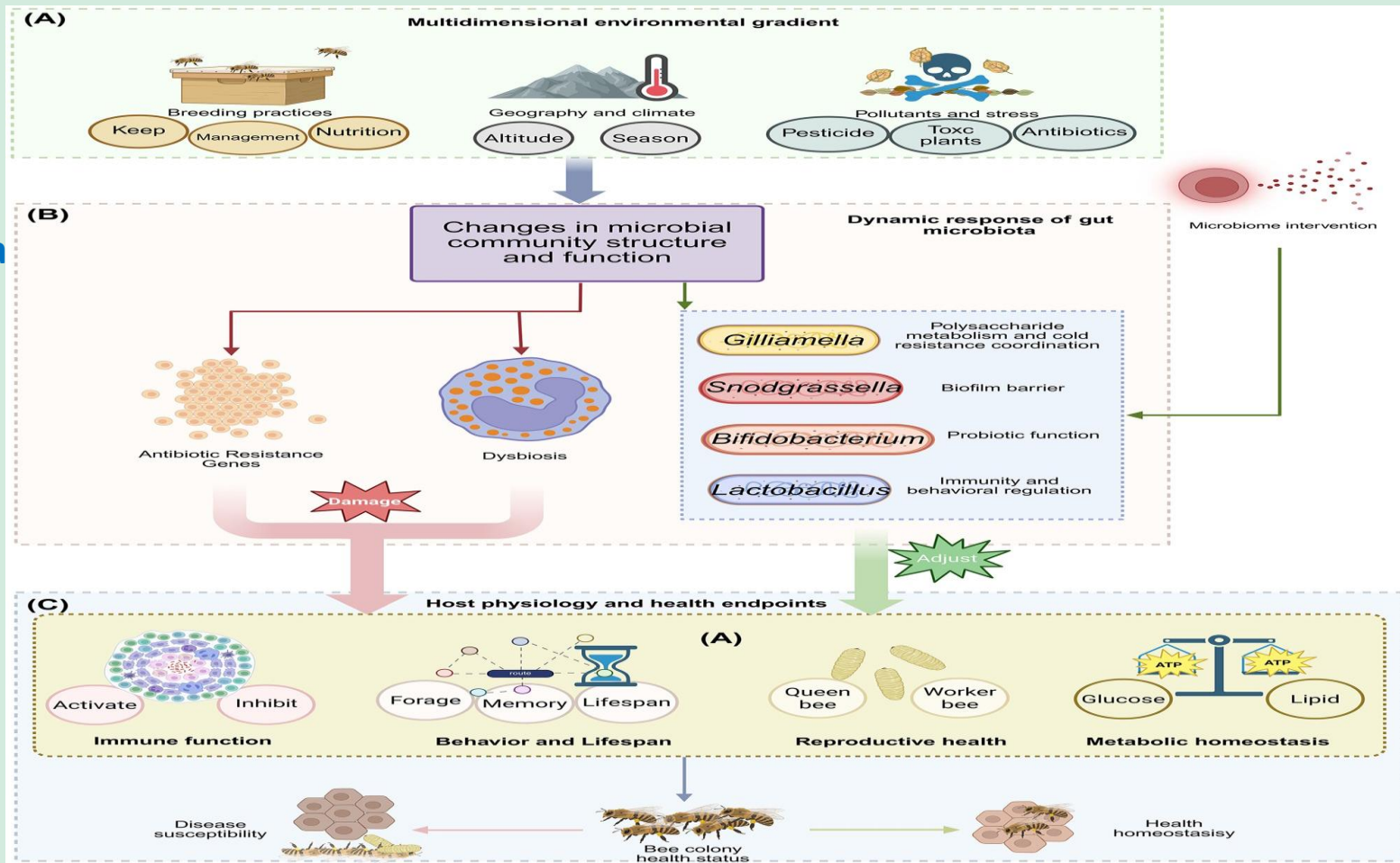


Gut microbial community of Bees

- In contrast to many other animals, honey bees have a relatively **simple and conservative gut microbiota community** which is dominated by **only eight core bacterial phylotypes**,
- *Snodgrassella alvi*,
- *Gilliamella apicola*,
- *Lactobacillus* spp.,
- *Bifidobacterium* spp.,
- *Frischella perrara*,
- *Bartonella apis*,
- *Parasaccharibacter apium* *Commensalibacter* spp.



