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**FIRST CONFERENCE ON  
ANIMAL BIOSECURITY**

# Biosecurity Economics

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# Aim of this presentation

- Describe the complexity of biosecurity economics
  - BSM implementation at farm level is considered in particular
- Focus on what is known and what would be useful to know about BS economics
  - Provide arguments to reflect on effective economic policies to improve the implementation of BSMs

# Economic complexity

Looking at the microeconomics of BSM, some characters emerge:

- BSMs differ for cost categories
  - This opens to complex decisional scenarios for farmers
- BSMs often work conjointly and largely depend on farm and contextual situations
  - Difficult to model also from an economic standpoint
- BSMs implementation depends on many factors
  - Economic drivers are not always determinant

# Economic complexity

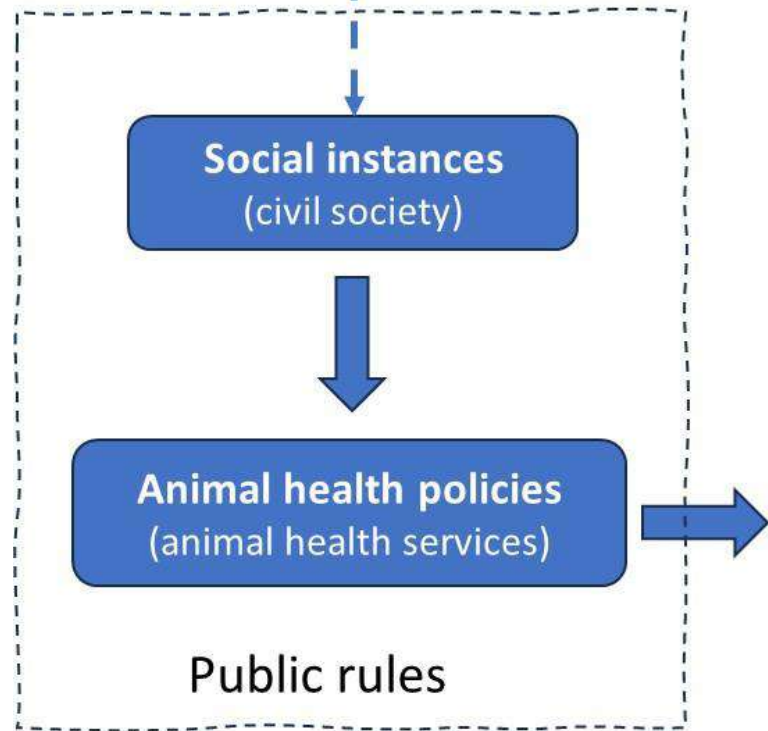
- The institutional framework is also complex
  - Public policy are in place, but farmers are subject to effective private rules too.
    - This evokes an influence of the food supply chain organization on biosecurity
- Biosecurity as such is probably away from consumer attention
  - Differently from other BS-related attributes (AM-free, animal welfare, organic production, etc.) biosecurity is almost unknown

# Our approach

- We adopted a supply chain approach, which takes into account the farm level in particular
  - Farmers are seen as the ending point of public and private (or market) drivers
- Structural economic factors are reviewed at each level of the supply chain
  - The approach is systemic, but necessarily non multidisciplinary

