UNIVERSITY OF CAMBRIDGE | Institute for Sustainability Leadership

Green shoots: Nature positive innovation as a route to increased food security

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A-Track

The University of Cambridge Institute for Sustainability Leadership (CISL)

The Cambridge Institute for Sustainability Leadership (CISL) is an impact-led institute within the University of Cambridge.

For more than three decades, we have worked with leaders and innovators across business, finance and government to advance practical solutions to the challenges shaping economies and societies.

We help create the leadership, partnerships and market conditions needed for resilient, competitive and sustainable economies.

About A-Track

A-Track is a four-year, €11 million project that will accelerate action for nature by business, financial institutions and government.

A-Track brings together leading thought leaders and practitioners who have been driving change in the measurement and valuation of natural capital and biodiversity in business, finance and government.

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Introduction – a food system under threat

Food system sustainability and security is increasingly at risk. Rising climate and environmental pressures are undermining yields, increasing costs and eroding the resilience of production and distribution systems. Combined with rising geopolitical volatility, these factors have elevated food security and supply resilience as increasingly pressing strategic priorities for governments and businesses.

At the same time, agricultural systems are among the most significant direct drivers of biodiversity loss, land degradation and pollution globally[1]. Intensive production methods and expanding land requirements (due to rising populations and consumption levels)[2] leave little space for nature. Current production models are unlikely to deliver the estimated 50 per cent increase needed in food outputs within the coming decades without exacerbating climate, water, soil and biodiversity pressures.

Nature loss is increasingly becoming an economic risk. Degraded ecosystems, resource scarcity and fragile supply chains are exposing weaknesses in existing business models and raising questions about their long-term viability.

This challenge, however, also presents an opportunity to build a nature positive bioeconomy: one in which biological resources, advanced technologies and circular value chains support economic prosperity and nature positive outcomes. Scaling nature positive business models goes beyond the environmental agenda, fundamentally underpinning successful competitiveness, resilience and industrial strategy.

Historically, the deployment of new technologies and approaches in food and agriculture has been slow and often contested. Many of the new technologies offer solutions to the sustainability and resilience of food production and supply to final consumers, but viable solutions are not scaling fast enough. There is also an urgent need to ensure any new pathways are deployed fairly and responsibly, meeting society's expectations of the food system and delivering good outcomes for citizens, including both consumers and those whose livelihoods will be affected.

A-Track and this report

Through the A-Track project, CISL is working to support the adoption and scaling of nature positive-aligned business models. Our previous work *Aligning business models with a nature positive economy: from theory to practice*, identified a number of barriers to their adoption, including challenges around data gathering, incorporating nature into decision-making and commercialisation.

It also highlighted a 'transformation gap': while understanding of nature-related risks is increasing, translating that understanding into action often requires wider changes to markets, incentives and value chains.

Building on this work has explored how practically a transition to nature positive aligned business models could occur in the agrifood and built environment value chains, including understanding where the current best practice is. This brief summarises findings for the agrifood sector. Our full report covers both sectors.

Nature positive business model innovations in agrifood

We examined two areas of nature positive business model innovation in the agrifood sector, focusing on barriers, opportunities and scaling strategies:

Alternative proteins in agrifood value chains: A shift away from impact-intensive conventional livestock production towards controlled biological processes with dramatically lower environmental impacts and increased resilience to supply shocks.

Bio-based nutrition inputs in agriculture: A shift in agricultural production methods away from high-volume synthetic nutrients and other inputs towards lower-volume, higher-value precision inputs that actively promote positive ecological outcomes such as regeneration of soil structure and function.

Alternative proteins in agrifood value chains

Technological advances across the alternative protein landscape can re-shape the agrifood system by shifting value creation away from land-intensive livestock systems and towards engineered biological production processes. These include a range of technologies and approaches such as reformulating food (using plant-based alternatives to livestock products), biomass and advanced/precision fermentation, insect protein and cultured meat.[3,4]

While there has been uncertain progress on innovations, this growth trajectory is likely to be further catalysed by wider applications of foundational technologies including artificial intelligence (AI) and precision fermentation.

