Demonstration of Innovative Functional food production systems based on more sustainable value chains of marine and freshwater raw materials for conscientious EU consumers

3.0 Legal requirements, policies and quality management

3.3 Ecological aspects of food quality and safety in the seafood and aquaculture sector

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Main objective

- Understand that food safety and quality needs to be seen from a wider perspective to foster a resilient and safe food system

Learning outcomes

- Describe safety aspects in the seafood and aquaculture sector including not only food safety, but also human safety within the One Health approach
- Know why extensive use of antibiotics is a problem for the safety and quality of food and its environmental impact

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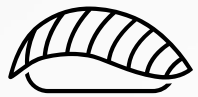
Agenda

Group exercise

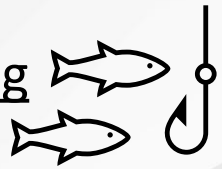
Food safety

- in the aquaculture and seafood sector
- from a One Health perspective
- Animal, plant and environmental health for safe food production



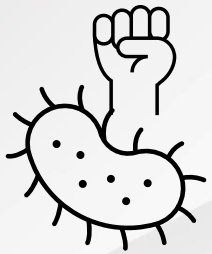
Conventional solutions and practices around aquaculture and fish farming

- Antibiotics & AMR, Eutrophication, Ecotoxicity, waste



Alternatives and better practice

- Principles to reduce antibiotic substance use
- Strategic holistic approach
  - Biosecurity practices, waste management



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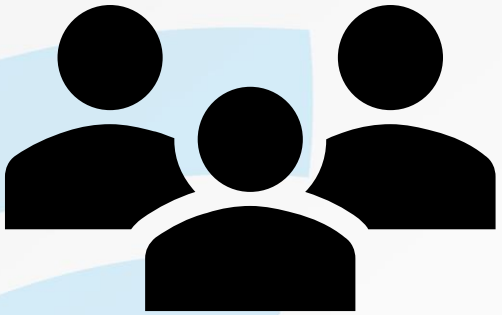

Group Exercise

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Leading question:

Can food be considered safe at the moment of consumption if the world we live in is degraded during its production?

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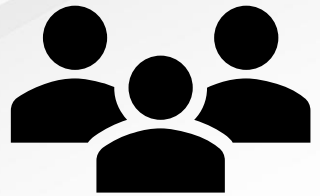
Fishbowl – Group exercise

- Put 3-5 seats in a circle or to the front, some participants who would like to start can take a seat.

→ They build the fishbowl. (You can choose how many seats should be filled at the beginning.)

- One chair must stay free the whole time.
  If a person who sat in the "audience" wants to say or ask something/ give input/ etc. the person takes that seat and **another participant has to leave** the fishbowl to make room again.

- Speaking rules:
  - ONLY people sitting on one of the fishbowl-chairs should be talking – while the audience listens.
  - Only one person speaks at a time. NO conversations on the side!



➔If you want to add or say something; enter the fishbowl and take a seat!

➔If a person enters the fishbowl, another person must voluntarily leave and clear a chair.

