Global Innovation Needs Assessments

Land system – Protein diversity

WORKING BRIEF

September 2021

The Global Innovation Needs Assessments (GINAs) project is funded by the ClimateWorks Foundation and the UK Foreign, Commonwealth & Development Office. Analysis was conducted by Vivid Economics. Thank you to the UK Department for Business, Energy and Industrial Strategy (BEIS) analysts and the Mission Innovation Secretariat who were consulted on aspects of the work, and for BEIS support for the 2017-2019 Energy Innovation Needs Assessments which developed the methodological approach taken here. The findings and views expressed across this project do not necessarily reflect the view of the Government of the United Kingdom or Mission Innovation.

This brief is one of four that presents summary findings for the land systems innovation analysis part of the project. For more information about the GINAs, please refer to our website.

Funded by:

climateworks FOUNDATION

Foreign, Commonwealth & Development Office

Analytical support from:

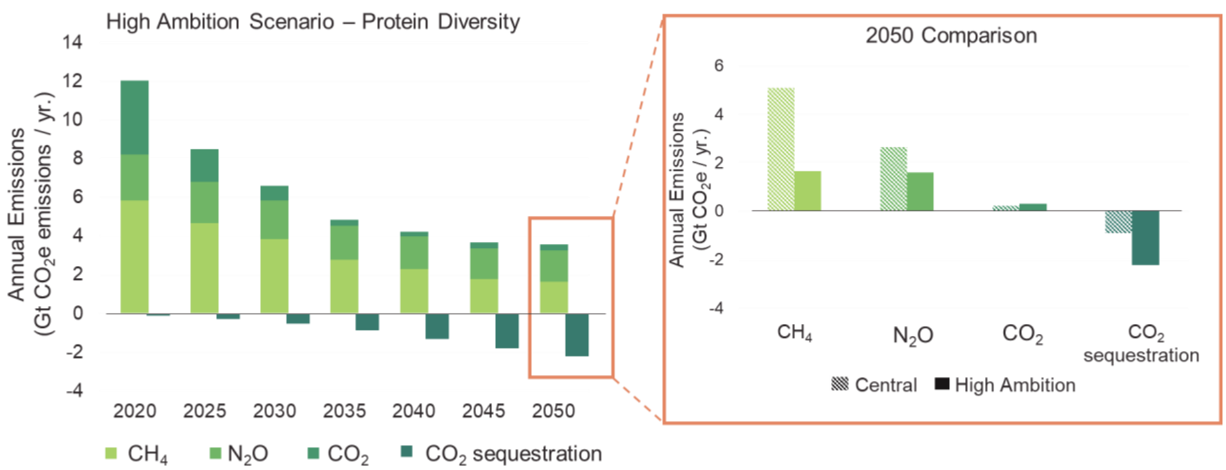
vivideconomics

Protein diversification

Diversification of proteins has substantial potential to reduce emissions - the robust development of this market is expected to make a 1.5ºC temperature target US$ 5.49 trillion cheaper to meet between now and 2050. Diversified proteins are expected to rapidly increase in market share globally as costs continue to decrease and taste profiles improve. Strong market development would result in emissions reductions associated with decreases in livestock production and conventional feed requirements (see Figure 1). The transition to greater protein diversity would reduce annual methane emissions by 70% and nitrous oxide emissions by 40% by 2050 relative to a scenario where robust innovation in diversified proteins was not included in a portfolio of climate actions. It would also lead to a twofold increase in annual carbon sequestration by using dramatically less land to produce the same total number of calories. Four key protein innovation categories are set to define this emerging market:

- **Novel plant-based products**: replacements free of any animal ingredients and with a sensory profile closer to traditional products.
- **Precision fermentation**: uses microbes to produce organic molecules to be used as ingredients to improve the taste or nutrient profile of alternative meats and dairy.
- **Cellular agricultural products**: lab-grown alternatives, identical to conventionally produced proteins and with great potential for disruption, but not yet commercially available.
- **Insect-based products**: replacements made from mealworms or crickets, with higher nutrition but a less adequate sensory profile leading to a greater potential as feed, rather than food.

