OXFORD ECONOMICS

THE SOCIO-ECONOMIC IMPACT OF CULTIVATED MEAT IN THE UK

REPORT FOR IVY FARM TECHNOLOGIES LTD.

SEPTEMBER 2021

ABOUT OXFORD ECONOMICS

Oxford Economics was founded in 1981 as a commercial venture with Oxford University's business college to provide economic forecasting and modelling to UK companies and financial institutions expanding abroad. Since then, we have become one of the world's foremost independent global advisory firms, providing reports, forecasts and analytical tools on more than 200 countries, 250 industrial sectors, and 7,000 cities and regions. Our best-in-class global economic and industry models and analytical tools give us an unparalleled ability to forecast external market trends and assess their economic, social and business impact.

Headquartered in Oxford, England, with regional centres in New York, London, Frankfurt, and Singapore, Oxford Economics has offices across the globe in Belfast, Boston, Cape Town, Chicago, Dubai, Dublin, Hong Kong, Los Angeles, Melbourne, Mexico City, Milan, Paris, Philadelphia, Stockholm, Sydney, Tokyo, and Toronto. We employ 400 full-time staff, including more than 250 professional economists, industry experts, and business editors—one of the largest teams of macroeconomists and thought leadership specialists. Our global team is highly skilled in a full range of research techniques and thought leadership capabilities from econometric modelling, scenario framing, and economic impact analysis to market surveys, case studies, expert panels, and web analytics.

Oxford Economics is a key adviser to corporate, financial and government decision-makers and thought leaders. Our worldwide client base now comprises over 2,000 international organisations, including leading multinational companies and financial institutions; key government bodies and trade associations; and top universities, consultancies, and think tanks.

SEPTEMBER 2021

All data shown in tables and charts are Oxford Economics' own data, except where otherwise stated and cited in footnotes, and are copyright © Oxford Economics Ltd.

This report is confidential to Ivy Farm Technologies Ltd and may not be published or distributed without their prior written permission.

The modelling and results presented here are based on information provided by third parties, upon which Oxford Economics has relied in producing its report and forecasts in good faith. Any subsequent revision or update of those data will affect the assessments and projections shown.

To discuss the report further please contact:

Henry Worthington: hworthington@oxfordeconomics.com

Oxford Economics

4 Millbank, London SW1P 3JA, UK

Tel: +44 203 910 8000

TABLE OF CONTENTS

Executive summary 1
1. Introduction 6
2. The economic footprint of the cultivated meat value chain 8
2.1 The global potential of the cultivated meat market 8
2.2 The cultivated meat market in the UK 9
2.3 The cultivated meat value chain in the UK 10
2.4 The direct economic contribution 13
2.5 Indirect and induced impacts 15
2.6 The total economic impact of the cultivated meat industry 16
2.7 Potential displacement effects 19
3. The benefit of first mover advantage 21
3.1 What is first mover advantage? 21
3.2 The role of UK regulatory decisions 23
3.3 The implications for UK PLC 24
4. Social and environmental benefits from cultivated meat 26
4.1 The environment 26
4.2 Health 28
4.3 Food security 29
4.4 Animal welfare 30
5. Conclusions 32

EXECUTIVE SUMMARY

BACKGROUND CONTEXT AND RESEARCH OBJECTIVES

Our world's hunger for meat is expected to increase with a growing population. According to the UN Food and Agricultural Organization (FAO) global meat consumption is expected to double in the first 50 years of this century, leading to unfavourable environmental effects and raising concerns over the implications for human health, animal welfare, and food security.

Cultivated meat—meat grown from animal cells in a lab—is an alternative that can help satisfy the ever-increasing demand for meat while at the same time reducing the adverse impacts associated with traditional meat.

Currently, cultivated meat is a nascent market—valued at US$6.6 million—with a number of start-ups investing in making the production of cultivated meat at scale viable and awaiting regulatory approvals. Singapore is the only market in the world where consumers can enjoy the product, after regulatory approval for commercial use was granted in December 2020.

Despite these regulatory headwinds the global potential of the cultivated meat market is vast. Perhaps inevitably, published market research studies present a very wide range of long-term forecasts but even the most conservative projection is for sales to exceed $100 billion by 2040.

Reflective of its transformative potential, a range of studies have been published around the topic. However, the literature is fragmented and piecemeal and to-date lacks a holistic lens. Oxford Economics has been commissioned to fill this white space. Specifically, this report assesses:

- How demand for cultivated meat might evolve in the UK and the associated **economic footprint** that would be sustained across the industry value chain.
- To what extent UK producers might be expected to benefit from **first mover advantage** if UK regulators were to expedite approval and the associated consequences for UK plc.
- The potential **wider social benefits** that would be supported by the growth of the cultivated meat industry.

£1.1 to £2.1 billion

contribution to UK GDP supported by the cultivated meat industry in 2030.



THE ECONOMIC IMPACT OF THE CULTIVATED MEAT INDUSTRY IN THE UK

Prior to this study, Ivy Farm Technologies commissioned market research to forecast the value of consumer demand for cultivated meat products in the period to 2030 under different scenarios. An international consulting company called Integration forecast that the global demand for cultivated meat would be $15 billion (£10.3 billion) by 2030, significantly conservative in comparison with estimates from other studies such as those by AT Kearney ($140 billion), Barclays ($69 billion) and Jeffries ($46 billion).[1]

[1] Integration analysis, as reported in 'Market sizing', a study for Ivy Farm conducted by the Integration Group.

The Integration study indicated that consumer spending on cultivated meat in the UK might range between £850 million and £1.7 billion by 2030 in nominal terms, accounting for between 9% and 12% of consumer demand for meat in 2030.

We have used these assumptions as the basis for our economic impact modelling which has sought to estimate the value created through the associated value chain. While other studies do not present a UK-specific forecast, it is likely that the Integration UK figures are conservative in line with the benchmarks for their global forecasts.

Further detail can be found in the main body of this report and the methodological appendix but the major findings from this modelling exercise are detailed overleaf. Our analysis focusses on the economic contribution based on domestic consumer spending on cultivated meat in the year 2030, i.e., it does not include exports to foreign markets or profits repatriated by UK companies operating abroad.

Through the value chain, **we forecast that the industry will support a total gross value added contribution to UK GDP of £1.1 billion to £2.1 billion in 2030.** Of this contribution, the industry itself generated **£290 million to £574 million**. The remainder is expected to be stimulated by:

(i) the industry's spending on goods and services from its UK supply chain (which is expected to contribute **£414 million to £829 million** to UK GDP in 2030); and

(ii) wage payments to those working directly in the UK cultivated meat industry and for companies in its UK supply chain, which they then will spend in the consumer economy (leading to a projected GDP contribution of **£369 million to £738 million in 2030**).

9,200-16,500 jobs

Supported by the cultivated meat industry in 2030.



This means that the cultivated meat industry will have a 'GDP multiplier' of 3.7 in 2030. In other words, for every £1 million of gross value added created by the industry, a further £2.7 million is expected to be supported elsewhere in the UK economy that year.

We calculate that the British cultivated meat industry will support a total of 9,200-16,500 jobs across the UK in 2030. Of these, 4,400-8,300 workers (46%-50%) will be employed directly by the cultivated meat industry. The remaining 4,800-8,200 jobs will be supported by the cultivated meat industry's procurement of goods and services, and by the payment of wages to its employees and to those in its supply chain.