Advanced fermentation systems in particular, which build on traditional fermentation (eg, cheese) and established biomass fermentation (eg, Quorn)[5], have the potential to revolutionise the food system and accelerate the shift. The range of applications is enormous, offering potential to reduce human dependency on environmentally problematic ingredients including and beyond livestock products. Progress is most advanced for production of high-value ingredients including proteins, fats, enzymes and functional additives, often producing molecules identical to conventional counterparts with far greater control and consistency, and using only simple feedstocks that can be derived from organic waste.

Bio-based nutrition inputs in agriculture

Emerging agricultural input systems demonstrate that landscapes can be managed in ways that maintain crop productivity while reducing reliance on synthetic fertilisers. Critically, these systems offer potential to decouple agricultural productivity from volatile, energy-intensive and environmentally damaging global mineral and chemical fertiliser supply chains.

Efficient systems that integrate biological resources and biomanufacturing can create localised/regionalised resource loops that replace ecologically damaging synthetic inputs with regenerative, equitable options that genuinely enhance farmland and improve nature across landscapes. Both organic fertilisers and biofertilisers are part of the solution[6].

Organic fertilisers and biofertilisers are being complemented by parallel developments including in biotechnologies such as biopesticides and (to a lesser extent to date) biostimulants, ecological approaches to farming including regenerative agriculture that encourage integration with natural processes, and wider technological capabilities in AI and agritech. Together these trends can support a shift away from heavy reliance on synthetic fertilisers towards more circular and biologically driven nutrient systems.

Constraints to scaling and scaling strategies

Alternative protein scaling bottlenecks[7]	Bio-based input scaling bottlenecks[8]
Technology and infrastructure: Novel production techniques such as precision fermentation and insect farming require specialised infrastructure. Dedicated capacity remains limited and bioprocess scale-up is technically challenging. Feedstock logistics – particularly for waste-based inputs – are underdeveloped.	**Technical and agronomic uncertainty:** Outcomes vary across soils, climates, crops and native microbiomes, making results less predictable than synthetic inputs. Many biological products require precise timing and preventive application rather than the curative use patterns farmers are accustomed to. Variability in nutrient content (especially for waste-derived fertilisers), shelf-life limitations, formulation challenges and incompatibility with existing equipment and processes further undermine scaling.
Capital intensity: Biomanufacturing facilities are capital-intensive and characterised by high technology, market and regulatory risk. This creates two persistent 'valleys of death': first between demonstration and first commercial plants, and then when firms seek to scale production volumes. Current financing remains heavily skewed towards early-stage research and development (R&D) and venture capital, with limited availability of patient, low-cost capital suitable for investment in large-scale infrastructure.	**Regulatory and standards misalignment:** Biological inputs often fall between regulatory categories for fertilisers and plant protection products, facing fragmented definitions and disproportionate data requirements. Waste-derived fertilisers are caught between waste and product legislation, with inconsistent standards shaping market access. Lack of standards undermines quality control and reinforces perceptions of unreliability.
Regulatory fragmentation: The EU has articulated strong bioeconomy ambitions and its largest economies including France, Germany, Italy and Spain have national-level strategies. But implementation is hindered by fragmented governance and incompatible regulatory templates (e.g. Novel Foods regulations) for food safety, waste, chemicals, energy and agriculture across Europe[9]. This raises compliance costs, regulatory risk and the cost of capital.	**Economic risk and behavioural inertia:** Upfront investment, learning costs, potential yield variability and market risks fall primarily on farmers operating with thin margins. Sustainable fertiliser systems often require system redesign rather than simple input substitution, including new soil management practices and crop rotations. Existing agronomy advisory systems are often optimised for high-volume synthetic inputs, limiting support for more complex biological and organic approaches.
Market acceptance and demand: Consumer perceptions, regulatory uncertainty and weak demand signals in key markets continue to constrain investment and scale[10].	**System lock-in and infrastructure constraints:** Existing fertiliser supply chains, advisory services and market structures continue to favour conventional inputs and slow adoption of biological alternatives.