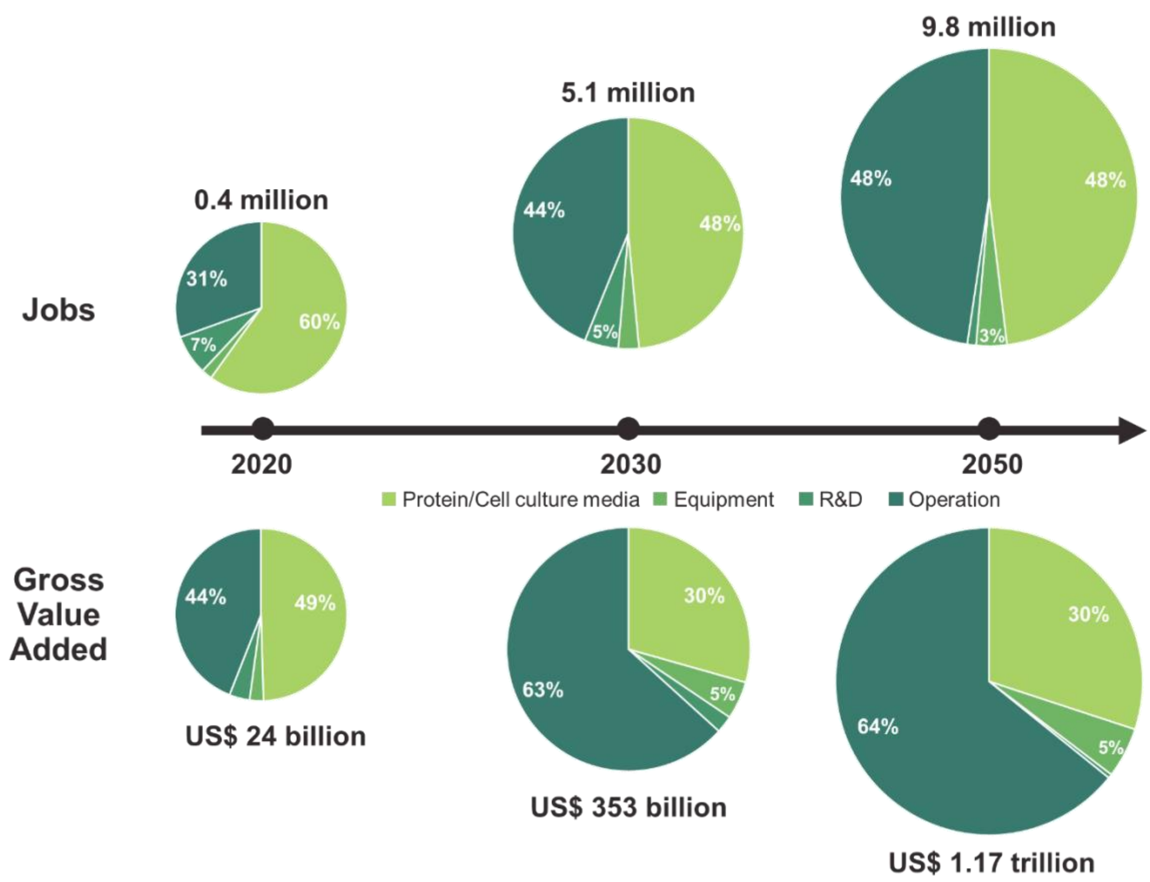
Figure 1 Left side: The combination of policy and innovation in the high ambition scenario reduces anthropogenic land system emissions to less than 20% of today's emissions.
Right side: The innovation present in the high ambition scenario (and not in the central scenario) dramatically reduces emissions for all major greenhouse gases.



Source: Vivid Economics

If this potential were to be realized, investment in protein diversity would be associated with over US$1 trillion in Gross Value Added (GVA) and almost 10 million jobs globally. The rapid development of these opportunities across all key technologies is associated with a GVA increase of the diversified proteins market by as much as 10.9% a year through 2050, from a baseline of US$18 billion in 2021. This transition will also be associated with significant employment opportunities across equipment, operations and manufacturing, and research and development. Although a full profile of employment for the market is uncertain given the novelty of some protein technologies, it is expected that jobs will require a mix of workers, including specialized and highly skilled ones. Figure 3 below illustrates the expected scale and distribution of economic benefits.

Figure 2 Estimates of jobs and GVA growth across the technology value chain resulting from the innovation unlocked with robust public support



Source: Vivid Economics

Beyond emissions mitigation and economic benefits, protein diversity also offers biodiversity and health advantages. Global average food prices are 10% and 34% lower for crop and livestock products respectively by 2050 in a high protein diversity scenario, compared to a 1.5°C future with current technologies and slower diversified protein uptake. Lower prices mean protein-rich diets are available to more consumers in developing countries, reducing malnutrition, and reducing the cost burden for lower income households in developed countries. Diversified proteins also produce the same total calories using 640 million hectares less land for agriculture, making both biodiversity and deforestation targets easier to meet.

Both the public and private sector have a role to play in supporting this future. Public support in the form of research and development funding will be needed to realize innovation in diversified proteins. This is particularly relevant for emerging technologies that are not yet close enough to commercialization for private sector investment. Agricultural extension targeting upstream input suppliers will also be critical, especially for adapting supply chains and improving feedstocks for diversified proteins. Not all technologies are new inventions, and greater focus needs to be directing at supporting producers to adopt and commercialize existing technologies. The development of this market is also contingent on an enabling policy environment, which ensures the global ecosystem surrounding agriculture is suitable. This may encompass supporting intellectual property rights or developing standards to stimulate trade and technology transfer. Policy setting in adjacent sectors like infrastructure, education and science and technology should also coordinate with agriculture innovation priorities.

The development of protein diversity will vary across countries and regions, matching the varied approaches to managing the zero carbon agricultural transition. The diversified proteins market promises export opportunities to countries that invest in developing the skills and infrastructure needed. Consequently, providing support globally for this transition could be channeled through technology spending and dissemination. Ultimately, technological innovation in protein diversity presents only one solution to a challenging agricultural transition, which may take different forms across the world.

A NOTE ON METHODS

Quantitative results in this brief are supported by a modelling exercise using a leading land use model and subsequent estimation of job and GVA creation. The Model of Agricultural Production and its Impact on the Environment (MAgPIE), a leading global land use integrated assessment model developed by the Potsdam Institute for Climate Impact research, underpins the analysis undertaken for this project. Quantitative results on emissions and environmental impact rely on the comparison of two scenario types:

- **Central Scenario –** A scenario that models a world of coordinated global action to limit climate change. The scenario limits warming to 1.5ºC using only existing technologies
- **High ambition innovation scenarios –** A set of scenarios that illustrate ambitious but realistic support and uptake of a given family of technologies

Scenarios are compared to estimate how much cheaper it is to achieve a given temperature target with the innovation. GVA and jobs increases are then estimated based on the land use and agricultural production outputs from MAgPIE.