Response of bee gut microbiota under multidimensional environmental stress and its mechanism of impact on



Gut bacteria contribute to honey bee health



Regulating host
hormonal signaling (Zheng
et al., 2017)



Participating in food
digestion (Zheng et al., 2019).

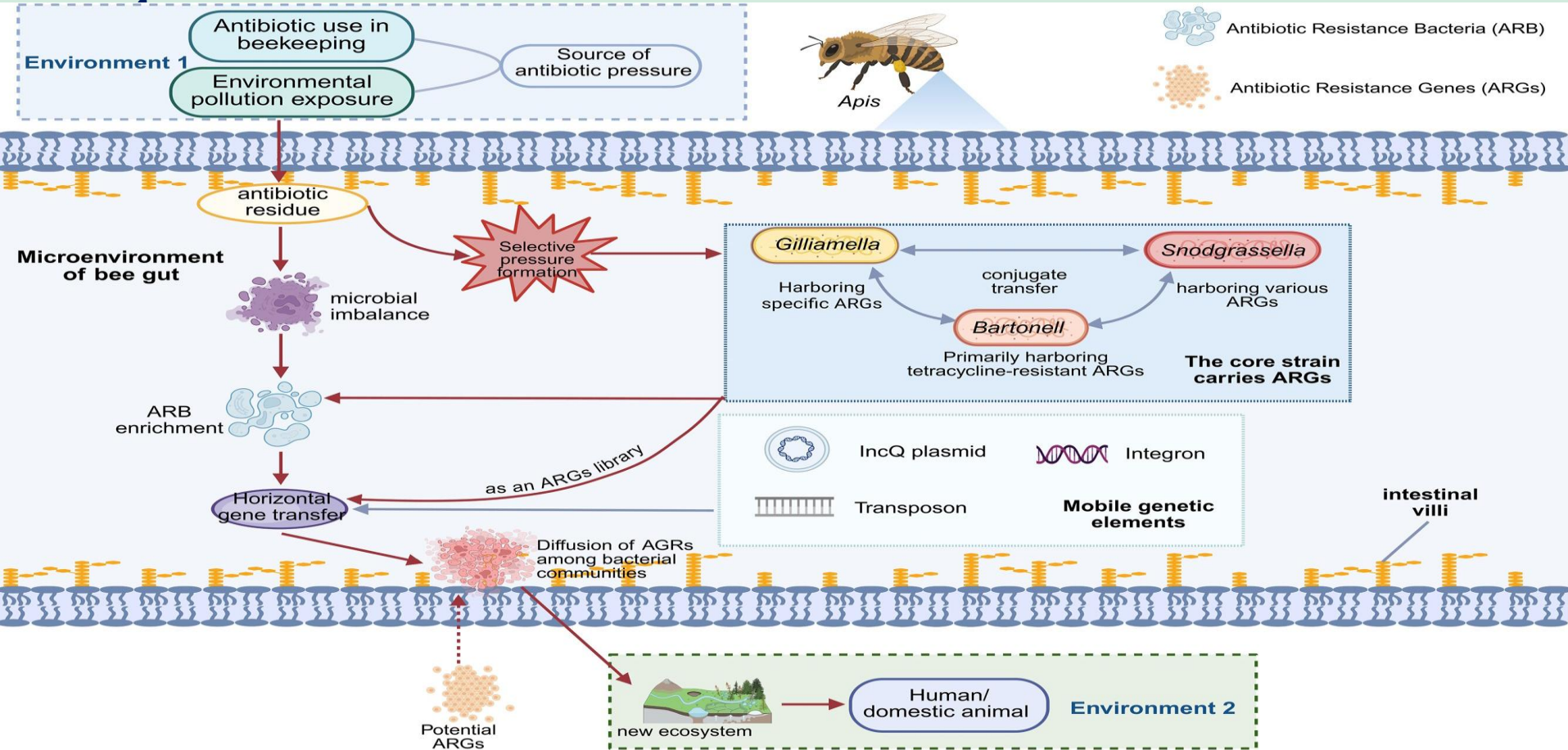


Priming the immune
system against
pathogenic infections
(Emery et al., 2017).



