THE ECONOMIC OPPORTUNITY OF PRECISION AND BIOMASS FERMENTATION FOR THE UK

September 2025

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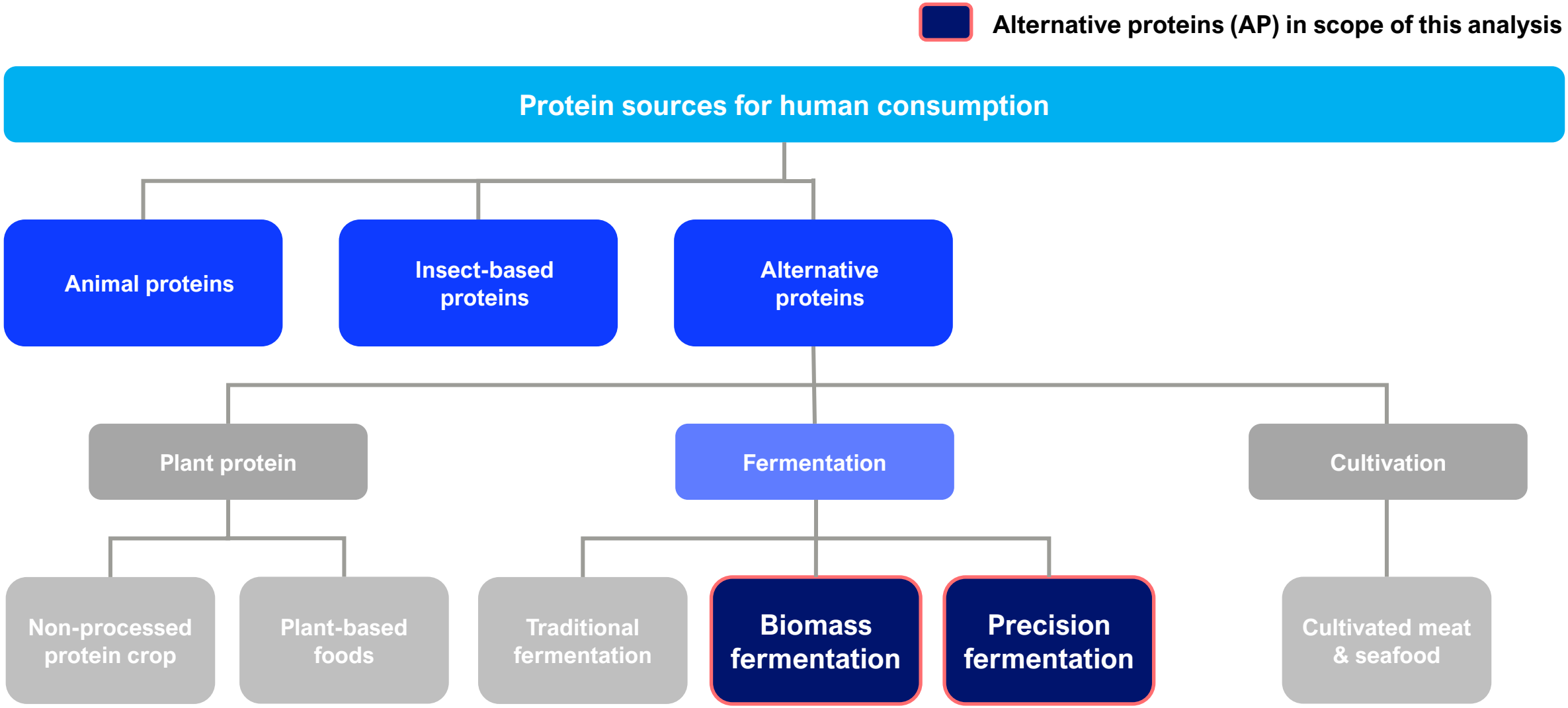
PRECISION AND BIOMASS FERMENTATION CAN PLAY AN IMPORTANT ROLE IN HUMAN PROTEIN CONSUMPTION



Source: adapted from: FAIRR, 2024: Protein Diversification: A Tool to Address Climate, Nature, and Public Health Risks

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FERMENTATION HAS BEEN WIDELY USED THROUGH HISTORY, PRODUCTS HAVE THE POTENTIAL TO UNLOCK THE BROADER ALT. PROTEIN MARKET