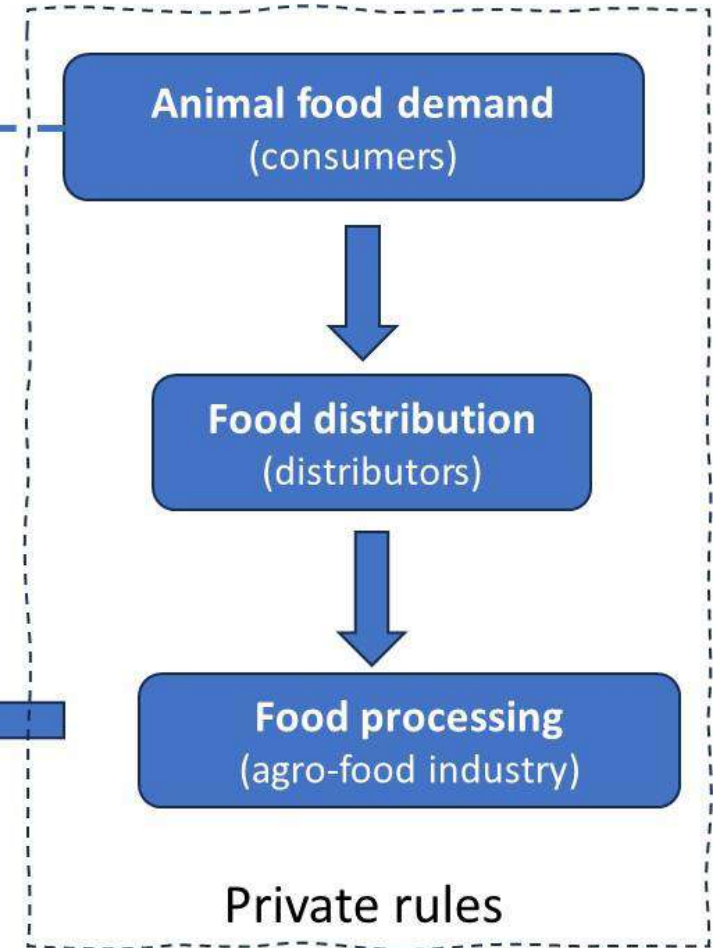
# Our approach

*no-market rules*



*EU policy mix for animal farming biosecurity*

*market rules*



The market side

Farm level

# Cost and benefits of biosecurity

- BSM implementation can be seen as insurance against the risk of future revenue losses due to the spread of animal diseases
- Farmers' decision about BS is based on the comparison between current BSM cost and the future risk of economic losses
  - Future losses are subject to probability, farmer risk perception and risk attitude
  - Current expenses are real
- The cost/benefit ratio is the economic tool usually applied in this context
  - Both costs and benefits deserve a careful focus to understand the economic evaluation problem at farm level

# BSMs cost

- BSMs consist in fixed and variable costs
  - Fixed costs: material and immaterial investments
    - Sensitive to scale economies
      - They generate an overall cost (depreciation or amortisation) that becomes lower in terms of unit cost when the production volume increases
  - Variable costs: labour, consumable, raw materials
    - Directly valuable, related to production volume and not sensitive to scale economies
    - Often, variable costs appear low as individual events, but repeated many times in a short period may become relevant
- BSMs investments are mainly farm specific
  - They can only be used in the farm where they are applied
  - Can not be shared among farmers

# BS benefits

- Savings of variable costs
  - Reduced drugs and veterinary expenses
- Production volume
  - Increased production
  - Reduced disease risk > Reduced health outbreaks > less production losses over time
- Product quality
  - AM-free may gain a premium price (or be just a pre-condition to access the market)
- No trade restriction

# Balancing costs and benefits

We can assume that the K/B balance may result in different situations:

$$\delta(Kf + Kv) < \delta B$$

Development opportunity



$$\delta(Kf + Kv) = \delta B$$

Economic neutrality



$$\delta(Kf + Kv) > \delta B$$

Marginalization risk

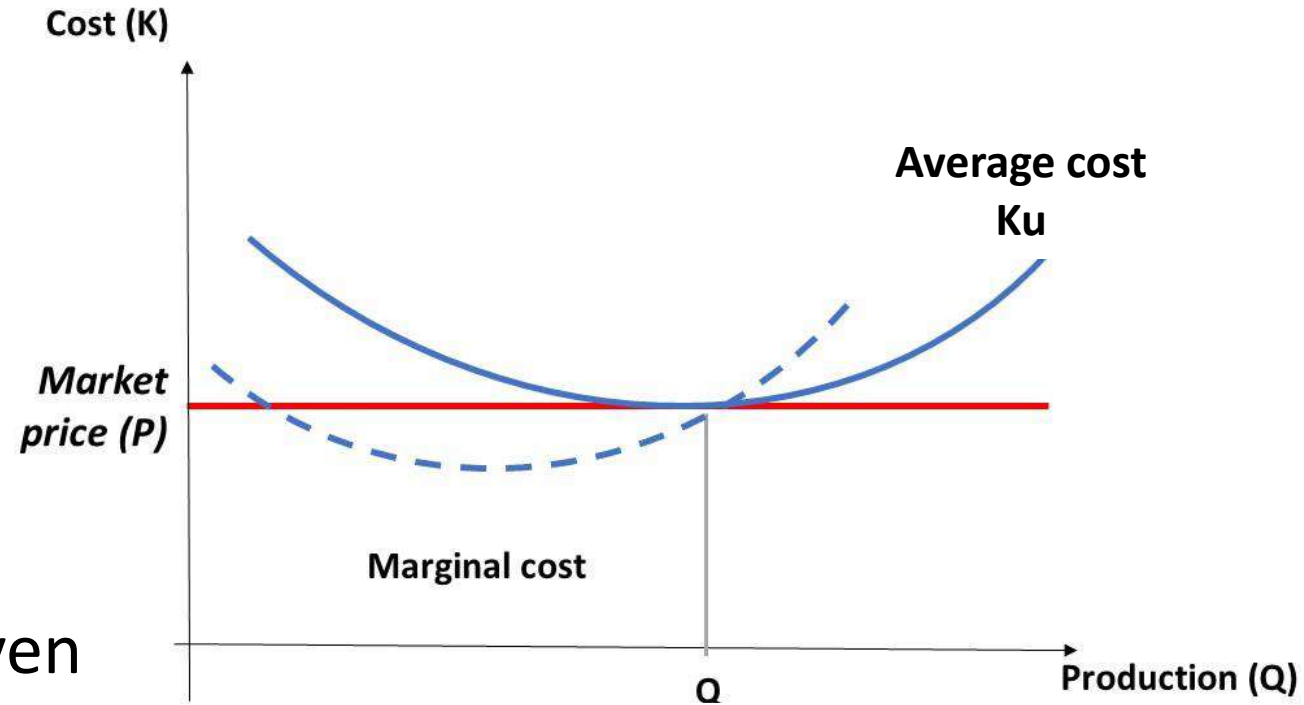


# Marginalization

- Marginalization occurs when:

$$Ku_{min} \geq \text{Price}$$

- In this case the firm may lose or even cancel profits (or revenue)
- Firms which are already in a critical position may stop production because of BSM implementation
  - This depends of course on the magnitude of benefits and cost, but also on the structure of the cost (i.e. the mix of fixed and variable costs in relation to the production volume)



# What we know and what is missing

- A large literature on BSM economics does exist but mainly focusses on technology and practice effectiveness
  - Single or few BSMs combinations are analysed; technical effectiveness assessment prevails
- Few studies report about K/B balance and unit production cost
- The link between costs and farm dimension/organization is missing
  - Scale economies knowledge would provide useful information:
    - To farmers, to locate themselves in the respect of the economic sustainability of different BSM in their own organization
    - To animal health policy administrators, to guide and target incentives and supporting measures, and to evaluate potential sector impact of any policy intervention

The market side

Sector/Supply chain level

# Sector level

- Assuming a negative aggregated impact of BSM (e.g. high marginalization rate), sectorial effects may be also relevant
  - Production volume
  - Competitiveness
  - Employment
- At the same time, the remaining farms may apply adaptive solutions, differentiated according to the economic period (short vs. long term)
  - In this sense, we can assume that BSM implementation adds to the long-term structural trend of the animal production sectors (which usually favours larger farms)

# Sector level

## Short/medium term

- Production shortage
- Loss of competitiveness



- Increased import
- Supplier substitution

## Medium/long term

- Increased scale economies of remaining/new farms
- Organizational innovation (horizontal and vertical integration)



- Increased production
- Increased competitiveness

Distributional effects go with the trends above.

Who loses and who gains (and at what cost) may be not a marginal issue in national or regional systems

# Supply chain level

- The supply chain level is about behaviours and mutual influences among the relevant chain actors (farmers, processing industries, food distribution), to satisfy consumer demand
- Each level has specific economic issues
  - Consumer level
    - What is the consumer behaviour toward biosecurity or biosecurity-related attributes (i.e. animal welfare, AM-free)?
  - Food industry/distribution level
    - How these actors adapt to consumer behaviour in a competitive context?