Promoting the
endogenous
detoxification (Wu et al., 2020b).

Transmission and diffusion mechanism of ARGs in the bee gut. ARGs can enter the bee



1. *Env Microbiol Rev*, Volume 66, 2020, Page 61, <https://doi.org/10.1093/emicro/dnab001>

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POLICY BRIEF

STEWARDSHIP FOR ELIMINATING ANTIBIOTIC USE IN APICULTURE: HOW TO COMBAT ANTIMICROBIAL RESISTANCE AND PROTECT HONEY BEE HEALTH, HONEY BEE WELFARE AND FOOD SAFETY

TOWARDS ZERO ANTIBIOTICS IN BEEKEEPING

Protect Bees. Protect People. Protect Our Planet.

Antibiotics in beekeeping pose risks to bee health, food safety, human health, and the environment. A **One Health** approach and coordinated action can eliminate the need for antibiotics and ensure sustainable apiculture for future generations.

**ZERO
ANTIBIOTICS**
OUR GOAL
OUR FUTURE

KEY CHALLENGES



INCONSISTENT REGULATIONS

Diverse rules and enforcement gaps lead to uncontrolled use and barriers to trade.



LIMITED VETERINARY SURVEILLANCE

Lack of diagnosis, monitoring and reporting systems hinders appropriate treatment and control of bee diseases.



INSUFFICIENT ALTERNATIVES

Limited access to effective, proven non-antibiotic solutions and good beekeeping practices.



RISK OF ANTIMICROBIAL RESISTANCE (AMR)

Antibiotic use can drive AMR, threatening bee health, human health and the effectiveness of critical medicines.



CONTAMINATION OF BEE PRODUCTS AND ENVIRONMENT

Residues in honey, wax, pollen and propolis harm consumers and ecosystems, and reduce market access.

THE ONE HEALTH CONNECTION



Healthy bees contribute to food security, biodiversity and resilient ecosystems.

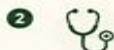
Eliminating antibiotics in beekeeping protects people, animals and the planet—today and for future generations.

RECOMMENDATIONS: THE PATH TO ZERO ANTIBIOTICS



1 STRENGTHEN POLICIES AND REGULATIONS

- Establish clear, science-based rules.
- Prohibit routine use and ensure enforcement.



2 IMPROVE VETERINARY SERVICES AND SURVEILLANCE

- Build capacity for diagnosis and monitoring.
- Implement national disease reporting systems.



3 PROMOTE GOOD BEEKEEPING PRACTICES

- Focus on hive hygiene, nutrition, queen health and biosecurity.
- Prevent disease rather than treat.



4 SUPPORT EFFECTIVE ALTERNATIVES

- Invest in research and validation of non-antibiotic solutions.
- Ensure availability and accessibility for beekeepers.



5 EDUCATE AND EMPOWER BEEKEEPERS

- Provide training on disease prevention and alternatives.
- Encourage responsible management decisions.



6 MONITOR, EVALUATE AND ENSURE TRANSPARENCY

- Track progress towards zero antibiotic use.
- Share data to build trust and drive continuous improvement.



**ZERO ANTIBIOTICS.
SUSTAINABLE APICULTURE.
A HEALTHY FUTURE.**

LET'S ACT TOGETHER NOW.



GOVERNMENTS



VETERINARIANS



BEEKEEPERS



RESEARCHERS



CONSUMERS



ZERO ANTIBIOTICS IN BEEKEEPING IS POSSIBLE.

COMMIT TODAY. PROTECT TOMORROW.





Identify bacterial diseases accurately
Not all problems need antibiotics.



Use antibiotics only for confirmed bacterial infections as prescribed by a veterinarian.



Use the right product, dose, route, and duration.



Do not harvest honey or hive products until the withdrawal period is over.



Record all treatments and monitor colony health.

Strong colonies through good nutrition, clean hives, and biosecurity

2. GOOD BEEKEEPING PRACTICES

Regular inspection and timely management

**INTEGRATED
APPROACH**
Combine best

- management practices and judicious use of antibiotics

PROTECT THE

ENVIRONMENT
Safe disposal of medicines
and packaging

Bacteria can become resistant, making treatments less effective



Resistant bacteria can spread to other bees, animals, humans, and the environment.



AMR threatens animal and human health and increases costs.

