Written evidence from UK Agri-Tech Centre (ENB0040)

The UK Agri-Tech Centre strengthens connections between science, business and funders to accelerate R&D that overcomes the agri-industry's most critical challenges, such as climate change, labour issues, disease mitigation and environmental sustainability. The company launched in April 2024 following the merger of the Agri-Tech Centres Agri-EPI, CHAP and CIEL, and receives core funding from Innovate UK. The Centre is an independent entity, a key pillar of the UK Government's agriculture strategy and is a significant boost in its investment into the UK's agri-tech sector. The UK Agri-Tech Centre works closely across government departments and devolved administrations supporting the transition to net zero, economic growth, international trade, skills development and levelling-up. Engineering Biology is an important part of the UK Agri-Tech mission to discovering, developing, delivering and scaling scientifically robust and commercially viable agri-innovation in collaboration with science communities, industry and government.

Q1. What are the UK's key strengths in the area of engineering biology?

A key strength in the UK is the excellent R&D base with significant understanding of the building blocks for synthetic biology approaches, including rapidly growing genomic knowledge. The Genetic Technology (Precision Breeding) Act 2023 offers a window of opportunity, ahead of regulatory progress in the EU, where the UK is well placed to assist breeding and capitalise by acting as a test and trial site for Northern European crops (with similar geographical cline for plants) with associated companies and linked to the vibrant VC investment ecosystem in London. The UK also has engaged farmer networks open to being involved in the development of new technologies e.g. the British On-Farm Innovation Network (BOFIN) involved in the Innovate UK (IUK) funded 'A Platform to Rate Organisms Bred for Improved Traits and Yield' (PROBITY) project (UK Agri-Tech Centre) and the National Institute of Agricultural Botany (NIAB) with connections to a farm network.

Examples of other important institutes and groups include plant research institutes such as the John Innes Centre (JIC), James Hutton Institute and Rothamsted Research, and animal research at the University of Edinburgh and its Roslin Institute.

Q2. What are the key applications for engineering biology?

Key applications for engineering biology for crop breeding include those addressing climate change e.g. drought tolerance, salt tolerance;

sequestering more carbon in soils and marine environments, or reducing emissions (e.g. engineer methanotrophs in ruminant guts or waterlogged soils); resilience e.g. flooding/submergence tolerance; diet and health e.g. increased vitamin content, protein content; new markets e.g. plant protein from plants not suited to UK e.g. Quinoa or Amaranth; reduced waste e.g. reduce browning in banana, so they last longer and production of novel fibre, fuel, biomaterial, feedstock to replace ones currently derived from petrochemicals. Increasing crop productivity through improved traits (e.g. photosynthetic efficiency), resulting in more efficient use of land and resources. Enhanced pollination of crops e.g. engineer insect microbiome for pathogen/pesticide resistance or introduce crop traits that attract more pollinating insects.

Additional applications in plants include biosensors and biosurveillance e.g. building 'artificial leaves' that detect the presence of spores/pathogens before they cause disease symptoms, which helps to reduce application of chemicals as they would only be applied as and when needed. Improved pest and disease resistance of crops and weed suppressing crops, which reduces pesticide/herbicide inputs and environmental impact. Also, biopesticides produced by microbes and not just outcompeting pathogens in soil but directly targeted them too.

Environmental sensors can be used for pollutants and bioremediation utilising plants/microbes engineered to capture and degrade contaminants e.g. heavy metals, antibiotics, hormones, pesticides, excess nutrients, plastic waste, toxins, explosives and air quality e.g. Volatile Organic Compounds (VOCs) in soils, wastewater and aquatic environments. In livestock and aquaculture, engineering biology applications include novel vaccine and therapeutics, along with pen-side diagnostics and biosensors.

Microalgae can be used for the same things as plants e.g. biofactories/biofuels/carbon capture etc but are much more scalable (in photobioreactors).

Microbes can also be manipulated to enhance and promote water and nutrient uptake from soils e.g. to increase availability and to better use of applied fertilizer, preventing run off; specific plant rhizome interactions so plant fix nitrogen (similar to legumes) and reduce application of fertilizer; form biofilms on plant leaves to improve nutrient uptake or prevent infection; microbiome combinations in soil to out compete pathogens and disease i.e. promoting a good soil microbiome versus bad one (similar concept as human gut microbiome); and convert waste to new feedstocks in a circular economy approach.

Biomaterials can be produced such as new fibres, fuels, and feedstock as well as smart materials to reduce food waste (e.g. fresh veg). Alternative protein production e.g. Quorn, cellular agriculture/synthetic meat etc. For food security onshoring versus import, where it has been suggested there is lower emissions but the evidence base is low.

Molecular farming can use plants to produce vaccines, therapeutics, vitamins etc. e.g. fish oils in plants, covid vaccine in Medicago and using plants as factories we can ultimately produce anything via a Synthetic Biology approach using the power of the sun. There is also potential for petrochemical based replacement that is not feasible via microbe/fermentation approach due to complex processing not possible in microbes.

Co-developing new strains alongside new agri-tech from other areas may provide a benefit at a system level. A good current example being strawberry varieties which are more suited to robotic picking (more separation between fruit, longer stems, firmer).