# The consumer level

- Willingness-to-pay for BS as such is poorly investigated
  - Consumer attention is mostly focused on animal welfare, AM-free products and other quality attributes
  - AM-free can be assumed as a proxy (and a result) of biosecurity but the technical connection linking BS and AMU is not certain at consumer level
- Wtp for BS may be a relevant piece of information for farm/firm strategy in view of BSMs implementation, having in mind some caution
  - Health attributes are meant to gain a premium price and cover increased costs, but in some sectors BS is just a pre-requisite to access the market
  - Consumer wtp may differ in different socio-economic context (i.e. rural, industrial, post-industrial economies)
  - Additional quality attributes (i.e. via certification) may also have paradoxical effects on consumer

# Processing industry level

- Product quality is a competitive tool in horizontal and vertical competition, in industrial/post-industrial societies
  - This kind of competition may determine backward integration (industry vs. farms) to comply with quality standards in downstream markets
  - Quality standards (including biosecurity) imposed to farmers by processing industry go beyond law requirements in some cases
- The question is: to what extent competitive strategies of processing industry influence the implementation of BSMs at farm level?
  - What are the motivations of the industry to enforce biosecurity in vertically integrated organizations? What are the tools?
  - What is the BS level of integrated farms compared to independent ones?

# BS within the supply chain: a scoping review

## Positive BS drivers

- Trust in institutions
  - Public or private (more trusted)
- Integrators do have stronger enforcement tools
  - Contracts, control, oversight
- Market destination (distributors)
  - Buyer's market power
- Producer's cooperative (H integration)
  - Knowledge transfer, strategy sharing

## Opposing BS drivers

(despite other favourable conditions)

- Individual risk perception
- Lack of farmer's autonomy
  - Leading to buyer substitution to bypass rules
- Informal practices
- Market segmentation
  - Informal markets
  - Poor markets

# What we know and what is missing

- Very few papers focus on the relationship between food supply chain organization and BSMs implementation at farm level
  - Only 17 papers, out of 141 apparently coherent with the key term
- Also, the internal motivation of industrial integrators should be better investigated
  - To what extent BS is a driver of vertical integration? What are the economic motivations of biosecurity for the s.c. industrial integrators?
- Finally, not only consumer behaviour but also FSCh organization changes in different economic context
  - It's logical to assume that the role of processing industry in BS implementation may change with the type of society
- These pieces of information may be relevant in the definition of public BS strategies and supporting measures

# The no-market side

# Policy Mixes

Complex societal issues, like biosecurity in animal farming and product supply chains, should be addressed through **multiple and interacting policy measures** covering areas such as:

- standards and regulations;
- controls and sanctions;
- monitoring;
- infrastructures and capacities;
- communication and training;
- voluntary schemes;
- economic and fiscal incentives;
- ....

(for the concept of **Policy mixes**, see Fedrigo-Fazio, 2014)

# The EU animal biosecurity policy mix

## Identified animal biosecurity policy areas

1. Legal and regulatory framework
2. Surveillance and Monitoring Systems
3. Movement Control Policies
4. Border and Trade Biosecurity
5. Emergency Preparedness and Response
6. On-Farm Biosecurity Guidelines
7. Public Awareness and Education
8. Research, Innovation, and Capacity Building
9. Multi-Stakeholder Coordination



**Policy areas directly aimed at improving animal public health**



**Policy areas aimed at raising stakeholders' awareness and involvement**

# Policy areas and sub-areas (1)

<b>1. Legal and regulatory framework:</b>	<b>Animal health laws:</b> Mandate disease reporting, surveillance, movement controls, and response protocols.
	<b>Import/export regulations:</b> Enforce veterinary checks, quarantine, and certifications for live animals and animal products.
	<b>Enforcement mechanisms:</b> Define penalties for non-compliance and powers for disease control authorities
<b>2. Surveillance and Monitoring Systems</b>	<b>Disease surveillance programs:</b> Monitor animal health status across regions.
	<b>Early warning systems:</b> Detect emerging and notifiable diseases.
	<b>Reporting obligations:</b> Require timely reporting by veterinarians and farmers.
<b>3. Movement Control Policies</b>	<b>Animal identification and traceability:</b> Implement systems to track animal movements and health history.
	<b>Zoning and compartmentalization:</b> Define disease-free areas and manage disease control measures accordingly.
	<b>Transport biosecurity:</b> Regulate cleaning and disinfection of vehicles and equipment.

