

THE BIOECONOMY AND ONE HEALTH

AS INTERDEPENDENT GOVERNANCE FRAMEWORKS

Panel Contribution

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Roadmap

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Two Paradigms, One Problem

Bioeconomy & One Health: shared blind spots in conventional governance

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Health as an Anti-Rival Commons

The paradox of underproduction and what it implies for governance

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Genome + Exposome = Phenotype

Why integrating the two registers is essential — and what it demands from economics

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The SAM-CGE Modelling Bridge

Incorporating natural capital, health capital & exposome accounts

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Bioeconomy Governance under Uncertainty

Real options, R&D investment, and path-dependence

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An Integrated Framework

Three governance pillars for the biological commons

Two Paradigms in Search of a Common Frame

BIOECONOMY

Production-side: biological resources replace fossil inputs across value chains

Governance vision: sectoral and national, calibrated to industrial policy & innovation systems

Key challenge: directing R&D investment and managing transitions under deep uncertainty

Analytical toolkit: real options, path dependence, value chain economics

ONE HEALTH

Commons-side: health of humans, animals and ecosystems is fundamentally co-constituted

Governance vision: necessarily transnational and multi-species; sectoral agencies are structurally insufficient

Key challenge: uninternalised externalities and collective action failures at biological network scale

Analytical toolkit: epidemiology, ecology, network theory, public economics

YET
BOTH...

Both claim that the conventional economic treatment of biological systems is structurally inadequate to 21st-century challenges.

Health as an Anti-Rival Global Common Good

Rival good

My use reduces your access



Non-rival good

My use does not reduce your access



Anti-rival good

My use actively INCREASES your benefit



One Health view

Health is anti-rival: broader participation amplifies the entire biological commons

THE PARADOX OF UNDERPRODUCTION

As the biological community EXPANDS
(globalisation · intensive farming · urbanisation)...



...the shared health commons become MORE VALUABLE to every participant...



...yet free-rider dynamics and uninternalised externalities leave them MORE UNDERSUPPLIED.

Urgency grows monotonically with network size — globalisation is a governance accelerant, not just background context.

Genome and Exposome: Why Both Registers Are Indispensable

Phenotype = Genotype + Environment $\Rightarrow$ **Genome + Exposome = Health Outcome**

GENOME (Novelli's domain)

Nature — fixed at birth

DNA sequence, gene expression, epigenetic marks; the inherited biological programme

Precision medicine

Personalised risk stratification, pharmacogenomics, targeted therapy — actionable at the individual level

Necessary but insufficient

Genome alone cannot explain the majority of complex disease variance; gene-environment interaction is decisive

EXPOSOME (One Health domain)

Nurture — modifiable throughout life

Cumulative record of all environmental exposures from prenatal period onwards (Wild, 2005)

One Health bridge

Integrates chemical, biological, social & occupational exposures across human, animal and ecological systems

The domain of prevention

Unlike the genome, the exposome is responsive to policy — pollution control, food systems, land use governance

Interaction is non-linear: gene-environment interactions produce emergent health outcomes neither register predicts alone. Governance must internalise the costs of exposome modification — pollution, land use, food systems, AMR — because these directly alter the conditions under which genetic predispositions are expressed.

The Exposome in Economic Models: From Concept to Measurement

The Exposome in SAM-CGE

Extended Social Accounting Matrix incorporating Natural Capital (NC), Human Health Capital (HC), and Exposome Accounts (EXP) — making invisible externalities visible in macroeconomic balance sheets.

Physical Capital (PC) Standard factor: machines, infrastructure, equipment

Natural Capital (NC) Ecosystem services incl. sink functions — partly non-market

Human Health Capital (HC) Health stock as productive asset; formation via prevention spending

Exposome Accounts (EXP) Cumulative exposure burdens as contingent balance-sheet liabilities

PARADIGM CASE: LEAD EXPOSURE

Larsen & Sánchez-Triana · Lancet Planetary Health · 2023

A genome-exposome case: lead disrupts neurological gene expression — IQ loss is a gene-environment interaction, not a simple toxic dose response.