- ✓ Beekeepers: use antibiotics wisely.
- ✓ Veterinarians: prescribe responsibly.
- ✓ Regulators: ensure proper oversight.
- ✓ Researchers: develop better tools.
- ✓ Consumers: support responsible beekeeping.
- ✓ Together: safeguard bees, food, and health.

RESPONSIBLE TODAY
SUSTAINABLE TOMORROW



Care for bees
Care for nature



Good practices
Better outcomes



Antibiotic stewardship

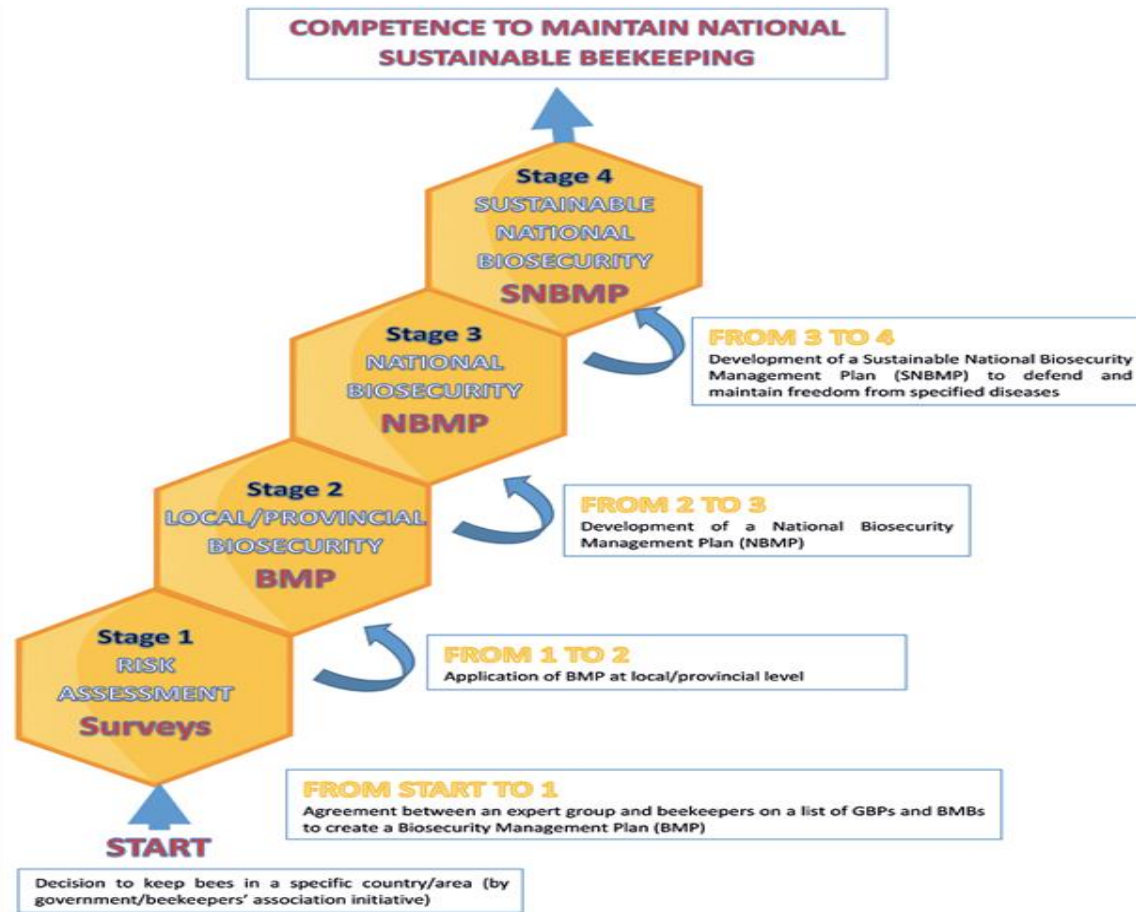
A shared commitment



Healthy hives.
Healthy planet.

When in doubt, consult your veterinarian.
Responsible use today ensures effectiveness tomorrow.