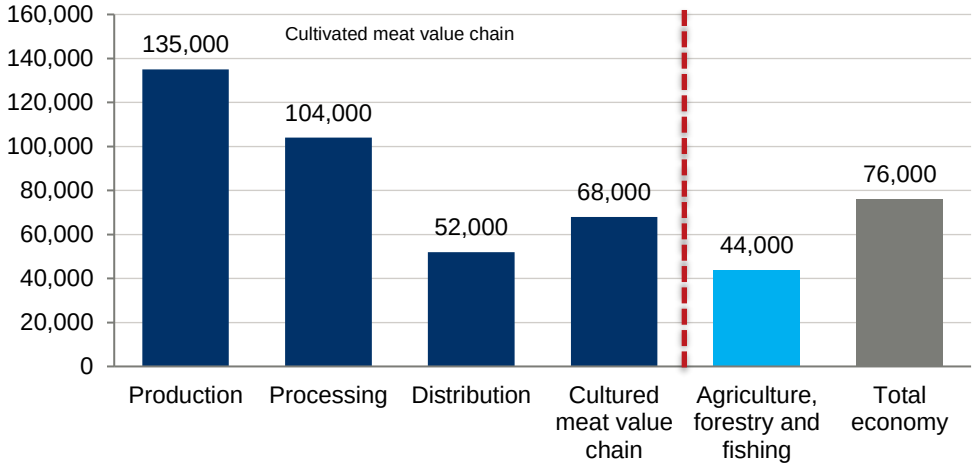
The cultivated meat industry will have an 'employment multiplier' of 2 in 2030. In other words, for every 100 jobs in the industry, a further 100 will likely be supported elsewhere in the UK economy that year.

Further, workers in the cultivated meat production and processing sectors are expected to have much higher productivity at £135,000 and £104,000 (gross value added per worker) than the average worker in the agriculture, forestry, and fishing sector or the average UK worker who are expected to generate £44,000 and £76,000 respectively (gross value added per worker).

The reason behind this disparity is because the cultivated meat production and processing sectors will create jobs for scientists and technologists who typically have higher productivity than the average worker.

Fig. 1. Productivity across the cultivated meat value chain, 2030

GVA per worker, current prices



Source: Oxford Economics. Note: Numbers rounded to the nearest 1,000.

> By opening up the market early, UK-based cultivated meat producers will be better placed to establish themselves as global leaders and improve their chances of delivering higher economic and social benefits for the UK.

The total economic output and employment sustained by the cultivated meat sector is expected to generate £266-£523 million in tax revenues in 2030. The amount of taxes supported by the cultivated meat industry in 2030 would roughly be able to finance the annual salaries of 5,000-10,000 teachers in UK schools or 6,000-12,000 nurses (assuming salaries remain constant in real terms).

The extent to which these benefits will be realised, is, to some extent, in the hands of the UK government. Delayed regulatory approval may result in the UK falling behind in the global agri-tech race. But by opening up the market early, UK-based cultivated meat producers will be better placed to establish themselves as global leaders and improve their chances of delivering higher economic and social benefits for the UK.

What about displacement effects?

The economic footprint results reported above are presented on a *gross* basis and, therefore, do not account for potential displacement effects. Whilst it is impossible to precisely simulate this effect, the fact that the UK is currently highly reliant on imports—60% of all the pork and 35% of the beef consumed is produced overseas—suggests that displacement of demand for UK farmers would be far from one-for-one.[2] Cultivated meat production could complement UK domestic food production, reducing the need for imports and maintaining high standards of farming and food security in the UK.

The purpose of this research is not to evaluate the outlook for the UK's farming industry. Clearly though the UK's departure from the European Union (EU) has led to a heightened state of uncertainty. From the proposed substantial reforms

[2] https://britishmeatindustry.org/industry/imports-exports/pigmeat/

to the system of agricultural subsidies that operate under the EU's Common Agricultural Policy (CAP)[3] to the resultant increase in trade barriers with the industry's largest export market to the short-term squeeze on labour supply[4], risks, and potentially opportunities, abound.

In this context, the growth of the cultivated meat sector, which in our baseline scenario would account for roughly 12% of consumer demand in 2030, would not appear to represent a primary risk to the farming industry.

CAN THE UK BENEFIT FROM FIRST MOVER ADVANTAGE?

We have reviewed a wide body of literature to understand the conditions under which a first mover could succeed, and how that affects the local and national economy. Our findings suggest that the cultivated meat market is likely to be characterised by the appropriated features that will enable firms to establish a *durable* competitive advantage *if* they are able to access the market first.

Swift regulatory approval in the UK would allow domestic firms to leverage their existing market knowledge and networks to further develop their technological know-how in anticipation of the global market opening up.

Swift regulatory approval in the UK would allow domestic firms to leverage their existing market knowledge and networks to further develop their technological know-how in anticipation of the global market opening up. This could help establish UK firms as trend setters and the knowledge spillovers could help establish an ecosystem of technologically advanced businesses in the UK.

Although we do not attempt to size them in this study, contextual evidence suggests that the associated benefits for UK plc could be substantial. As described, UK cultivated meat producers would be better placed to gain market share abroad and, therefore, boost flows of income from overseas via repatriated profits. In addition, the growth of an R&D-intensive sector is bound to generate spillover benefits for technological proximate sectors with the UK's thriving ecosystem of agri-tech start-ups seemingly particularly well-placed to gain.

OTHER BENEFITS

In addition to the economic benefits, there is a wider set of arguments for why cultivated meat production can be positive for UK society.

- **Environmental benefits**: Various studies have concluded that the overall environmental impacts of cultivated meat production were substantially lower than those of conventionally produced meat. They found that within Europe cultivated meat produced using renewable energy leads to 29%-93% less air pollution (particulate matter formation) than conventionally produced meat. Further, cultivated meat was found to take up 63%-95% less land use which will contribute to restoring the carbon balance in the ecosystem. Using cultivated meat could also reduce transportation and refrigeration costs and help reduce waste management.
- **Human health benefits**: Consuming cultivated meat helps avoid infections associated with contamination and slaughter, and it also helps reduce the risk of diseases jumping from animals to humans

[3] https://www.gov.uk/government/collections/common-agricultural-policy-reform
[4] https://www.ft.com/content/ad37558e-be89-4bdc-81bc-79ace20938a7

such as swine flu or avian flu. Cultivated meat has the potential to replace saturated fats in minced meat used for burgers, sausages, and meatballs—popular food choices in the UK—with healthier fats such as Omega-3 and Omega-6. It also avoids the need for antibiotics whose overuse in agriculture has led to concerns of antimicrobial resistance by humans that will leave people more vulnerable to infections.

- **Food security**: By keeping production local, food supply is more resilient to global supply chain shocks such as those witnessed during the recent Coronavirus pandemic or potential political uncertainty due Brexit.
- **Animal welfare**: Producing cultivated meat starts with painless biopsies from a live animal and eliminates the need for intensive farming methods. Local production would also help assure UK consumers that their food was produced in accordance with the highest animal welfare standards which are difficult to verify when the meat is imported from foreign markets.

CONCLUDING THOUGHTS

From ‘net zero’ to the war against obesity to boosting the domestic supply of essential goods to the creation of high skilled jobs and building a more research-intensive economy the promotion of this industry aligns seamlessly with stated government policy objectives.

The cultivated meat industry is in its infancy, both in the UK and in most countries around the world. But it clearly presents significant opportunities for entrepreneurs, investors, and other commercial partners to exploit the global potential of a move away from conventional farming towards more sustainable methods. As concerns around global warming have intensified over the past year, there has been a growing recognition of the role that alternative proteins can play in helping countries reach their climate change targets. However, the UK industry is currently not able to take advantage of the commercial opportunities while it awaits regulatory approval.

As is inevitable with any technological shift there will be some economic losers. Our analysis, however, suggests that the immediate impact on the UK agriculture sector is likely to be minimal this decade, and could potentially be mitigated with the industry’s expansion into the export sector.