Scaling strategies

We can see from the above that technological innovation is no longer the principal barrier to nature positive transitions in agrifood. Across alternative proteins and bio-based inputs, commercially relevant technologies and business model innovations already exist. The key challenge is co-ordination: scaling requires new infrastructure, financing mechanisms, standards, procurement models, value-chain partnerships and regulatory frameworks that no single actor can deliver alone.

Alternative proteins in agrifood value chains	Bio-based nutrition inputs in agriculture
Support bioprocess scale-up and spread technology costs and risks through new manufacturing models **Examples:** Open-access biorefineries: Biorenewables Development Centre; full-stack bio-manufacturing solutions: Planetary Group	Reduce life-cycle impacts and improve value chain economics through circular bio-materials models **Example:** Circular bio-based fertiliser production: RUSTICA
Substitute alternative proteins into existing products to mitigate market and regulatory risks **Example:** Food reformulation services: Nomad Foods Future Foods Lab	Bundle sustainable fertilisers with other value propositions to reduce risk and costs **Example:** Full-stack agronomy solutions: Koppert
Improve the impact and economic performance of alternative protein value chains through circular processes and infrastructure **Example:** Use of waste- and residue-based inputs: BioVale	Provide working capital, revenues and risk mitigation for farmers through mechanisms that link financing and environmental outcomes **Example:** Ecosystem services trading mechanisms: EcoHarvest; Soil Capital
Overcome gaps in the investment pipeline through procurement and financial innovations **Examples:** Public–private procurement platform: BioPreferred; Denmark's municipal food strategies	Empower farmers and rural communities through co-operative, localised and value reward models **Example:** Co-operative and cluster-based investment: Organic Valley
Deploy collaboration mechanisms to reduce regulatory and cultural frictions **Example:** Farmer network: Foodvalley NL	

Conclusions

Examples from the agrifood sector demonstrate how nature positive business models can be a strategic component of Europe's future competitiveness, resilience and green growth. But scaling these innovations will depend less on technological breakthroughs than on the ability of businesses, governments, financial institutions and civil society to co-ordinate transition pathways, align incentives and build the intellectual, institutional and financial architecture needed to support systemic change.

Financial innovations, including nature markets, blended finance, and natural capital accounting, can improve the commercial viability of nature positive business models by helping make nature-related risks, costs and benefits visible and investable. Successful deployment of these innovations is, however, also highly dependent on systemic co-ordination, for example across standard setters, accountants, auditors, regulators, investors, businesses, scientists and civil society.

Scaling nature positive business models will therefore require development of collaboration mechanisms that align strategic direction among multiple actors (often across different cultures, industries and sectors), manage uncertainty, promote regulatory alignment and co-ordinate the re-organisation of value chains. Because nature positive transitions address market failures and complex interactions between ecological systems, infrastructure and economic activity, they cannot be delivered through private enterprise alone.

Investing in this capacity will deliver outsized returns for both nature and society, including supporting competitiveness, resilience and growth. For policymakers, this means creating a more coherent policy architecture, aligning environmental, industrial and economic policy and using transition pathways, public–private partnerships and standards to support the growth of new nature positive-aligned markets. For businesses and financial institutions, nature positive-aligned business models need to be seen as offering a strategic response to emerging risks and a source of commercial opportunity.

We recommend the active creation of a new ecosystem of co-ordination organisations and activities, within which:

- Governments play a critical role in shaping the enabling environment through regulation, standards, procurement policies and financial incentives.
- Businesses (particularly startups and early adopter corporates) develop and deploy the technologies and business models that translate these signals into operational solutions that can be financed.
- Financial institutions incorporate nature into decision-making and enable the flow of capital and availability of insurance to these solutions to fund and de-risk scaling.
- Civil-society organisations and research institutions act as intermediaries to build trust, co-ordinate action, and support diffusion of information and resources.

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