High Value Biorenewables

UK GROWN:
HOW BIOTECHNOLOGY CAN UNLOCK HIGHER VALUE PRODUCTS FROM UK CROPS

Executive Summary

The High Value Biorenewables (HVB) Network commissioned this review in order to identify target crops, which in combination with industrial biotechnology, have the potential to deliver UK grown resources for higher value biorenewable markets. This review includes innovation from within and beyond the HVB Network, to provide inspiration for further innovation, development and collaboration in the UK to realise the full value of these crops.

The overall aim was to identify and review exemplar plants and fungi that are suited to UK climate conditions and present an opportunity, in combination with industrial biotechnology, to deliver higher value biorenewable products.

Data was gathered from scientific, industry, news, government, patent and market research sources to identify opportunities and challenges across supply chains for potentially high value crops. Twenty-six interviews were conducted with experts from the research, industry, and consultancy community, as well as related networks.

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The review explores how industrial biotechnology (IB) can be applied across biorenewables supply chains to create value from UK grown crops in a number of ways.

- **Breeding:** The review provides examples where breeding efforts have, or could, lead to higher value products. In particular, the UK has strong expertise and supply chain infrastructure around specialist oilseed crops, and this is seen as a target area for further innovation and development. Examples are also provided for work on colourants and plant derived anticancer and antioxidant compounds.
- **Crop, seed and soil treatments:** The rapidly emerging 'biostimulants' market is still being defined and regulations are likely to be introduced within the next few years. The use of micro-organisms to support crop health and regenerate soils will become more established and widespread as the scientific evidence and understanding develops. This opens a multitude of opportunities related to biotechnology innovation.
- **Extraction:** Enzymes have been used to enhance extraction of target compounds, such as in fruit pressings, and antioxidant, and aroma compounds. Examples are provided for rosmarinic acid from sage, betalain from beetroots and carotenes from carrot residues. It does not seem that this area has gathered much attention in the UK to date and could warrant further investigation.
- **Biotransformation:** Biotechnology can be used to enhance the value of compounds extracted from crops. The review highlights work conducted on colourants, antioxidants and flavours, conjugated fatty acids and glucosinolates.

There is an opportunity for the UK to further develop high value markets for the residues and offcuts from existing crops, such as beetroots, carrots, potatoes, soft fruits, apples, brassicas and forestry.

As industry commits to net zero targets, along with reduced biodiversity and environmental impacts, they are looking towards research and innovation to develop new solutions that are naturally derived, biodegradable, but deliver high quality and performance. In addition, recent supply issues have highlighted the importance of localised sourcing.

Experts highlighted that the issue of land use should be considered when proposing UK grown biorenewable products. They also drew attention to how non-food crops can bring significant benefits to rotational farming by increasing diversity and supporting soil health, beneficial species such as pollinators and pest-predators, and helping manage pest and disease cycles and suppress weeds by providing a break between food crops. This review identifies a number of emerging and underutilised crops that could be expanded in the UK to this end. In addition, various crops have multiple uses and can be used for foods as well as extracted higher value products.

Experts also highlighted how fermentation and vertical farming provide alternative production methods to conventional growing of crops for higher value products, and that these different methods need to be assessed when selecting the best production approach. The full impacts, resource inputs and related supply chain land use must be accounted for when comparing the efficiencies of the different approaches. Field scale or basic greenhouse growing, as covered in this review, can be a more cost-effective and resource efficient approach, even where a bioreactor route has been developed, but may be of lower purity or consistency due to greater variation in the plant material. Currently there are several examples of markets, such as stevia compounds and squalene/squalane, where different specifications of products are produced using multiple methods, each serving different markets.

High value markets are seeing substantial growth in several areas where UK crops can deliver. The global crop biostimulants market is emerging and growing exceptionally fast, valued at $2.85 billion in 2021 and growing to $6.69 billion by 2029 with a CAGR over 11%. The natural dyes market is also seeing similar growth rates of over 10%. The plant derived health fatty acid markets, antioxidants, natural colourants, fragrances, and flavours all show continued strong growth, with global trends driving these markets.

Whilst recognising the strong biotechnology capability in the UK, some experts interviewed for this review felt that more investment and technical expertise in extraction and processing for high value products was needed to transform innovation into commercially viable enterprises. As with many sectors the transition from innovation to commercialisation is challenging, with a lack of connectivity between investors and start-ups. Furthermore, the co-ordination required between farmers supplying materials, the processors and the end users adds another layer of complexity to scaling up. The UK appears to be behind European and North American markets in terms of cross-supply chain collaboration and public-private investment to enable the full value realisation of UK crops. The exception is the strong model set by the supply chain of the oilseeds sector within the UK. This review highlights the examples of collaborative ventures that have been observed overseas. This is a critical time for biorenewables, with synergies between the agricultural transition and industry's recognition of its imperative role in greenhouse gas reduction.

Commercialisation of higher value products from UK crops is a vital piece of the puzzle to unlock development of multiple markets that can drive the broader biorenewables market. These products offer an opportunity to support the transition to Net Zero and towards regenerative, high diversity farming, thus supporting multiple governments objectives, so long as commercialisation is executed with sustainable systems principles: fair share, with social and ecological benefits derived from the economic returns.