On the other hand, perhaps uniquely, from whichever angle you look, the public policy rationale in favour for cultivated meat appears compelling. From ‘net zero’ to the war against obesity to boosting the domestic supply of essential goods to the creation of high skilled jobs and building a more research-intensive economy the promotion of this industry aligns seamlessly with stated government policy objectives.

1. INTRODUCTION

The world's population is growing and will need to be fed. The total number of people on the planet is expected to increase by 2 billion in the next 30 years, from 7.7 billion in 2019 to 9.7 billion in 2050, according to the United Nations[5]. An immense amount of food will be needed to sustain this growing population. Meat is already playing a major role in people's diets: it is one of the largest consumer goods categories in the world with an estimated annual value of around US$1 trillion[6]. This in turn puts a burden on arable farming: according to the Food and Agriculture Organization of the United Nations (FAO), nearly half of the annual worldwide harvest is required to feed the livestock population.

Currently, conventional farming methods create a large environmental footprint and, in places, raise issues related to human health and animal welfare. Meanwhile, the supply chain disruptions caused by the coronavirus pandemic has raised the profile of the topic of food security. These problems seem set to worsen without some mitigating action. Indeed, the FAO has warned that increasing population size and per capita meat consumption in the developing world is expected to lead to global meat consumption doubling between 1999 and 2050.

Against that backdrop, the cultivated meat market offers a huge potential to provide an alternative to satisfy the ever-increasing demand for meat while at the same time reducing the environmental and other negative impacts. Cultivated meat—also known as clean meat, in-vitro meat, lab-grown meat, and cell-based meat—is an umbrella term used to describe meat products grown in a laboratory from cell multiplication. Cultivated meat is processed from a living animal by painlessly extracting muscle cells. Scientists then feed and nurture the cells so that they multiply to create muscle tissue, which is the main component of the meat people eat. It is biologically precisely the same as the meat tissue that comes from the animal.

Cultivated meat is currently a nascent market. It has been valued at just $6.6 million globally. One reason for the limited size is that supply of cultivated meat products to consumers is pending regulatory approval. The UK is far from unique in this respect: at the time of writing, Singapore was the only market in the world where consumers can enjoy the product following its regulatory approval of commercialisation of cultivated meat in December 2020. This means that in almost all jurisdictions, the industry is at the research and development stage: developing novel biotechnologies and lodging patents to protect the intellectual property.

A number of start-ups are nevertheless aiming to get their products on the market soon. However, they are waiting for the regulatory requirements of cultivated meat to be more clearly established before launching commercially. The European Food Safety Authority's regulation on novel foods, which specifically includes cultivated meat, establishes a process of around 18 months during which a company has to prove the product is safe. In 2019 the

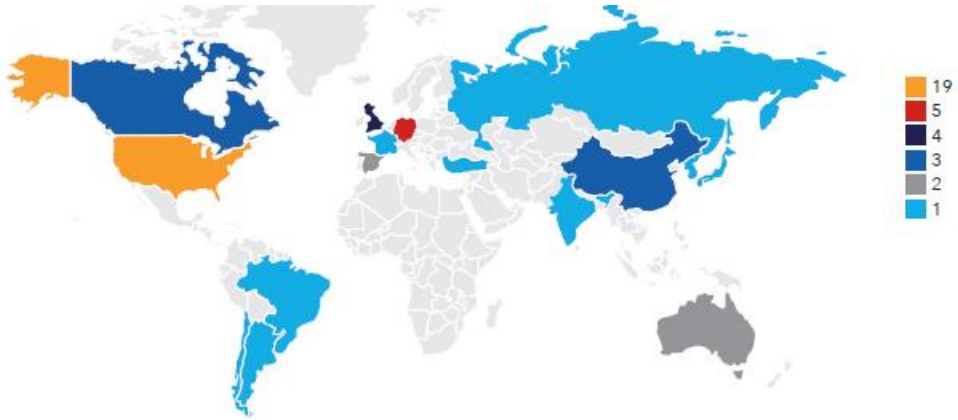
[5] United Nations. 2019 Revision of World Population Prospects. June 2019

[6] Statista. Global meat industry - statistics & facts (July 2021). Accessed 26 August 2021

US Food and Drug Administration and the Department of Agriculture's Food Safety and Inspection Service established a formal agreement on how it would use its regulatory tools to help ensure that foods comprising or containing cultivated animal cells entering the US market were safe and properly labelled.

By the end of 2020, the number of start-ups focused exclusively on developing cultivated meat inputs or end products rose to more than 70, according to the Global Food Institute. The number of companies, largely in the life sciences, that have publicly announced a business line in cultivated meat increased to 40.[7] Start-ups had been established in at least 19 countries across five continents: although more than a third of these companies are based in the United States, large concentrations also exist in the EU-UK region, Canada, Israel, and Asia Pacific.

Fig. 2. Geographic distribution of cultivated meat companies



Source: Good Food Institute

Last year saw several milestones for the industry. Eat Just secured regulatory approval for the sale of cultivated chicken in Singapore. Former Prime Minister of Israel Benjamin Netanyahu became the first head of state to taste cultivated meat in a tasting event hosted by GFI Israel and Aleph Farms. Lab Farm Foods of the US demonstrated three different prototypes, unveiling two types of chicken nuggets and a pork liver pâté.

Reflective of its transformative potential, a range of studies have been published around the topic. However, the literature is fragmented and piecemeal and to-date lacks a holistic lens. Oxford Economics has been commissioned to fill this white space. In this report, we examine the potential socioeconomic impact of the cultivated meat sector in the UK and shed some light the potential advantages that government support and regulatory approval would give to the UK economy.

[7] Global Food Institute. 2020 State of the Industry Report Cultivated Meat. 2021

2. THE ECONOMIC FOOTPRINT OF THE CULTIVATED MEAT VALUE CHAIN

2.1 THE GLOBAL POTENTIAL OF THE CULTIVATED MEAT MARKET

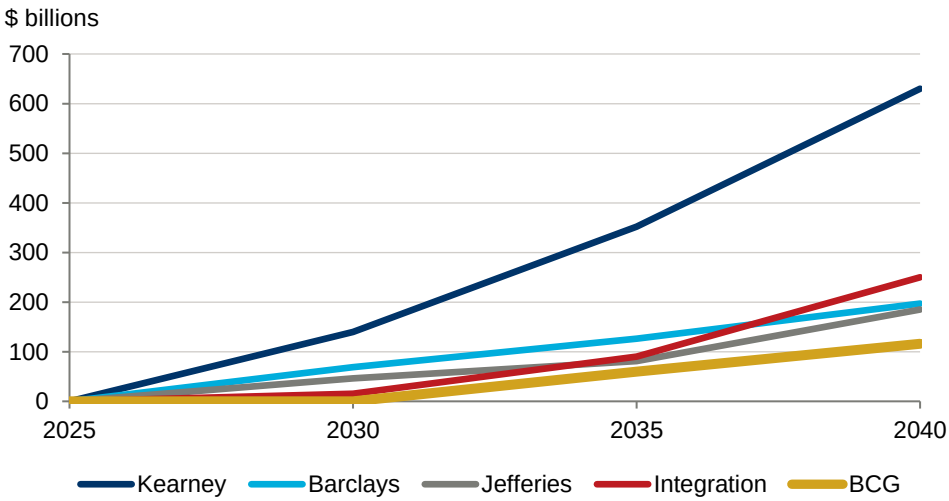
$15bn-$140bn

Demand for cultivated meat globally by 2030, as forecast by various studies

Conventional farming is unlikely to be able to cope with the growing demand for meat globally over the coming decades. There is a rising imperative for alternatives—such as plant-based meat and cultivated meat—to meet global demand, and this requirement seems set to increase exponentially as concerns related to human health, environmental sustainability, and animal welfare become more prominent.