Q3. How can Government policy support the development of engineering biology?

Government policy can support investment, which is needed to capitalise on the UK opportunity e.g. more infrastructure and mechanisms to de-risk private investment.

The regulatory environment needs to be responsible, but also conducive to innovation and business growth. A robust, but effective regulatory framework is crucial to enable, rather than stifle, innovation. If regulatory framework becomes too burdensome or slow, R&D activity will migrate overseas. Regulatory agencies have a key role and responsibility to balance the risk and reward, but currently there are examples where companies view the UK system, e.g. FSA, as a disincentive to progress with R&D projects and submit applications due to the longer timeframes involved compared to the USA and FDA regulations. Another example includes vaccine production in plants, which originated in the UK, but transferred to Canada.

Policy can also help with a joined-up approach recognising the need for a harmonized pipeline of innovation infrastructure across the Technology Readiness Levels (TRLs), underpinned with the required interdisciplinary skills base.

There is a window of opportunity to support scale up in the UK whilst the EU is catching up on the UK Genetic Technology (Precision Breeding) Act

2023. However, this needs infrastructure i.e. set of coordination and regulated trial sites across the UK.

Q4. How can the UK maximise the economic potential of developments in engineering biology?

Investment in the agriculture sector can be challenging, where VC's can find the relative risk and the perception of long timescales for a return on investment a disincentive. Engineering Biology is a scientifically complex area, with a degree of uncertainty that is a challenge to investors. The market is usually serviced by a small number of specialist investors, and to widen opportunity to generalist investor networks, would need better understanding of e.g. regulatory "gates", scalability prospects (globally), core IP understanding etc.

The model for accelerating innovation in agritech has been very reliant on funding through the UKRI/Defra Farming Innovation Programme (FIP). Careful consideration is required to determine the right channel for supporting innovation and attracting investor interest at this stage. An approach from Government that facilitates connections and sparks potential ideas is required.

Innovate UK and the British Business Bank offer support in Engineering Biology and UKRI are supporting a national roadshow for Investor Accelerator programmes. The British Business Bank invests into funds, directly into companies, and also partnering. The key will be both timeline and scale to realise the eventual returns. Some investments take time to clear regulation, or demonstrate efficacy, and it can take a number of years, and this is where shared risk investment is important.

In the Agri-Tech sector includes engineering biology companies developing livestock treatments/therapeutics, biological plant protection, alternative engineered proteins, circular economy materials, cellular proteins etc., some of which require specialist and adaptable facilities, especially at the test scale they require. The UK Agri-Tech Centre can facilitate this, with the appropriate inbound market-failure investment.

Support is needed for the scale up of SMEs e.g. Micro Gene Editing companies in this space are going to the USA/Canada as the UK market is uncertain and UK sales are minor compared to the international opportunity.

Stronger R&D tax relief/credits are needed, covering all aspects of the development to scalable product cycle with domain knowledge expertise to guide investors to the specific needs of this sector, and likely returns profiles.

In the Agri-Tech sector, clusters of expertise are crucially important. Plant and livestock domain clusters in the UK typically do not have the "largeco" infrastructure around to routinely support, and there is a perception that major players are potentially less likely to be collaborative in their approach. Newcos tend to be local, highly specialized and linked to academic work. Aggregating around engineering biology knowledge clusters, with appropriate facilities, and pipeline commercial routes to global exploitation, would be a good model.

Q5. What are the risks posed to society by engineering biology?

There is the potential for IP capture by a few companies e.g. major companies taking a large % of all the plant breeding varieties that are generated via CRISPR.

There is potential for engineered organisms to outcompete native organisms (e.g. microbes released into the environment), which could lead to changes in community structure/reduced biodiversity. Tools need to be in place to model potential environmental risks and to responsibly monitor engineered organisms post-release. Funding will be required to develop novel monitoring/containment processes, alongside the engineered organisms themselves.

There is a risk of hype and overselling the technology as a quick fix, which does not have a strong on farm application or work well in a commercial environment, so the potential advantages are not realised. To mitigate this, it is prudent to explore the agricultural need first, look at how the product will integrate within a current system and then measure its impact (with robust data collection) within the intricate systems of commercial test farms, to prove the new product works and to understanding how these advancements fit into the broader picture.

Q6. How should engineering biology be regulated?

The product not process should be regulated using a risk based approach with lessons to learn from US/Canada/Singapore.

Q7. What are the possible barriers and limitations to good and effective use of engineering biology?

Economic displacement e.g. generating a product via Engineering Biology that disrupts a community/market that relies on the product for majority of income.

There remains a challenge with end-users/societal acceptance for certain engineering biology technologies such as Gene Editing (GE), and government policy ambitions and work with industry needs to incorporate follow through to the marketplace to help foster public understanding.

Developing interdisciplinary specialists and interdisciplinary businesses, who have both technical (e.g., biology, engineering, data science) and agri-business skills (agronomy, sustainability, finance, integrated farm/crop management), is needed to unlocking the potential of Engineering Biology. The UK has been sensitive to skills shortages in these highly skilled areas as a result of EU Exit.

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