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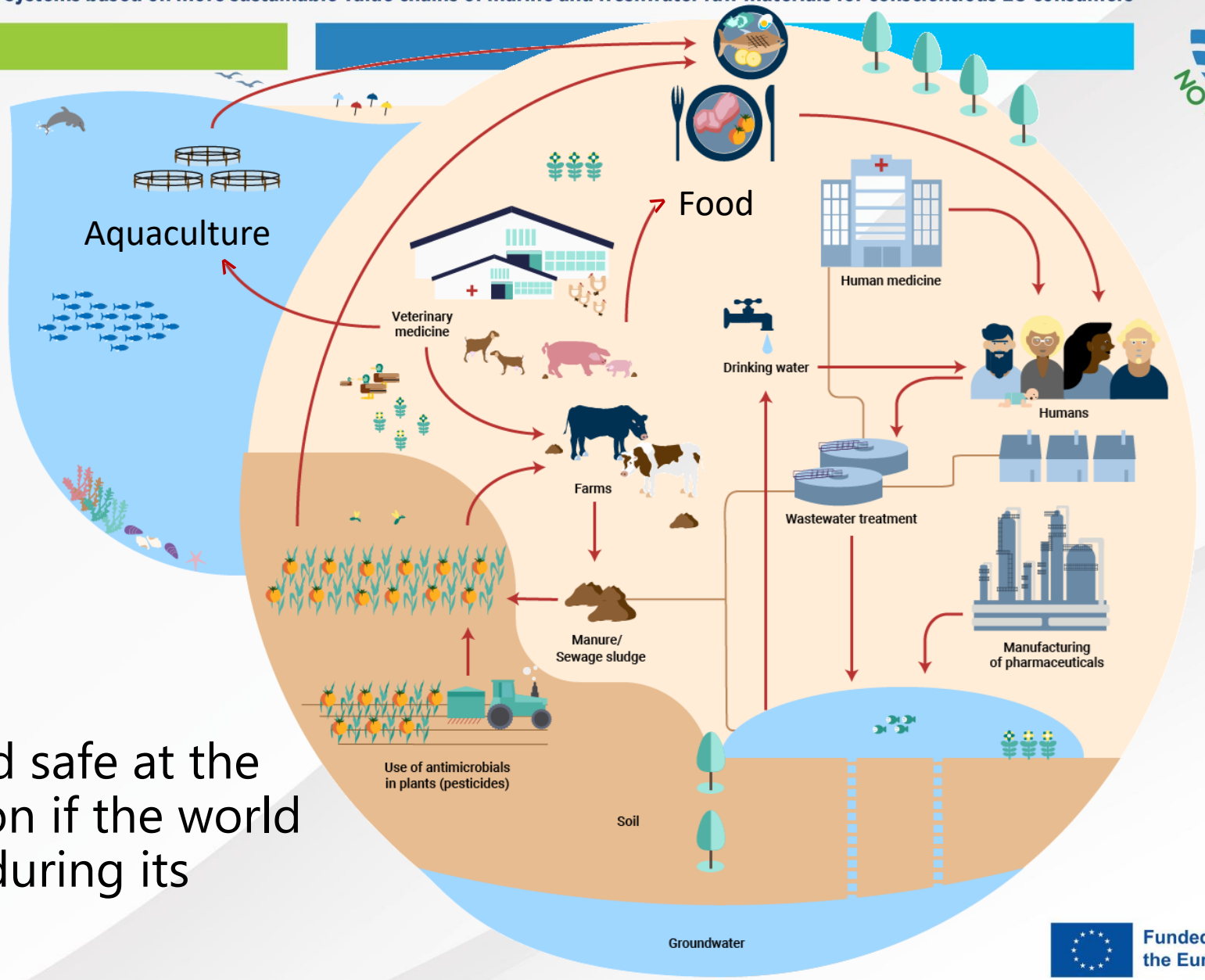
Consider how food gets onto our plates!



Can food be considered safe at the moment of consumption if the world we live in is degraded during its production?

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Food safety in the aquaculture and seafood sector

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(chemical, biological, physical) contaminations

biofouling

pollution

heavy metals

(introduction of) Invasive species

Distinction of native species …

lack of control mechanisms

quality deficits

What are (safety) problems of seafood and aquaculture products?

…

lack of food safety

animal and plant diseases

lack of hygiene

toxins

unwanted microorganisms

Waste (water)

Insufficient cleaning practices

Ship-traffic

sewage

Environmental stress and damage

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Food, food safety and One Health

Back to basics!

What is Food?

- *Energy source for living organisms*
- *"Human food" is fit for human consumption*
  Including harvested, produced and, or processed things

However, …

Food can also serve as:

- Growth and reproductive medium for pathogens
- Carrier material loaded with unintended, harmful substances

→ Food affects human, animal, and environmental health

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Food safety - definition

- Food safety

  … addresses the safety of food at the moment of consumption.

- Food safety incidents

  … are situations where there is a potential or confirmed health risk associated with food consumption.

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Food safety from a One Health perspective

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One-Health

Animal Health

- wild animals
- domestic animals
- animal production

Human Health

- health system
- food system
- food production

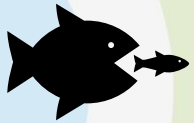
Environmental Health

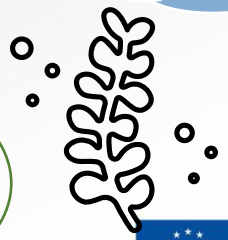
- habitats
- biodiversity
- plants
- soil
- air
- water

Diseases/ Infections

Invasive species

waste





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Due to the interdependence of everything,

the impact of (human) actions has far-reaching and often underestimated effects.