The cultivated meat market is nascent, and, therefore, its potential for growth is highly uncertain. Various studies forecast the final demand for cultivated meat to be between $15 billion and $140 billion (£10.3 billion and £96.6 billion) globally by 2030, with the range of forecasts widening to $116 billion to $630 billion (£80 billion and £434 billion) by 2040.

Fig. 3. Size of the cultivated meat market, 2025-2040



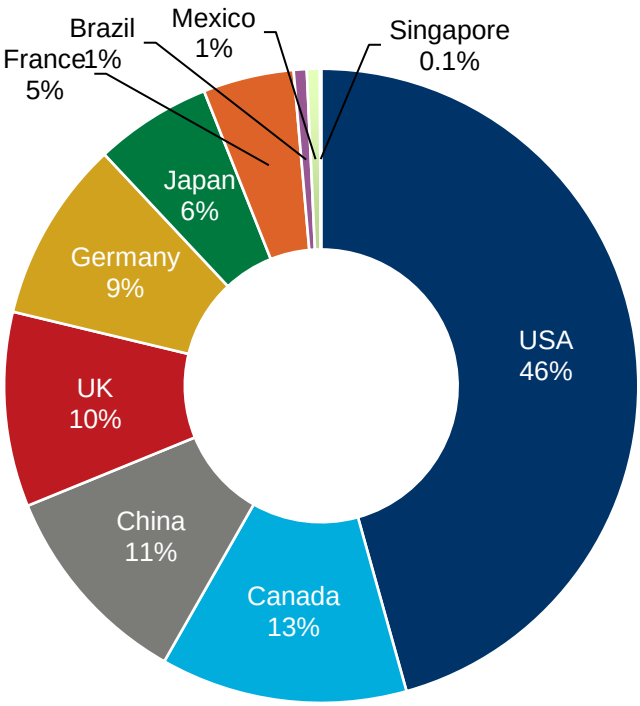
Source: Various studies

According to a study by Integration commissioned by Ivy Farm, the cultivated meat market is forecast to be $15 billion (£10.3 billion) by 2030. The Integration forecasts are conservative when compared to AT Kearney ($140 billion), Barclays ($69 billion) and Jeffries ($46 billion).[8] According to the Integration study, the UK, along with the US, Canada, and China, is expected to be one of the largest markets for cultivated meat. Fig. 4 shows the forecast relative size of the various cultivated meat markets in 2030. The US is expected to the be

[8] Integration analysis, as reported in 'Market sizing', a study for Ivy Farm conducted by the Integration Group.

the largest market of those included in the study, followed by Canada, China, the UK, Germany, and Japan. France, Brazil, and Mexico are expected to be the other large markets for cultivated meat, and demand in Singapore—currently the only country where cultivated meat is commercially available—is forecast to be relatively small compared to the other markets.

Fig. 4. Forecast allocation in 2030



Sources: Arizton, Market Line, RaboBank, Euromonitor, Statista, as reported by Integration Analysis.

In the rest of this section, we focus on the cultivated meat industry in the UK and estimate its contribution to the UK economy. Our economic contribution estimates are for 2030 which marks the year when the industry is at the threshold of potentially rapid growth in the following decade.

2.2 THE CULTIVATED MEAT MARKET IN THE UK

In 2019, UK consumers spent approximately £19 billion on meat and meat products, most of it coming from traditional sources. But consumer spending on plant-based alternatives and cultivated meat is expected grow in the coming years. Our modelling, focussed on the UK, is underpinned by market size forecasts from Integration, who have modelled three scenarios reflecting different assumptions on the speed and extent of regulatory approval in the UK and the pace of technological growth – see Fig. 5.

Fig. 5. Differences in UK cultivated meat market scenarios

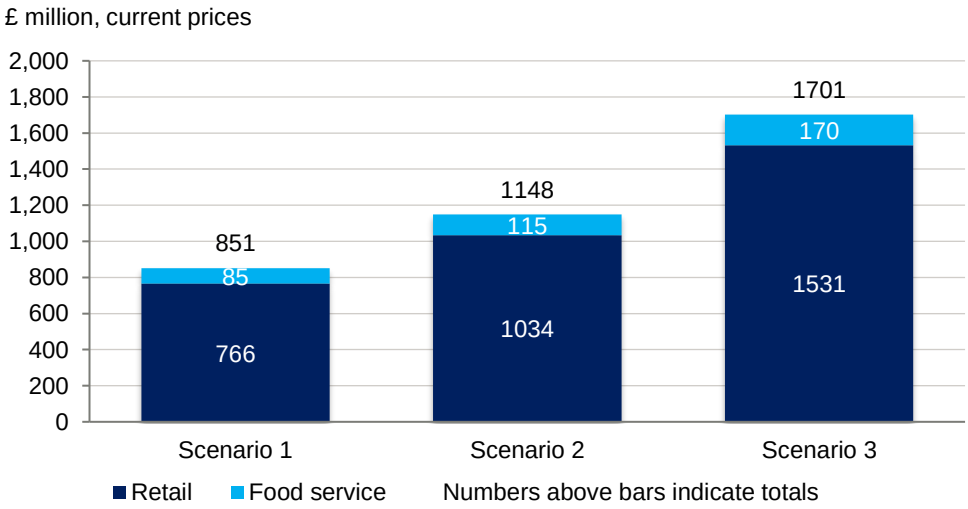
	Scenario 1	Scenario 2	Scenario 3
Year by which costs become viable	2028	2027	2026
Speed at which the entire potential market[9] is captured	5 years following regulatory approval	4 years following regulatory approval	3 years following regulatory approval

Source: Integration analysis

As shown in Fig. 6, the size of the UK cultivated meat market is forecast to grow to between £850 million and £1.7 billion in 2030 in nominal terms, roughly the same as UK consumer spending on coffee or eggs in 2020.[10] Almost 90% of this expenditure is expected to take place through retail, and the remaining 10% is through the food service sector (i.e., restaurants and food delivery services).

While other studies do not present a UK-specific forecast, it is likely that the Integration UK figures are conservative in line with the benchmarks for their global forecasts.

Fig. 6. Size of the UK cultivated meat market, 2030



Source: Oxford Economics

2.3 THE CULTIVATED MEAT VALUE CHAIN IN THE UK

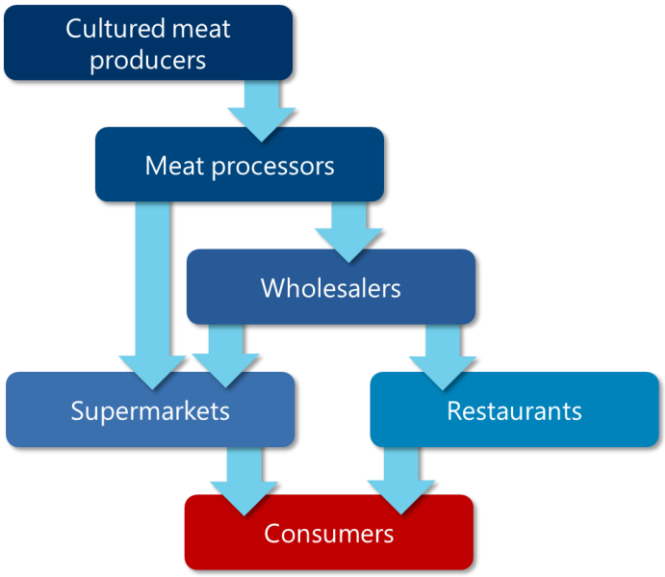
Consumer spending on cultivated meat products will sustain economic activity in a range of sectors through the industry's value chain (see Fig. 7). Cultivated meat producers "cultivate" meat from animal stem cells, which are then processed and packaged by meat processors into products that can be used

[9] The potential market constitutes all consumers who would be willing to consume cultivated meat eventually.