# Policy areas and sub-areas (2)

<b>4. Border and Trade Biosecurity</b>	<b>Import risk assessments:</b> Evaluate disease risks of animal and product imports.
	<b>Quarantine stations and procedures:</b> Isolate and test animals before entry or exit
	<b>International standards compliance:</b> Align with OIE and Codex guidelines.
<b>5. Emergency Preparedness and Response</b>	<b>Contingency planning:</b> National plans for disease outbreaks (e.g., foot-and-mouth, avian flu).
	<b>Simulation exercises:</b> Test coordination among veterinary services and stakeholders.
	<b>Stockpiles of equipment and vaccines:</b> Prepare for rapid deployment.
<b>6. On-Farm Biosecurity Guidelines</b>	<b>National standards or codes of practice:</b> Provide structured guidance to farmers on hygiene, isolation, and farm design.
	<b>Incentives for compliance:</b> Link subsidies or certifications to adherence to biosecurity protocols.
	<b>Extension services:</b> Support farmers with training, audits, and technical advice.

# Policy areas and sub-areas (3)

<b>7. Public Awareness and Education</b>	<b>Training programs:</b> For farmers, vets, transporters, and abattoir workers.
	<b>Biosecurity campaigns:</b> Raise awareness of disease risks and prevention methods.
	<b>Curriculum integration:</b> Include animal health and biosecurity in agricultural education.
<b>8. Research, Innovation, and Capacity Building</b>	<b>Support for R&amp;D:</b> Focus on vaccines, diagnostics, and risk modeling.
	<b>Capacity development:</b> Strengthen veterinary services, labs, and infrastructure.
	<b>Technology adoption:</b> Encourage use of digital tools for tracking, reporting, and communication.
<b>9. Multi-Stakeholder Coordination</b>	<b>Public-private partnerships:</b> Engage industry, academia, and NGOs in biosecurity governance.
	<b>Inter-agency coordination:</b> Between agriculture, health, customs, and environmental departments.
	<b>Regional cooperation:</b> Align policies with neighboring countries for transboundary disease control.

# The EU's animal biosecurity policy core legal framework

The EU set of rules directly aimed at improving biosecurity in animal farming

- **Regulation (EU) 2016/429** – *Animal Health Law*
- **Regulation (EU) 2017/625** – *Official Controls Regulation*
- **Regulation (EU) 2019/2035** – *Model certificates and official controls for imports & identification and registration of animals*
- **Regulation (EU) 2020/687** – *Measures during outbreaks of listed diseases*
- **Regulation (EU) 2020/688** – *Animal movement between Member States*
- **Regulation (EU) 2020/689** – *Surveillance, eradication, and status recognition*
- **Regulation (EU) 2020/692** – *Import requirements for animals and animal products*
- **Regulation (EU) 2020/2002** – *Notification obligations and emergency measures*
- **Regulation (EU) 2021/963** – *Animal movement information systems (TRACES, ADIS)*
- **Regulation (EC) 2005/1** – *Animal welfare during transport (complementary)*
- EU rules align with **WOAH** and **Codex Alimentarius** standards to ensure safe trade and disease prevention.

# EU institutions, agencies and operative tools involved in the animal biosecurity policy (1)

Type	Actor/Tool	Main Role in Biosecurity in Animal Farming
Policy/ Legislation	European Commission (DG SANTE)	Drafts regulations, supervises enforcement
	European Parliament/Council	Approves laws and funding
Science/ Risk Assessment	EFSA (European Food Safety Authority)	Scientific advice, risk analysis
	EURLs (European Reference Labs)	Diagnostics and lab support
Control/ Audit	Health & Food Audits (DG SANTE)	Audits Member States and third countries
IT Tools	TRACES NT (Trade Control and Expert Sys.)	Manages animal movements and certifications
	ADIS (Animal Disease Information System)	Tracks animal disease outbreaks
	IMSOC (Integrated Management Sys. for Official Controls)	Coordinates official control systems
	RASFF (Rapid Alert Sys. for Food and Feed)	Alerts on food and feed risks
Funding/ Support	CAP (Market and RD policies), FAS,	Funds advisory services and investments in farm biosecurity




# EU institutions, agencies and operative tools involved in the animal biosecurity policy (2)

Type	Actor/Tool	Main Role in Biosecurity in Animal Farming
Funding/ Support	CAP (Market and RD policies), FAS (Farm Advisory System),	Funds advisory services and investments in farm biosecurity, training for farmers, technicians, vets, and abattoir operators
	Horizon Europe	Funds research and production of training materials
	BTSF (Better Training for Safer Food)	EU flagship initiative supporting training, and digitalization in this sector
	EUFRAS (European Forum for Agricultural and Rural Advisory Services)	Training of farm advisory services operators
	Many EU institutions, agencies and initiatives ...	Involved at various degrees in research and innovation, capacity building, and stakeholder coordination

# Member States role in the EU's animal biosecurity policy implementation

Below is an evaluation of the **relative importance of Member State roles** across the **9 policy areas** and their respective **sub-areas**.