The Progressive Management Pathway for Biosecurity Measures in Beekeeping (PMP-BMB)



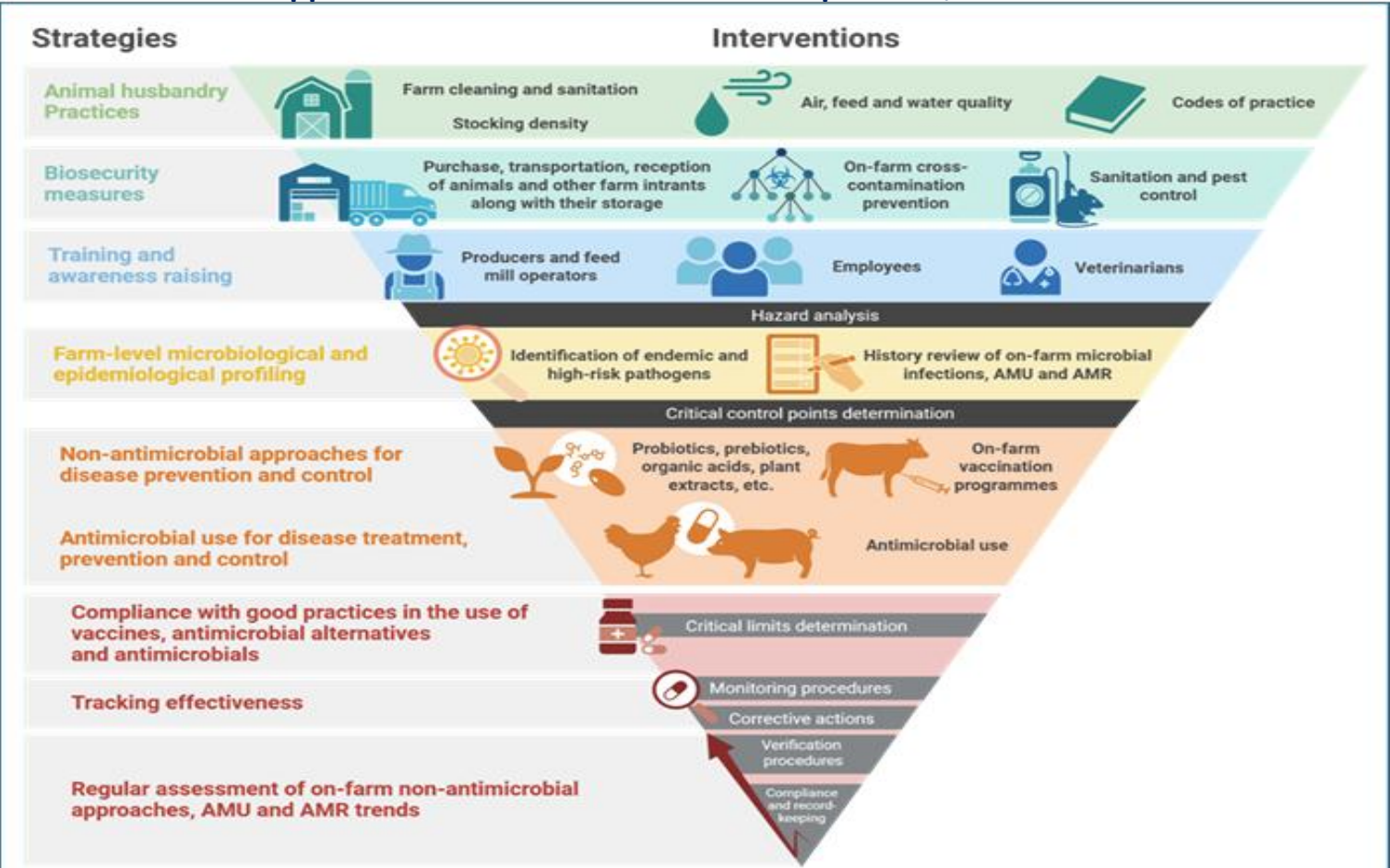
Antibiotics cannot protect against poor beekeeping practices