[10] According to the ONS Living Costs and Food Survey, total UK weekly consumer spending on coffee and eggs in the financial year ending 2020 was £30 million and £21 million respectively, translating into an annual expenditure of £1.1 billion and £1.6 billion in 2019 prices (or £1.3 billion and £1.8 billion in 2030 prices).

by consumers (e.g., packs of sausages and patties). These packaged products then reach end-consumers in traditional ways, i.e., through wholesalers and then retailers and food service businesses (i.e., restaurants, hotels, etc.). We have modelled the combined direct, indirect, and induced impact of all elements of the value chain.

Fig. 7. The cultivated meat industry value chain



WHAT IS AN ECONOMIC IMPACT ASSESSMENT?

To quantify its total economic contribution of the cultivated meat industry, we use an analytical method called an Economic Impact (EI) Assessment. This examines the impacts of three separate types of expenditure, all of which stimulate significant activity throughout the UK economy:

- The **direct impact**—economic activity stemming from the operational expenditure at the production plants, processors, retailers, wholesalers, and distributors in the cultivated meat industry itself.
- The **indirect impact**—economic activity supported in the supply chain of the cultivated meat industry. This impact is felt as a result of the industry's purchases of goods and services.
- The **induced impact**, or wage expenditure impact—this arises as employees working in the cultivated meat industry, and throughout its supply chain, spend their wages; for example, in local retail and leisure establishments.

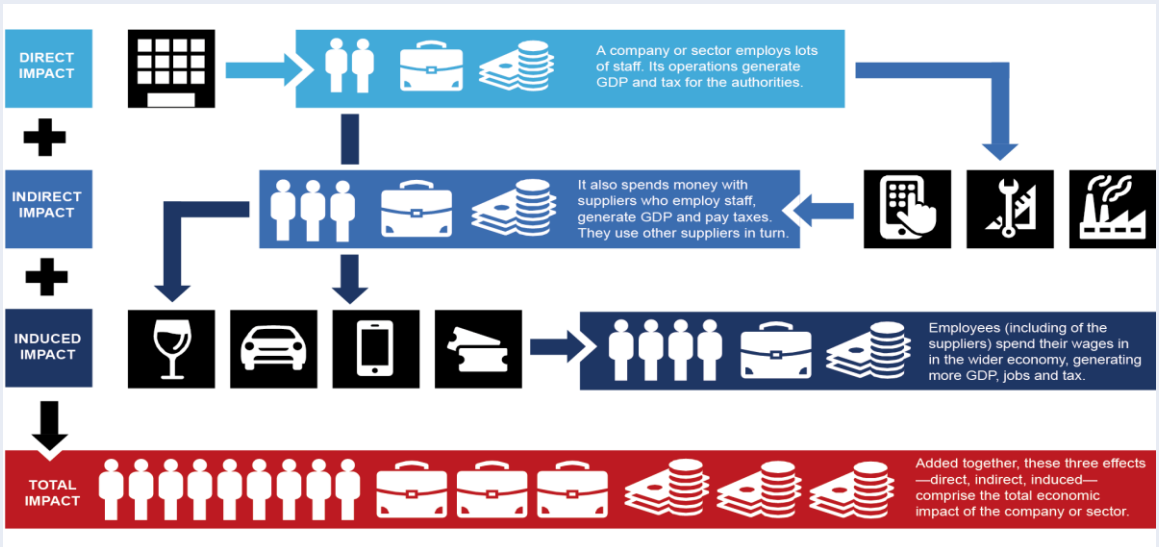
The total economic impact of the UK cultivated meat industry in 2030 is the sum of its direct, indirect, and induced impacts for that year. (See Fig. 8 for a visual description of how the total economic impact is calculated using these three channels of impact.)

We use three metrics to quantify each channel of economic impact:

- **Gross value added contribution to GDP**—this measures the contribution to the economy of each individual producer, industry, or sector in the UK.
- **Employment**—this is measured on a headcount basis, to facilitate comparisons with employment data for other businesses and industry sectors and regions sourced from the Office for National Statistics (ONS).
- **Tax revenues**.

Note: this study is undertaken on a *gross* rather than a *net* basis. This means it focuses on the economic activity created by the resources the cultivated meat industry uses, rather than only what they create *in excess of being deployed in their second-best usage*. It also ignores the displacement of activity from other industries, and any substitution through time.

Fig. 8. Overview of Economic Impact Assessment model



2.4 THE DIRECT ECONOMIC CONTRIBUTION

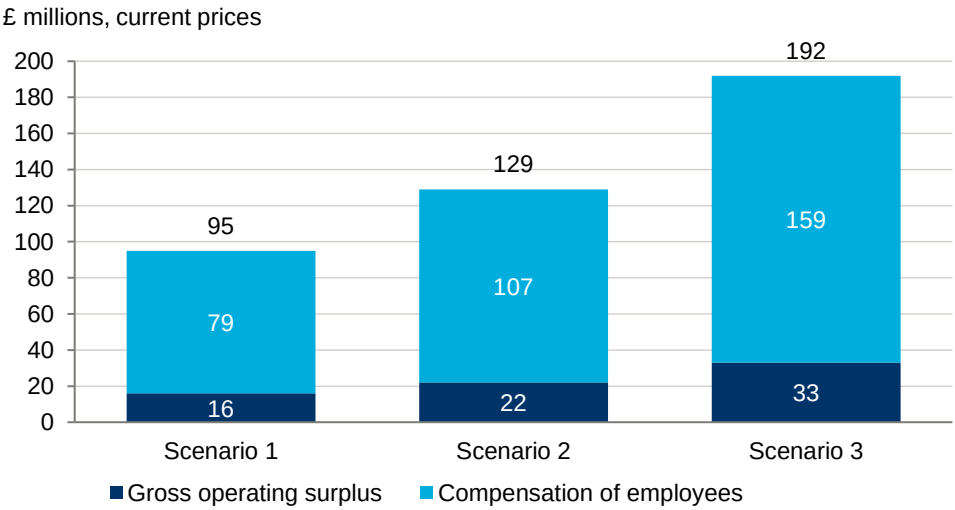
This section assesses the impact of the cultivated meat industry's own activities on the UK economy in 2030, known as its direct impact. We begin by assessing the industry's gross value added contribution to GDP in 2030, and subsequently describe the industry's direct contributions to employment.

2.4.1 Direct economic contribution

In 2030, the cultivated meat industry is expected to earn between £851 million to £1.7 billion in turnover. Of this, almost half (45%) accrues to meat producers, 22% to processors, and the rest accrues to the distribution network (wholesalers, retailers, and food service businesses).

Through these activities, we calculate that the cultivated meat industry is expected to create a projected £290 million to £574 million of gross value added contribution to UK GDP in 2030 in nominal terms. Of this, 17% was comprised of gross operating surplus and the remaining 83% was comprised of employee compensation.

Fig. 9. The UK cultivated meat industry's gross value added composition, 2030



Source: Oxford Economics

1.8%-3.5%

Cultivated meat contribution to the GVA contribution of the UK agricultural sector in 2030 —as large as the GVA growth in Swansea or the Cotswolds between 2022 and 2030



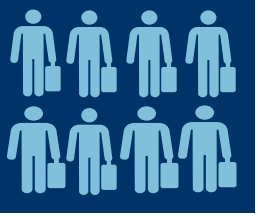
The industry's direct contribution to GDP is particularly significant when examined within the context of the wider agricultural and meat processing industries. In 2030, cultivated meat farming is expected to be responsible for 1.8% to 3.5% of the £16.4 billion gross value added contribution made by the entire agricultural sector. Put differently, the direct GVA contribution in 2030 could roughly be as large as the nominal GVA growth of Swansea, North Somerset, or the Cotswolds between 2022 and 2030.