	Fermentation	Biomass fermentation	Precision fermentation
What is it?	**Using microorganisms to transform ingredients** The process of **changing a plant-based ingredient through microbial anaerobic** (using intact, live microorganisms) **into food** [1,2]	**The microorganism is the end-product of interest** • Process utilizes **fast-replicating natural microorganisms**, e.g. fungi or algae, to produce high protein biomass • Resulting biomass is either used as a **standalone product** (e.g. mycoprotein) or as an **ingredient in AP foods** • **6x more fungi species than plants globally**, offering a diverse range of nutrient and taste profiles for human diets	**Using microorganisms as cell factories** • **Precision fermentation has been used for decades** to produce ingredients like low-cost rennet for cheesemaking, and is now being used to make **next-generation alternative protein ingredients.** • Similar to how traditional fermentation involves microorganisms turning sugars into alcohol, **PF gives organisms like yeast the instructions to turn sugars into ingredients** like heme or dairy proteins
Food applications *(non exhaustive)*	• Yogurt • Cheese • Tofu • Tempeh • Miso • Kimchi • Bread	• **Mycoprotein:** e.g., Quorn grows filamentous fungi via fermentation since 1985. The fungi biomass produced is used as primary ingredient in their alt protein products[1] • **Algae protein** • **Bacterial single-cell protein** • **Yeast protein** Quorn, marlow ingredients, The Protein Brewery, revyve, Nature's Fynd	**Widely used for:** • Rennet (80-90% of modern cheese production uses PF-derived rennet enzymes, rather than extracts from calf stomachs)[2,3,5] • Riboflavin (vitamin B2) **Novel ingredients:** • Dairy proteins (e.g., whey and caseins) • Egg white proteins • Heme protein • Fats Standing Ovation, Every Better Dairy, Formo, Onego Bio, remilk.
Other uses	• Beer • Wine • Sake	• Leather alternatives	**Widely used for:** • Insulin • Citric acid • Enzymes for biofuel processing **Novel ingredients:** • Palm oil • Ingredients for cosmetics • Cotton fiber

Sources: [1] GFI (N.D.) What is fermentation for alternative proteins – Resource Guide; [2] GFI (2024) 2023 State of the Industry Report – Fermentation; [3] The term 'precision fermentation' was coined in 2019 by RethinkX to combine concepts of fermentation and precision biology; RethinkX (2019) Rethinking Food and Agriculture 2020-2030; RethinkX (2020) Precision Fermentation: What exactly it it?; [4] Planet A Ventures (2023) Introducing Precision Fermentation: Accelerating the Plant-Based Revolution; [5] GFI (N.D.) The Protein Transition: The science behind alternative proteins (Lecture 4, Fermentation);

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CURRENT POLICIES PUT THE UK ON TRACK FOR A £2.4 BILLION FERMENTATION MARKET BY 2050

UK fermentation market size projections, based on level of policy support and investment, in £B, future prices

Low Ambition

UK market size for end-product by 2050
(£B, future prices)

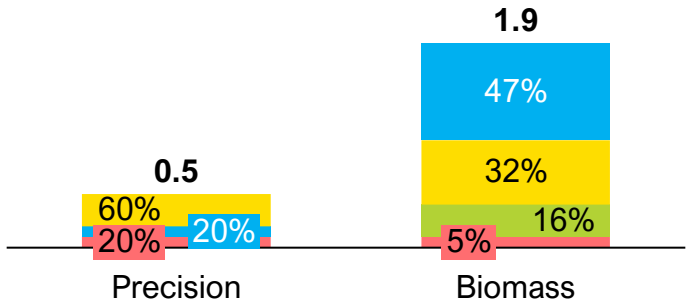
£0.6 B

- **UK falls behind global leaders** as regulatory delays, lack of guidance and limited FSA capacity **make it difficult for companies to launch products**
- **Public funding remains low,** with minimal support for pilot infrastructure or scale-up
- Strict naming rules and no coordinated terminology **reduce consumer understanding and trust**
- Market size remains small, comparable to the current UK **manufacturing of leather and related products** (£0.5 B)

Business As Usual (current policies)