The main advice for **beekeepers** on use of antimicrobials in beekeeping

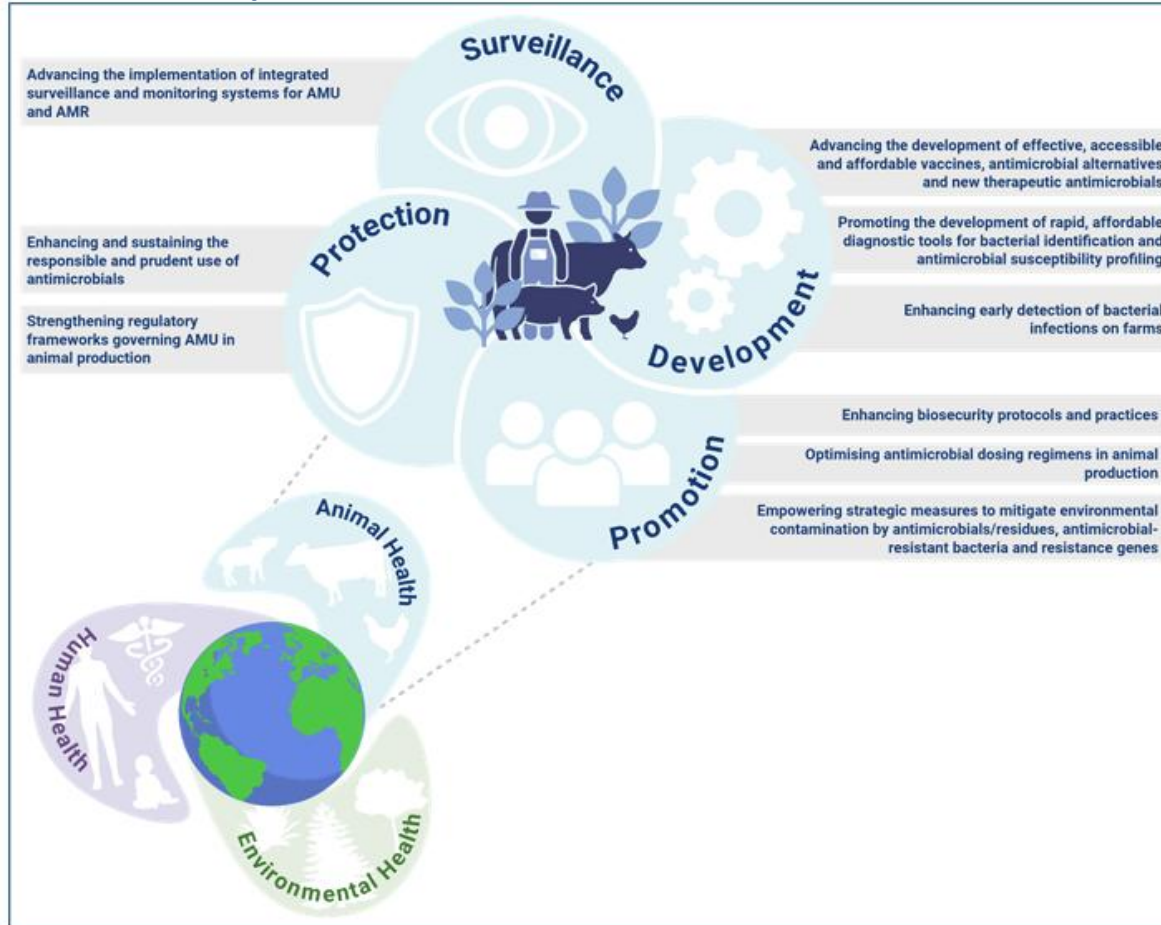
- Avoid/reduce use of antimicrobials and adopt GBPs and BMBs – medicines should never be considered a substitute for GBPs or BMBs;
- Only use antimicrobials according to a veterinarian's indication and the instruction label;
- Do not administer any antimicrobial during a honey flow or into honey supers;
- Do not misuse antimicrobials, including prophylactically, because it may lead to AMR;
- Spillover of antimicrobials may be toxic for honey bees and may lead to residues in hive products;
- Only use antibiotics for individual treatment on affected hives.



On-farm intervention strategies structured according to the adapted prerequisite programme principles and the Hazard Analysis Critical Control Point approach to reduce infectious disease pressure, AMU &AMR



Future directions for livestock stakeholders in One Health approach to promote prudent and responsible antimicrobial use in animal production and minimise the selection for antimicrobial-resistant bacteria





Thank You

www.woah.org woah@woah.org



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for Animal
Health

Organisation
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de la santé
animale

Organización
Mundial
de Sanidad
Animal



Ministry of Agriculture &
Livestock Development



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