2.4.2 Direct employment contribution

In 2030, the cultivated meat industry is expected to employ a projected 4,400-8,300 people. Of these, 6%-8% will be in the cultivated meat production sector, 18%-19% in meat processing, and the remaining 71%-76% in the distribution part of the value chain (see Fig. 10). In other words, the direct employment

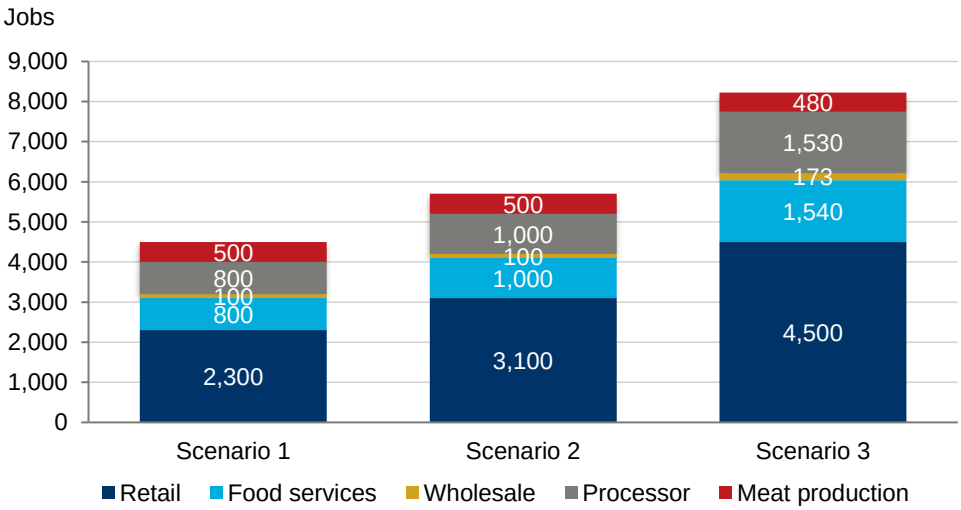
4,400-8,300

Jobs directly supported by the cultivated meat industry value chain in 2030.



contribution in 2030 could be approximately as large as the size of the Welsh local government today.[11]

Fig. 10. The UK cultivated meat industry's employment by sector, 2030



Source: Oxford Economics. Note: Numbers rounded to the nearest 100.

The average cultivated meat worker across the value chain is expected to generate £68,000 of GVA in 2030. Workers in the cultivated meat production and processing sectors are expected to have much higher productivity at £135,000 and £104,000 (gross value added per worker) than those in the distribution sectors at £52,000 per worker. In comparison, the average worker in the agriculture, forestry, and fishing sector is expected to generate £44,000 and the average UK worker is expected to generate £76,000 (gross value added per worker). The reason behind this disparity is because the cultivated meat production and processing sectors will create jobs for scientists and technologists who typically have higher productivity than the average worker.

[11] The Welsh devolved government employed 5,740 people as of 2021 according to the ONS Public sector employment datasets.

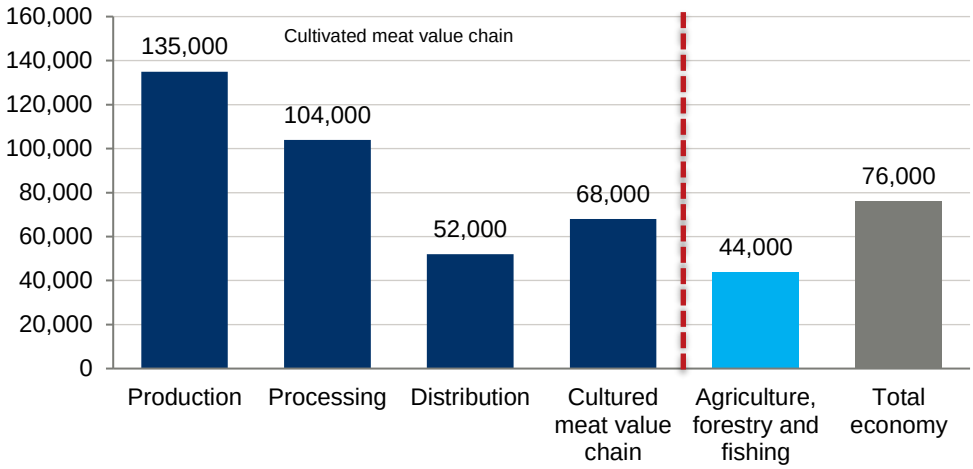
The jobs directly supported by the cultivated meat production and processing sectors will be in highly productive tech sectors.

£91,000

Difference in GVA contribution of the average worker in the cultivated meat production sector when compared to one in the agriculture, forestry, and fishing sector .

Fig. 11. Productivity across the cultivated meat value chain, 2030

GVA per worker, current prices



Source: Oxford Economics. Note: Numbers rounded to the nearest 1,000.

2.5 INDIRECT AND INDUCED IMPACTS

We have also examined the knock-on impacts of the UK cultivated meat industry's expenditure throughout the wider UK economy. We present projections of the economic activity supported by the industry's procurement of goods and services in its supply chain (the indirect impact), and by the wage-related spending of employees within the industry and its supply chain (the induced impact).

2.5.1 Indirect economic contribution

In addition to generating gross value added, employment, and tax revenues through its own operations, the cultivated meat industry stimulates economic activity through its procurement of goods and services from UK suppliers. This indirect impact has been forecast using Oxford Economics' suite of input-output models, which have been constructed from national accounting data published by the ONS.[12]

£530 million to £1.1 billion

Cultivated meat GVA contribution through supply chain spending in 2030.



The cultivated meat industry is projected to spend £530 million to £1.1 billion on inputs of goods and services from UK suppliers in 2030 in nominal terms.[13] **We calculate that the cultivated meat industry's procurement of goods and services is expected to support £414-£829 million gross value added contribution to UK GDP in 2030.** This expenditure impact benefitted a wide range of industries across the UK economy, with the largest contributions being enjoyed by the manufacturing, retail & wholesale, professional & administrative services, and transport & storage sectors.

[12] ONS. 2019. *United Kingdom Input-Output Analytical Tables, 2015.* *https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed*

[13] This procurement figure only includes purchases made from other industrial sectors. To avoid double counting, we have excluded purchases made from other businesses in the cultivated meat value chain, as this revenue has already been counted in the direct gross value added projections.

Through this supply chain expenditure, we project that the cultivated meat industry is expected to sustain more than 5,000 to 10,000 jobs throughout the UK economy in 2030, the higher estimate is roughly comparable to the number of jobs in the real estate sector in Northern Ireland in 2020.

2.5.2 Induced economic contribution

£369 million to £738 million

Cultivated meat industry GVA contribution through wage-financed spending in 2030.



The final channel of economic impact considered in this study is the induced impact of the cultivated meat industry. This channel captures the GDP, jobs, and taxes supported by the wage-financed consumption of employees within the cultivated meat industry, and also those employed by firms in the industry's supply chain.

The cultivated meat industry is projected to pay its direct employees an average of £321 million in gross wages in 2030 across the three scenarios. These workers, and those who will be employed in the industry's supply chain, will spend a proportion of these wages to purchase goods and services in the UK for their household's consumption (the remainder will be spent outside the UK, or saved). In turn, this spending will support economic output and jobs at the firms in the consumer economy that supply these purchases, and also throughout their own UK supply chains.