Meat Seafood Dairy Egg

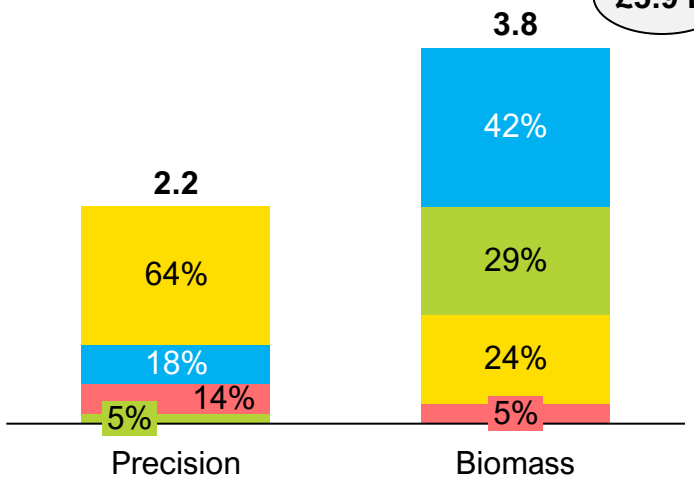
£2.4 B



- The UK maintains steady progress, with **modest public R&D support** through UKRI and **inclusion of fermentation in engineering biology strategies**
- The **FSA provides a functioning regulatory process**, though still slowed by limited resources
- **Broader use of clear terminology** improves consumer trust and investor confidence
- Market size grows modestly, comparable to the 2024 sales of **pet food industry** (£2.7 B)

High Ambition

£5.9 B



- The **UK becomes a leading hub for fermentation**, backed by strong public R&D investment, infrastructure funding, and a **coordinated national strategy**
- The **FSA is well-resourced**, enabling fast and predictable regulatory approval for novel foods
- **Naming laws are reformed** to allow terms like "milk" and "cheese", significantly boosting consumer trust
- Market size slightly surpassing the 2024 sales of the **beer manufacturing industry** (£5.6 B)

Projection in current course`

Notes: The market sizes represent the total addressable market in the UK based on projected demand and product prices, irrespective of domestic production and imports. Based on Systemiq Precision and Biomass fermentation analysis building on FAO consumption data; UK Manufacturing 2024 sales based on UK Manufacturers' sales by product dataset, link

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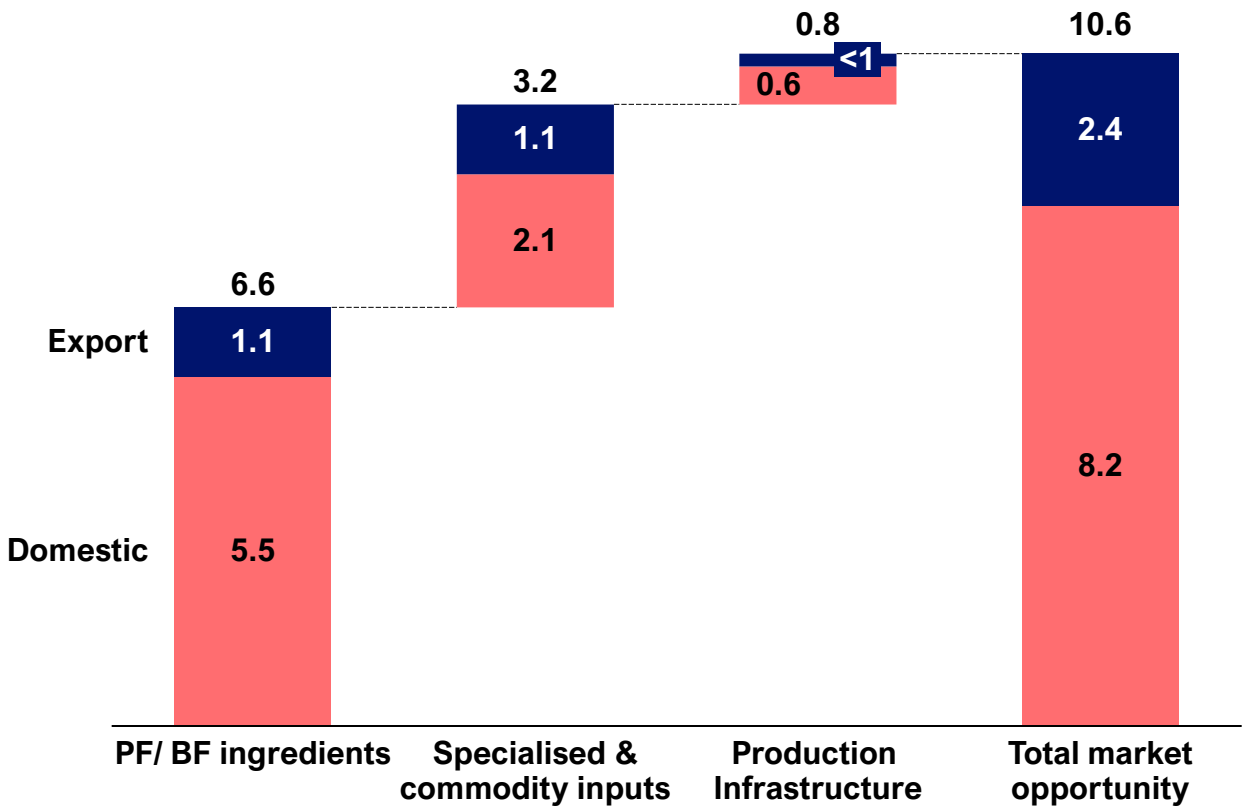
WITH MORE AMBITIOUS POLICIES, FERMENTATION COULD CREATE CLOSE TO £11 BILLION OF ECONOMIC VALUE, INCLUDING EXPORTS