Ecosystems are affected by human activity.

Which in turn affect us.

That includes
physical-, biological-, chemical- and lifestyle related risks.

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Food Safety trends, aspects and concerns - Examples

- Globalisation
- Natural disasters
- Resistances, adapting and invasive behaviour
- New opportunities to cross species lines
- Increasing prevalence of misinformation of fake news regarding certain foods and their safety
- …

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Food safety has crucial effects on …

- Human health (= public health)
  - Animal-borne (transboundary) diseases, residues, pesticides, …
- Animal health
  - Diseases, pathogens and parasites, residues, …
- Environmental health
  - Contamination, pathogens and parasites, displacement, …

One Health

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Food system and One Health issues

Effects of food production
(along the supply chain)

- Spreading and transmission of pathogen and parasites (hygiene)
- Pollution and waste
- Animal welfare and (transboundary) disease

Effects of produced food

- (Mal)nutrition
- Food borne diseases and illnesses affecting human, animal and plants
- Transferred hormones, toxins
- Chemical and biological contamination of food chains and the environment

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Effects of food production (along the supply chain)

- Spreading and transmission of pathogens and parasites (hygiene)
  - Biofilm formation (on machinery and tools)
  - Biofouling
- Pollution and waste
  - Atmospheric emission
  - Oil spills
  - Illegal discharge, microplastic, …
  - Underwater noise pollution
- Animal welfare and (transboundary) disease
  - Zoonoses, bacterial transmission to humans
  - Transfer of invasive aquatic species

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Effects of produced food

- Unbalanced diet; lack of macro- and micronutrients
- Zoonoses, bacterial infections, food poisoning
- Antibiotics and Antimicrobial resistances
- Toxins
- Accumulation of heavy metals
- Waste and water management

- (Mal)nutrition
- Food borne diseases and illnesses affecting human, animal and plants
- Transferred hormones, toxins
- Chemical and biological contamination of food chains and the environment

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Example – accumulation of heavy metals

- Source
  - Paints, biofouling paints *(from ship hulls, which should reduce spread of species and pathogens, …)*
  - Batteries, electronics, cables, generators, lamps, …

- Consequences
  - Decrease of overall condition and increased mortality of fish
  - Risks for human; kidney dysfunction, liver failure, cardiovascular system disorders, acute and chronic damage to the central and peripheral nervous system
  - Contamination of water (and the environment)
  - Loss of income due to yield losses

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Conventional solutions and practices around aquaculture and fish farming

and global problems they cause

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Conventional solutions in society

(Excessive) Use of

- Antibiotics and fungicides
- Chemicals
- (Concentrated) Feed
- Wastewater

Problems caused by these agents

- AMR (**A**nti **M**icrobial **R**esistance)
- Discharge of nutrients and eutrophication
- Introduction of chemicals to the native environment
- Waste, wastewater, grey water, etc.

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Antibiotics and microbial resistances

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Antibiotics

- Natural or synthetic compound that kills bacteria or inhibits their growth
- Are used to treat Bacterial infections in
  - Humans
  - Animals
  - (sometimes plants)

→ mostly acute

→ (acute,) preventive and growth promoting use

One of the main problems to cause AMR

- Specificity
  - Broad-spectrum
  - Narrow-spectrum
- 5 different working mechanisms (5 ways)

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Antibiotic and antimicrobial resistance (AMR) - Definition

Antibiotic resistance

… is the ability of bacteria to survive and grow in the presence of antibiotics (that would normally kill them).

Antimicrobial resistances (AMR)

… is a broader term referring to the ability also of other microorganisms like fungi and yeasts to withstand the drugs that were designed to kill them.