We calculate that this wage-financed spending is expected to stimulate a gross value added contribution to GDP of £369 million to £738 million in 2030 in nominal terms. We also find that this economic activity is expected to sustain some 3,700-7,500 jobs across the UK in 2030. The latter jobs figure is roughly comparable to the number of jobs in the water supply sector in Greater Manchester in 2020.

2.6 THE TOTAL ECONOMIC IMPACT OF THE CULTIVATED MEAT INDUSTRY

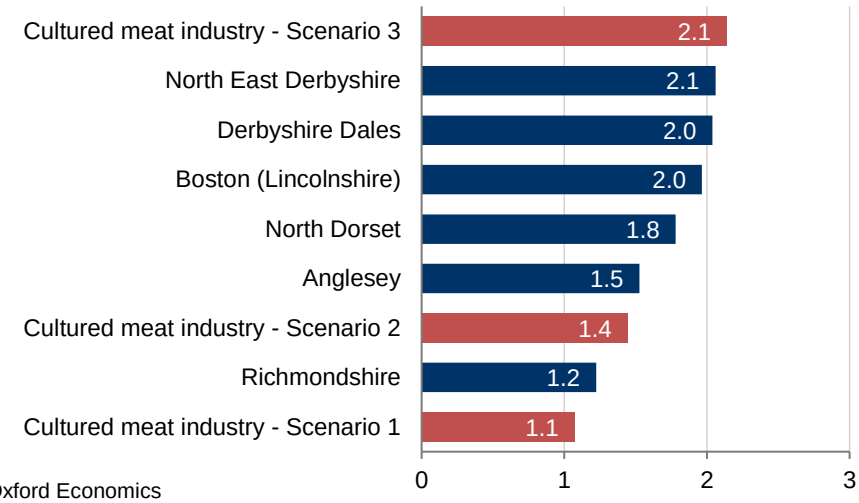
We now bring together the findings of sections 2.3, 2.4, and 2.5 to calculate the total economic impact of the UK cultivated meat industry in 2030.

Our Economic Impact Assessment model shows that the industry is expected to support a total gross value added contribution to UK GDP of £1.1 billion to £2.1 billion in 2030 in nominal terms. This has been projected by summing the industry's direct, indirect, and induced channels of impact for that year. This contribution is equivalent to 6.5% to 13.0% of the UK's total agriculture, forestry, and fishing sector GVA in 2030. Or to give an alternative sense of scale, it could be as high as the GVA of the Derbyshire Dales, Boston (Lincolnshire), Anglesey, or North Dorset in 2030. The value of the cultivated meat industry's total GVA contribution is comparable to the value added by the food manufacturing industry in London or the sports and recreation industries in Scotland in 2019 in real terms.[14]

[14] ONS regional statistics for the 'Manufacture of food products' in London and 'Sports, amusement, and recreation activities' in Scotland, with adjustments for inflation.

Fig. 12. The cultivated meat industry's total contribution to UK GDP compared to select UK Local Authority districts, 2030

£ billions



Source: Oxford Economics

Of this, less than a third (around 27%) is expected to be generated directly by the cultivated meat industry itself. The remaining 73% will likely be supported in other UK sectors by the industry's supply chain spending on inputs of goods and services, and by the wage-related spending of the industry's employees and those in its supply chain (see Fig. 11). This means that the cultivated meat industry will have a "GDP multiplier" of 3.7 in 2030. In other words, for every £1 million of gross value added created by the industry, a further £2.7 million is expected to be supported elsewhere in the UK economy that year.

Fig. 13. The cultivated meat industry's total contribution to UK GDP, 2030 (£ millions, nominal prices)

	Direct	Indirect	Induced	Total
Scenario 1	290	414	369	1,073
Scenario 2	388	559	498	1,446
Scenario 3	574	829	738	2,141

Combining our direct, indirect, and induced projections for employment, we find that the cultivated meat industry is expected to support a total of 9,200-16,500 jobs throughout the UK in 2030. This is equivalent to 7%-13% of the jobs in Oxford in 2030.

The largest share of this employment, 4,400-8,300 jobs (46%-50% of the total), is expected to be within the industry itself. The remaining 4,800-8,200 jobs will be supported by the cultivated meat industry's procurement of goods and services, and by the payment of wages to its employees and to those in its supply chain (see Fig. 14). This means the cultivated meat industry will have an 'employment multiplier' of 2.0 in 2030. In other words, for every 100 jobs in the industry, a further 100 will likely be supported elsewhere in the UK economy that year.

Fig. 14. The cultivated meat industry's total contribution to UK employment, 2030 (jobs)

	Direct	Indirect	Induced	Total
Scenario 1	4,400	2,400	2,400	9,200
Scenario 2	5,700	3,200	3,500	12,400
Scenario 3	8,300	4,700	3,500	16,500

Note: All figures rounded to the nearest 100.

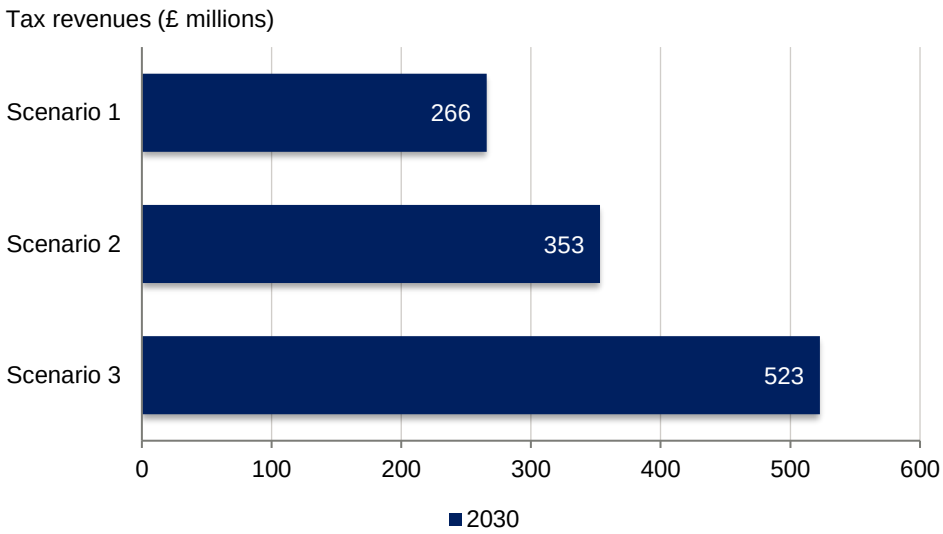
Finally, we project that the total economic output and employment sustained by the cultivated meat sector is expected to generate £266-£523 million in tax revenues in 2030. Of the total tax revenues, nearly half is through employment taxes including income tax, and employee and employer National Insurance Contributions (NICs)[15], 17% is through taxes on products from the consumption effect, 12% in corporation taxes, 13% from taxes on products, and 8% from taxes on production—see Fig. 16.