Opportunity & key benefits

UK domestic and export market sizes for precision and biomass fermentation 2050, (£B, future prices)

High ambition scenario



Key drivers

- **The UK government's stance toward the fermentation sector is broadly positive**, with growing momentum for change, regulatory modernisation initiatives, and investment in scale-up and consumer readiness
- **UK Industrial Strategy |** calls out **precision technologies** and **engineering biology** as priority sectors **to boost productivity**, build **climate resilience**, and **reduce emissions** in the agriculture sector[1]
- **Regulation | facilitates innovation by investing £1.4 million in the Innovation Hub**, enabling the Food Standards Agency (FSA) to expand its expertise in precision fermentation[2]
- **Public funding | since 2021, over £75M in public funding has been invested in alternative proteins incl. fermentation**, >50% of the amount recommended by a landmark review of England's food system[3]
- **How to unlock further growth**:
  - **Recognize the role of fermentation in the new UK Food Strategy**
  - **Reform the Precision Breeding Act** to enable some fermentation products to come to market without a novel food / GM food/ feed authorisation
  - **Revise dairy nomenclature regulations**, so fermentation products can use familiar terms like "dairy" and "cheese"

Investing in the future of fermentation (high ambition):

- **£150 M per year in R&D funding** until 2050 (total public & private)**:** critical research to reach **taste & price parity** and **unlock revenue opportunities** (e.g. target identification, strain optimization, bioprocess design)
- **£960 M per year to build the fermenters** until 2050 (total public & private): to build and develop **pilot, demo, commercial and biofoundry scale facilities**[4]

Note: The domestic market sizes shows the market size serviced by domestic production, which explains the slightly lower number than the total addressable market on the previous page. Sources: [1] UK's Modern Industrial Strategy, June 2025; [2] GFI, link; 3 GFI, link; [4] The investment numbers presented here are based on current strain and titer productivity, making them a conservative estimate for clarity and consistency. By 2050, yields are expected to improve significantly, which would reduce the demand on bioreactor hardware and capacity and could substantially lower investment requirements, especially for PF.

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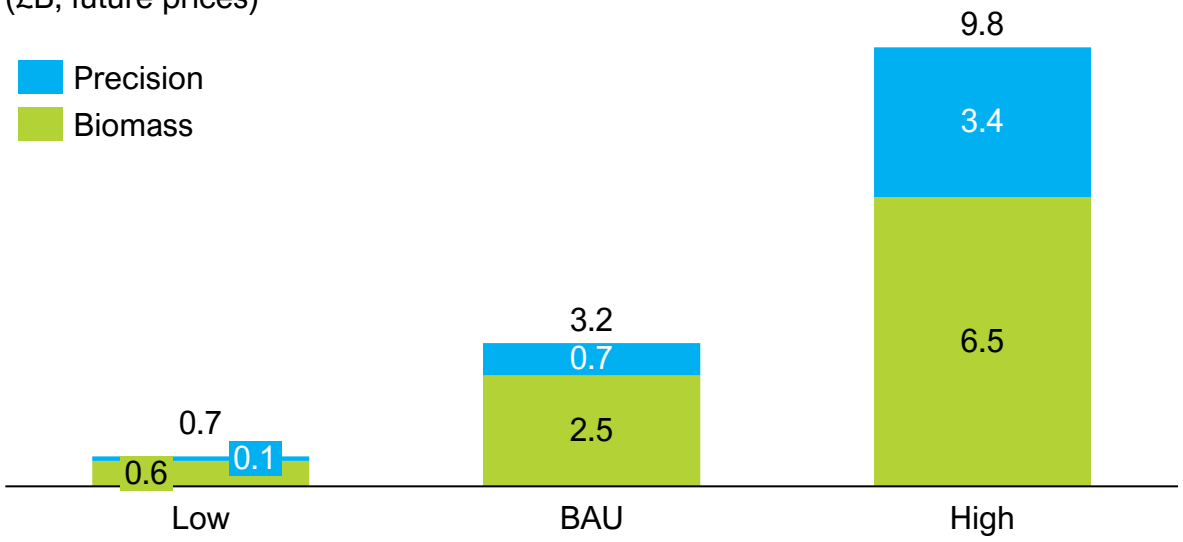
THE ECONOMIC BENEFITS OF A HIGH AMBITION SCENARIO COULD BE 3-4X HIGHER THAN THE BAU SCENARIO FOR GVA AND EXPORTS