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Key factors to drive resistances (AMR)

- Overuse and misuse of antibiotics → preventive, prophylactic and growth promoting use of broad-spectrum-antibiotics!
- Poor biosecurity practices and environmental contamination
- Economic pressure and intensive farming
- Lack of diagnostic tools and knowledge gaps → educational factors
- Regulatory issues
- Limited development of new antibiotics, global trade and movement, climate change

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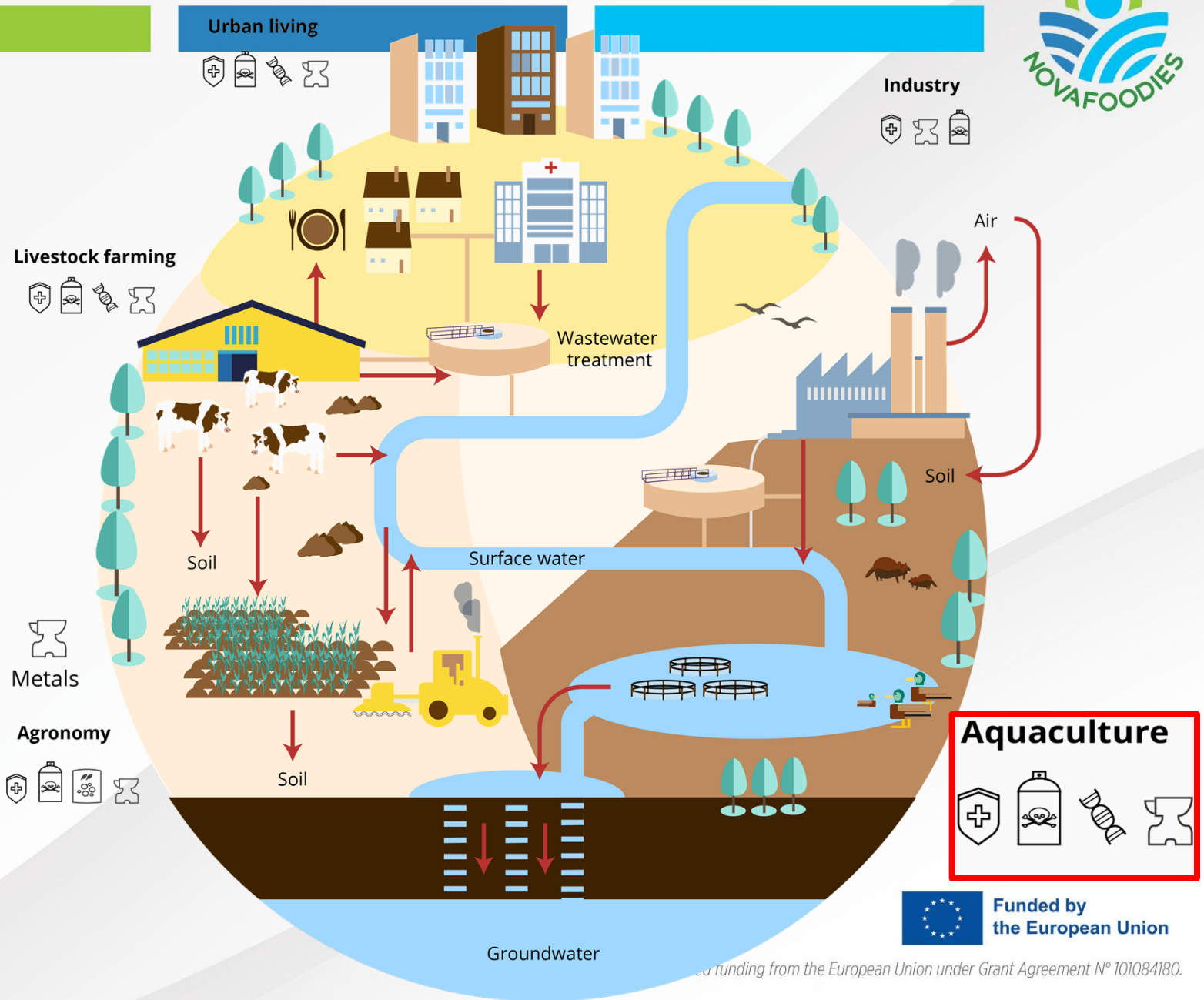
Uncontrolled spreading of antibiotics and AMR

- Antimicrobial use
- Biocides
- Genes
- Metals
- Inorganic fertilisers



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Impact of AMR (Antimicrobial resistance)