For each, the **Member State implementation role has been rated as either:**

-  **High** (Primary responsibility lies with Member States)
-  **Shared** (Mixed responsibilities between EU and MS)
-  **Low** (Primarily EU-led or harmonized at EU level)

# MSSs' role in the EU animal biosecurity policy (1)

<b>1. Legal and regulatory framework:</b>	<b>Animal health laws:</b> Mandate disease reporting, surveillance, movement controls, and response protocols.	● Shared → Framework set at EU level (e.g. Animal Health Law), but MS implement, adapt, and enforce.
	<b>Import/export regulations:</b> Enforce veterinary checks, quarantine, and certifications for live animals and animal products.	● Low → Strongly harmonized by EU legislation and TRACES system.
	<b>Enforcement mechanisms:</b> Define penalties for non-compliance and powers for disease control authorities	● High → Penalties, inspections, and enforcement powers are defined and applied at national level.
<b>2. Surveillance and Monitoring Systems</b>	<b>Disease surveillance programs:</b> Monitor animal health status across regions.	● High → Designed and operated by Member States based on EU surveillance requirements.
	<b>Early warning systems:</b> Detect emerging and notifiable diseases.	● Shared → EU supports tools (e.g. ADIS, EFSA), but MSs must detect/report locally.
	<b>Reporting obligations:</b> Require timely reporting by veterinarians and farmers.	● High → National authorities collect reports from veterinarians and producers.

# MSS' role in the EU animal biosecurity policy (2)

<b>3. Movement Control Policies</b>	<b>Animal identification and traceability:</b> Implement systems to track animal movements and health history.	● Shared → EU provides framework (e.g. cattle/passport regulations), but systems are run by MS.
	<b>Zoning and compartmentalization:</b> Define disease-free areas and manage disease control measures accordingly.	● High → MS define zones and enforce disease control boundaries.
	<b>Transport biosecurity:</b> Regulate cleaning and disinfection of vehicles and equipment.	● High → MS responsible for vehicle disinfection rules and farm access controls.
<b>4. Border and Trade Biosecurity</b>	<b>Import risk assessments:</b> Evaluate disease risks of animal and product imports.	● Low → Risk assessment methods are coordinated centrally via EFSA and DG SANTE.
	<b>Quarantine stations and procedures:</b> Isolate and test animals before entry or exit	● Shared → National facilities, but under harmonized EU border rules.
	<b>International standards compliance:</b> Align with OIE and Codex guidelines.	● Low → EU negotiates and ensures alignment with OIE, Codex.

# MSSs' role in the EU animal biosecurity policy (3)

<b>5. Emergency Preparedness and Response</b>	<b>Contingency planning:</b> National plans for disease outbreaks (e.g., foot-and-mouth, avian flu).	● High → National veterinary services design and activate emergency plans.
	<b>Simulation exercises:</b> Test coordination among veterinary services and stakeholders.	● High → MS conduct these exercises (though EU supports them under BTSF).
	<b>Stockpiles of equipment and vaccines:</b> Prepare for rapid deployment.	● High → Managed at national level, with optional EU support (e.g. vaccine banks).
<b>6. On-Farm Biosecurity Guidelines</b>	<b>National standards or codes of practice:</b> Provide structured guidance to farmers on hygiene, isolation, and farm design.	● High → Developed nationally based on EU minimum requirements.
	<b>Incentives for compliance:</b> Link subsidies or certifications to adherence to biosecurity protocols.	● High → Linked to national CAP implementation (conditionality, eco-schemes).
	<b>Extension services:</b> Support farmers with training, audits, and technical advice.	● High → Organized and funded nationally, often through CAP-funded Farm Advisory Systems.