Gross Value Added[1]

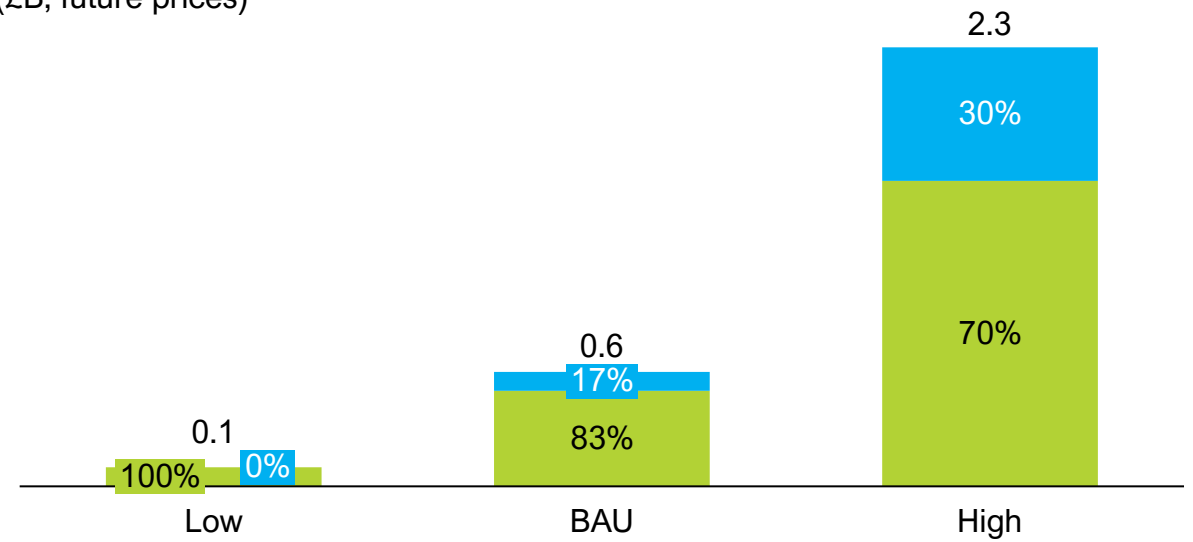
Total annual GVA contribution
(£B, future prices)



- There is a potential **£9.8 B** contribution to the UK economy by 2050. For context, the agri-food sector contributed **£146.7 B** to the national Gross Value Added in 2022[2].
- **>20%** of the GVA comes from the broader value chain outside of the end-product, showing the **catalyzing role fermentation can play for broader economic activity**

Exports

Annual market value of exports
(£B, future prices)



- Up to **£2.3 B** of trade opportunities are created with the fermentation value chain, of which **~45%** is driven by the UK **exporting product inputs**, and **~45%** by the **export of fermentation ingredients**
- For context, the total value of exports of **Food, Feed and Drink** from the UK was **£24.6 B** in 2024[3]; the value of Scottish whisky exports stood at **£5.4 B** in 2024[4]

Notes & Sources: [1] Total GVA contribution is based on 1) the direct GVA contribution + indirect and induced impact of the domestic fermentation end-markets, 2) the direct GVA contribution + indirect and induced impact of the export markets, split in fermentation end-market, high- and low-value input markets, high- and low-value infrastructure markets; [2] Link; [3] UK Capabilities in the Agri-Tech sector, 2018; [4,5] Link, Scotch Whisky Association, 2025;

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