	Examples
Animal Health and Welfare	→ reduced natural immunity due to stress
Economic impact	→ rising morbidity and mortality, lower yield
Public health concerns	→ increasing risks of transfer from animals / other organisms to humans
Environmental concerns	→ increasing costs for treatment of e.g. run-off
Multidimensional themes	→ ethical problems; what if new antibiotic classes are restricted for human therapy only

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Waste and wastewater

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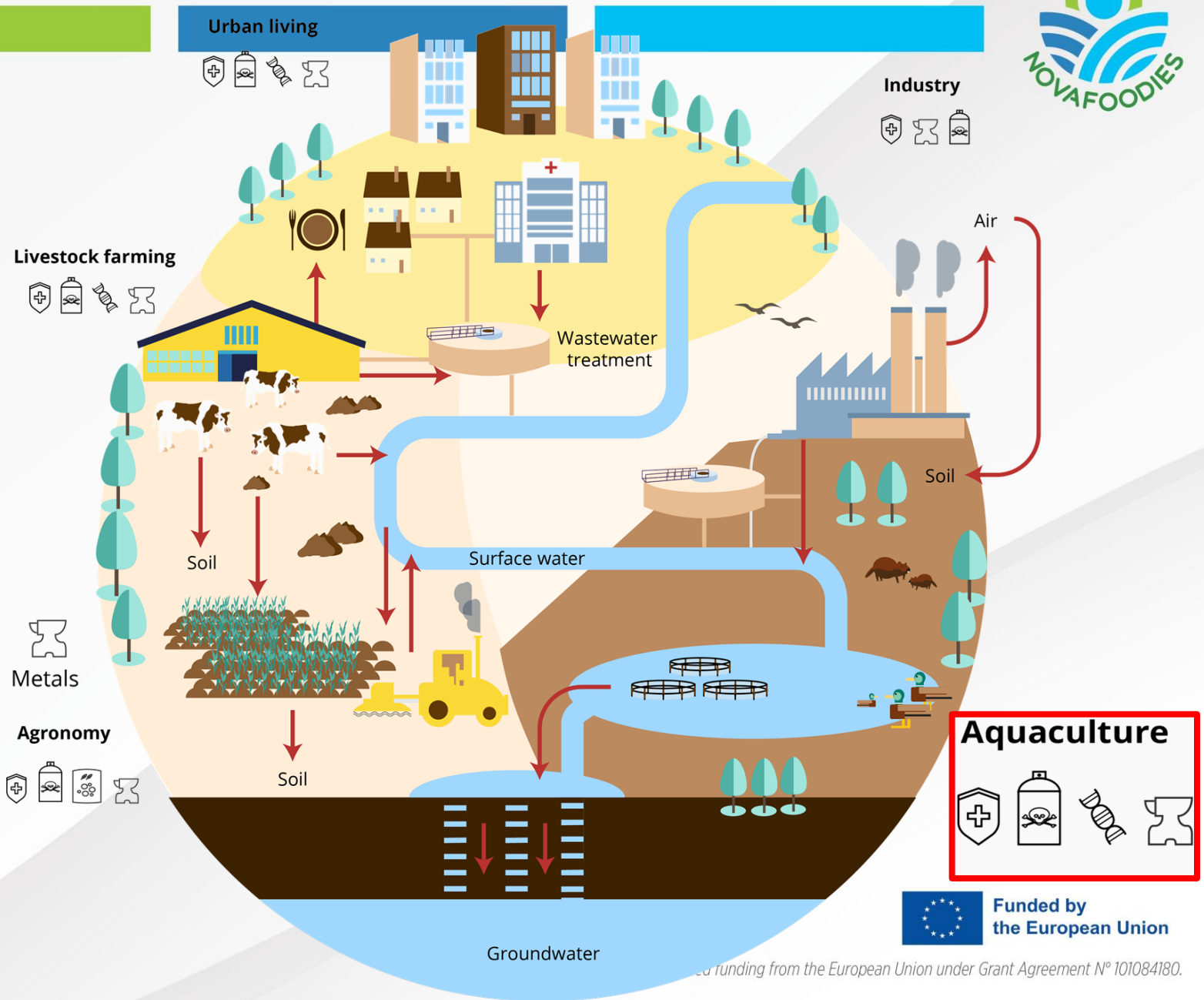
Uncontrolled spreading of antibiotics and AMR

- Antimicrobial use
- Biocides
- Genes
- Metals
- Inorganic fertilisers



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Waste

- … is a critical part of a product or process lifecycle and must be considered!