# MSSs' role in the EU animal biosecurity policy (3)

<b>7. Public Awareness and Education</b>	<b>Training programs:</b> For farmers, vets, transporters, and abattoir workers.	● High → Delivered by national/regional training bodies or farm advisory services.
	<b>Biosecurity campaigns:</b> Raise awareness of disease risks and prevention methods.	● High → National veterinary services, often co-funded by EU.
	<b>Curriculum integration:</b> Include animal health and biosecurity in agricultural education.	● High → Education is a national competence in the EU.
<b>8. Research, Innovation, and Capacity Building</b>	<b>Support for R&amp;D:</b> Focus on vaccines, diagnostics, and risk modeling.	● Shared → EU funds large research projects (e.g. Horizon Europe), MS fund local R&D.
	<b>Capacity development:</b> Strengthen veterinary services, labs, and infrastructure.	● High → MS invest in labs, personnel, and facilities, possibly with EU co-financing.
	<b>Technology adoption:</b> Encourage use of digital tools for tracking, reporting, and communication.	● Shared → EU promotes digital tools; MS facilitate uptake and integration.

# MSSs' role in EU animal biosecurity policy (4)

<b>9. Multi-Stakeholder Coordination</b>	<b>Public-private partnerships:</b> Engage industry, academia, and NGOs in biosecurity governance.	● High → These are mostly facilitated by national platforms.
	<b>Inter-agency coordination:</b> Between agriculture, health, customs, and environmental departments.	● High → Depends on national administrative arrangements.
	<b>Regional cooperation:</b> Align policies with neighboring countries for transboundary disease control.	● Shared → EU encourages and supports cross-border alignment, but MS lead actual cooperation.

# Summary of Member State Priority Areas (● High Role)

The areas where **Member States play the most direct and critical role** in implementation include:

- **Surveillance and Monitoring**
- **Movement Controls**
- **Emergency Preparedness**
- **On-Farm Biosecurity**
- **Public Awareness and Training**
- **Enforcement Mechanisms**
- **Multi-stakeholder Coordination**

These are the areas where **flexibility and adaptation to local conditions** are essential, and where **Member States are mostly responsible for day-to-day operations**, including enforcement, service delivery, and stakeholder engagement.

# MSSs' role in EU biosecurity policy implementation and regional disparities

Member States play an extremely important role in the implementation of EU policies for biosecurity in animal farming

Member States role is priority in both:

- the policy areas concerning the daily enforcement of animal health and hygiene regulations;
- and the policy areas related to raising awareness and engaging stakeholders;

Member States must largely carry out these tasks **using their own resources**.

The **varying availability of human and financial resources** and **operational capacities** among Member States and regions represents a **shortcoming for the proper and homogeneous application of the European animal biosecurity standards throughout the EU** and **for stakeholder engagement**.

# Summary of main gaps and shortcomings

Inconsistent Enforcement:	Especially at local levels, with varying resource capacities across Member States
Data Sharing and Integration:	Gaps in communication and surveillance data sharing between countries.
Weak Coordination in Cross-Border Outbreaks:	Lack of effective regional cooperation and preparedness in emergency scenarios.
Unequal Access to Resources:	Small and medium-sized farmers face difficulties in accessing adequate training, subsidies, and biosecurity resources.
Technology and Research Adoption:	Slow adoption of newer technologies for monitoring and disease management.
Inconsistent Public Awareness:	Difficulty in reaching all stakeholders, especially those in informal sectors or marginal rural areas.

# How addressing gaps?

Addressing the identified gaps involves:

- strengthening cross-border coordination,
- Improving surveillance data sharing,
- expanding training and support to all farm sizes,
- and aligning incentives to encourage full compliance with biosecurity measures across the EU.

# Weakest link dynamics and equilibria

From an economic point of view, the issue of biosecurity can be framed as a **"weakest link game."**

**Example:** on an island, each person builds a barrier to protect against flooding. However, since a single failed barrier can cause the entire island to flood, **the overall level of protection is only as strong as the weakest barrier.**

In a weakest link game, **the amount of effort each player invests depends on their expectations of how much effort others will contribute.**

... we can reflect on how strengthening confidence in institutional capacity and fostering mutual stakeholder engagement could contribute to addressing this issue.

# Thank you for attention

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