\$6 T

Global cost of lead exposure (2019)

~6.9% GDP

Equivalent share of global gross product

765 M pts

IQ points lost in children under 5 (LMICs: 80% higher than prior estimates)

5.5 M deaths

Cardiovascular deaths attributable to lead exposure

77%

Share of cost from premature cardiovascular mortality

Bioeconomy Governance: Real Options and Path Dependence

Real Options Logic

Bioeconomy transitions involve deep uncertainty, irreversibility and path dependence. Option value — the value of preserving flexibility to invest, defer, scale or abandon — must be built into investment appraisal frameworks.

Agricultural R&D Returns

Social returns to public agricultural R&D consistently exceed private returns by an order of magnitude (Pray; Zilberman). Stagnating public R&D investment in many OECD countries represents a structural governance failure with direct One Health consequences.

Path Dependence & Slack

Apparent resistance to bioeconomy transition may reflect rational option-holding under uncertainty. Policy design must account for option value rather than simply mandating outcomes — coercive mandates destroy option value.

Policy implication: build flexibility infrastructure — regulatory options, R&D reserves, transition pathways — not just outcome mandates.

An Integrated Governance Framework: Three Pillars

Pillar I

Commons-Based Governance of Biological Resources

Redesign around anti-rivalry. Replace single-species sectoral mandates with integrated transnational bodies holding multi-species, multi-domain authority. The EU One Health Joint Action and Global Biodiversity Framework are institutional precedents; extending them to bioeconomy value chains is the next step.

Institutional

Pillar II

Prevention as Capital — and Genome-Exposome Data as Infrastructure

Reclassify prevention spending as Natural Capital Formation (NCF) and Human Health Capital Formation (HCHF) in national accounts. Treat genome-wide and exposome-wide data infrastructure as public capital — analogous to transport networks — whose returns accrue to the biological commons.

Accounting

Pillar III

Real Options for Bioeconomy Transition under Uncertainty

Design transition policy with explicit recognition of option value, path dependence, and irreversibility. Invest in regulatory and R&D optionality; use real options valuation for public investment appraisal. Mandate flexibility, not just outcomes.

Investment

Conclusion

Not parallel agendas Bioeconomy and One Health are two faces of the same problem: governing biological systems as shared commons and productive assets simultaneously.

The paradox of underproduction Health commons become more valuable — and more undersupplied — as the biological network grows. No sectoral agency can resolve this alone.

Genome + Exposome = the full picture Precision medicine (Novelli) and environmental governance (One Health) are inseparable: risk cannot be assessed, and interventions cannot be designed, using only one register.

The analytical toolkit exists Real options · SAM-CGE with NC/HC/EXP accounts · Exposome accounting · Commons-based governance theory can bridge the frameworks operationally.

Questions for the Panel

**For Giuseppe
Novelli**

Genomics identifies predisposition; the exposome captures actualised environmental risk. How do we make the genome–exposome interaction operational in One Health risk assessment — and what does that imply for the data infrastructure we need to build publicly?

**For Federico
Perali**

The extended SAM-CGE framework with NC, HC, and exposome accounts is conceptually compelling. What are the binding data constraints for Italy, and is a multi-country GTAP extension with these accounts feasible within current statistical reporting systems?

**For Carl
Pray**

Given consistently high social returns to agricultural R&D — and the positive One Health externalities of precision agriculture (reduced AMR, lower pesticide burden, improved animal welfare) — what governance reforms would most effectively redirect public R&D investment toward bioeconomy transitions that are also One Health-compatible?

**Open to
the panel**

The paradox of underproduction implies that governance urgency grows with biological network size. Is there evidence that existing international governance institutions — WHO, FAO, WTO, CBD — are capable of the multi-species, multi-domain integration that One Health requires? Or do we need new institutional forms?