- … can be harmful to the environment, plants, animals and humans if not treated mindfully or at all (ecotoxicity)

- For a healthy system all the steps have to be considered, which leads us to

Waste management

- that is the final step in
  - removing all types of waste
  - recycling valuable resources and
  - treating them in a way that has the least impact on the system and environment

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Wastewater

- … has a major impact on One Health!

  → Untreated it increases the spread of pathogens, toxic compounds, etc. which leads to the spread of AMR and other cost-intensive (health) problems for humans, animal and plants!

- … has to be treated before being discharged into the environment

  → Different approaches for (waste)water treatments, that also produce e.g. algal biomass and biofuels

- "***Treatment processes*** ***can significantly reduce the levels of resistant bacteria and genes*** *in wastewater and manure before these are discharged in the environment or re-applied on land.*" (*European Environment Agency (2024), Veterinary antimicrobials in Europe's environment: a One Health perspective*)

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Ecotoxicity

- … is the result of (all the) various toxic and damaging mechanisms due to the release of substances that have a direct impact on the health of the ecosystem.
- Substances are
  - ➢ biological
  - ➢ chemical or
  - ➢ physical

  } stressors that have an effect on the ecosystem
- For example:
  - Wastewater
    - Containing: faeces, uneaten feed, chemicals to treat diseases and parasites
  - Antibiotics
  - Microplastics

→ causing stress in farmed fish, and
→ potential effects on the environment

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Alternatives and better practices

considering a One Health approach

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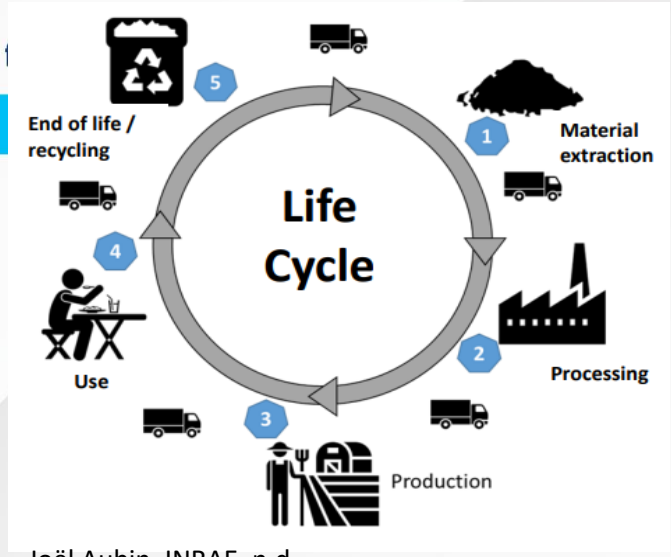
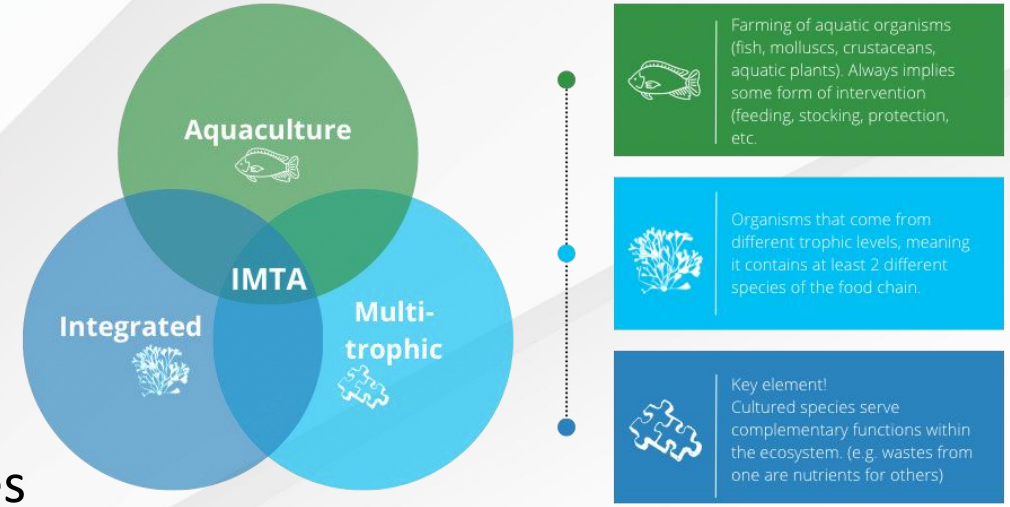
Alternatives to conventional practices



Joël Aubin, INRAE, n.d.

- Strategic holistic approaches
- Life cycle (impact) assessment and circular farming
- Ecosystem-based management
- Environmental monitoring
- Fleet capacity management, fight against IUU fishing
- (New) production techniques;
  - IMTA
  - Culture of seaweeds in earthen ponds or liquid wastes
- Development of new sources for food and feed, biofuels and bioenergy, biotechnology therapeutics and pharmaceutics, cosmetics, ….



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Alternatives to Antibiotics – key PREVENTIVE measures

Measures to reduce antimicrobial diseases and reliance on antimicrobials for farmed animals

- Adequate farming practices
- Biosecurity practices
- Controlled movement of animals, people, and vehicles
- Pest control measures
- Nutrition and stress management
- Vaccination and health monitoring

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Key principles to reduce use of antimicrobial substances

- Foster natural immunity of animal and humans → animal welfare
- Evidence-based decision making → monitoring and documentation!
- Continuous monitoring and adaptation
- Balancing animal health, welfare and productivity → sustainability, One Health

Benefits of reduced antimicrobial/antibiotic use

- Decreased risk of microbial growth and antimicrobial resistances
- Improved food safety and public health
- Enhanced farm sustainability and profitability
- Increased consumer confidence and satisfaction

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Strategic holistic approaches

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Strategic measures

Goal:

- Integrated strategies for (more) sustainable seafood and aquaculture

Strategic measures

- Genetics and selective breeding for disease resistance
- Optimised nutrition and feed management
- Improved housing and welfare practices
- Strategic use of alternative treatments
- **Comprehensive biosecurity measures**
- **Thoughtful waste management**

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Biosecurity practices

- Introduction of Biosecurity measures
  - Measures to prevent the introduction and spread of pathogens
  - Livestock management
- External biosecurity Measures (bioexclusion)
- Internal Biosecurity Measures (biocontainment)
- Sanitation and waste management
- Water quality and impact on the surroundings

→ Rise of animal health, while antibiotic use (and AMR!) is reduced.

Environmental monitoring parameter (examples)
Water temperature
Salinity
Dissolved oxygen
Current velocity
Chlorphill a
Particulate organic matter
Total particulate matter
Dissolved inorganic nitrogen
Ammonia
Nitrate
Nitrite
Dissolved inorganic phosphorus
Secchi depth (or other proxy for underwater light climate)

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Boosting natural immunity

- Considering the connection between welfare and immune function
  - Stress negatively impacts immune responses
  - Good welfare practices can enhance natural immunity
- Five Freedoms of Animal Welfare
  - Freedom from hunger and thirst
  - Freedom from discomfort
  - Freedom from pain, injury, or disease
  - Freedom to express normal behavior
  - Freedom from fear and distress
- Benefits of improved welfare
  - Enhanced disease resistance
  - Reduced need for antimicrobials
  - Improved productivity and product quality

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Waste management

- Refers to

  environmentally friendly processes for reducing the environmental impact of the waste of all types of materials used in a business.

- Different approaches to prevent excessive use of resources
- Avoid and minimise environmental impact
- Important aspects to consider:
  - Preparation of strategic waste management plans
  - Legal aspects of waste management
  - Sources and types of waste
  - Waste treatment
  - Waste storage and transportation

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Waste management hierarchy

REUSE
REDUCE
RECYCLE

Gives us a systematic order when we think about waste (reduction) and the environmental impact.

It guides and should help rank waste management decisions.

Examples

Prevent: overproduction, increase animal welfare to reduce illnesses/zoonoses

Reduce: waste through automated feeders, real-time monitoring

Reuse, recycle and recover: combine processes and production steps (circular farming with symbiotic species, reuse nets, container, waste-valorisation (biogas from organic sludge)

Dispose: treat harmful water residues, dispose through energy recovery incineration

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Thank you very much for your attention!

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