£266 million to £523 million

Total tax generated in 2030 through output and employment sustained by the cultivated meat industry



Fig. 15. Total tax contribution of the UK cultivated meat industry in 2030



Source: Oxford Economics

5,000-10,000

Number of teachers whose salaries could be supported in 2030 by the cultivated meat industry's total tax contribution



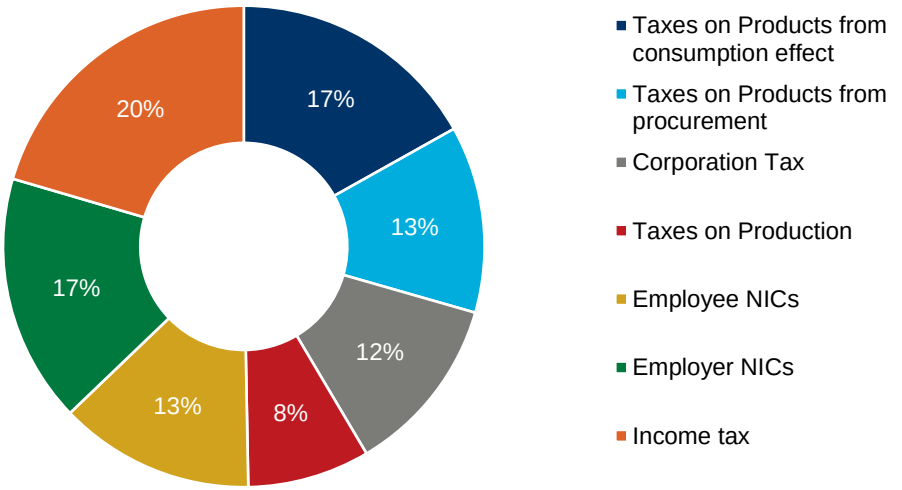
The amount of taxes supported by the cultivated meat industry in 2030 would roughly be able to finance the annual salaries of 5,000-10,000 teachers in UK schools or 6,000 to 12,000 nurses (assuming salaries remain constant in real

[15] Taxes have been projections using corporate tax rates from HM Revenue and Customs. 2019. *Annual UK Corporation Tax Statistics 2019*. https://www.gov.uk/government/statistics/corporation-tax-statistics-2019. Income and National Insurance Contribution allowances and rates from HMRC's online guidance on current rates and thresholds.

terms) or even support government expenditure on parks and recreational facilities in London.[16,17]

Fig. 16. Breakdown of tax contributions made by the UK cultivated meat industry, 2030

Share of total tax contribution



Source: Oxford Economics

6,000-12,000

Number of nurses whose salaries could be supported in 2030 by the cultivated meat industry's total tax contribution

2.7 POTENTIAL DISPLACEMENT EFFECTS

The economic footprint results reported in this chapter are presented on a *gross* basis and, therefore, do not account for potential displacement effects. For downstream activity in the value chain, it can be expected that these will be complete—retail and food services sales of cultivated meat products is simply replacement demand. Upstream, the growth of cultivated meat production will, to some extent, displace demand for the UK agricultural sector. Whilst it is impossible to precisely simulate this effect, the fact that the UK is currently highly reliant on imports—60% of all the pork and 35% of the beef consumed is produced overseas—suggests that displacement would be far from one-for-one.[18]

The purpose of this research is not to evaluate the outlook for the UK's farming industry. Clearly though, the UK's departure from the European Union (EU) has led to a heightened state of uncertainty. For example, the government has announced that it intends to implement substantial reforms to the EU Common Agriculture Policy (CAP) framework which governed the allocation of farming subsidies.[19] Furthermore, the withdrawal agreement has resulted in an increase in trade barriers with the industry's largest export market whilst the

[16] Based on a gross annual salary in 2020 for a secondary education teaching professional of £40,881 and for nurses of £33,920 gross per annum. ONS, 2020. Annual Survey of Hours and Earnings.

[17] Based on Ministry of Housing, Communities & Local Government estimates of total expenditure on sport, play and parks in London amounting to £247 million in 2019 prices (£290 million in 2030 prices). It is the total of community centres and public halls, foreshore, sports development and community recreation, sports and recreation facilities including golf courses and open spaces.

[18] https://britishmeatindustry.org/industry/imports-exports/pigmeat/

[19] https://www.gov.uk/government/collections/common-agricultural-policy-reform

government's stated objective to deepen trade ties with major agricultural producing markets might expose UK farmers to heightened international competitive pressures.[20] And finally, new migration laws introduced by the government have, in the short term, created a skills shortage on an industry that was heavily dependent on short-term EU labour, as demonstrated by recent issues for UK pig farmers.[21]

In this context, the growth of the cultivated meat sector, which in *Integration's* baseline scenario would account for roughly 12% of consumer demand in 2030, would not appear to represent a primary risk to the farming industry.

[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/737201/HMG_Export_Strategy.pdf

[21] https://www.ft.com/content/ad37558e-be89-4bdc-81bc-79ace20938a7

3. THE BENEFIT OF FIRST MOVER ADVANTAGE

3.1 WHAT IS FIRST MOVER ADVANTAGE?

A wide body of literature documents the benefits to companies and the wider economy of early access to technology. By starting earlier, first movers have more time to create technological know-how, identify and access scarce resources, and build an early base of loyal customers. The first mover can also set the standards for the new product and build a strong national and global brand.

The first mover also confers benefits to its local economy by building up a knowledge base and stimulating spillovers of knowledge and technical know-how through the supply chain.

Coca-Cola in soft drinks and Hoover in vacuum cleaners are examples of firms that succeeded in building durable first-mover advantages and have dominated their product categories for many years from the market's infancy to maturity. However, not all first movers are successful. While Gillette (safety razors) and Sony (personal stereos) were successful, others were not (e.g., eToys in internet retailing).

What determines success for a first mover?

The success of first movers depends on a variety of factors. Suarez and Lanzola (2005)[22] summarise them under the following headings:

- The pace of technological growth
- The speed of market expansion.

In general, a more gradual evolution of the technology and a less rapid rate of market growth provides first movers with the best conditions for creating a dominant position that can endure. On the other hand, rapid technological growth or market expansion erodes first-mover advantage rapidly. In other words, as discussed in Franco et al (2009)[23], early entry is beneficial only for pioneers that are technically strong in relatively stable markets.

It is worth noting, however, that even when the first-mover advantage is not durable, companies can still benefit significantly. For example, Netscape produced enormous gains for shareholders by being the first to market as an internet browser despite its dominance fading over time.

[22] Suarez, Fernando, and Gianvito Lanzolla. "The half-truth of first-mover advantage." *Harvard Business Review* (2005).

[23] Franco, April M., M. B. Sarkar, Rajshree Agarwal, and Raj Echambadi. "Swift and smart: The moderating effects of technological capabilities on the market pioneering–firm survival relationship." *Management Science* 55, no. 11 (2009): 1842-1860.

FIRST-MOVER ADVANTAGE AND NATIONAL DOMINANCE—A CASE STUDY OF THE TELECOMMUNICATIONS SECTOR

Significant economic benefits have accrued to the leaders of each wireless telecom network generation (2G, 3G, 4G, etc.) which has meant that they have been able to contribute to their respective national economies by stimulating the economy, and generating jobs and tax revenues for the local governments.

European countries benefit from of 2G standards

European countries led the world in the development of 2G standards, and manufacturers such as Nokia and Ericsson were able to develop their technologies and serve markets globally. 2G leadership enabled the rise of the European wireless tech industry, ranging from Nokia, Ericsson, Alcatel, and Siemens, which employed hundreds of thousands of people.

In 1993, Ericsson accounted for 60% of the global market for digital cellular equipment, while Nokia became the largest mobile phone supplier in Europe, and second largest in the world. By the end of the decade, Ericsson accounted for 50% of global GPRS (2.5G) sales, as well. That year, in 2000, Nokia's exports were 24% of total Finnish goods and service and approximately 80% of the telecommunications equipment the country exported.[24]

As mobile phone technologies grew more powerful with data-enabled services, European companies struggled to match their American and Japanese rivals in creating operating systems and apps that turned out to be vital in the data-driven age.

US companies benefit from early adoption of 4G and a global approach

While the US had been slow to roll-out 3G, they corrected their error. As advanced smartphones made a major impact, industry investment grew, and regulators made smart wireless policy decisions. As a result, the US became a leader in its adoption of 4G—and a host of American companies such as Google and Apple created new products and services and became market leaders. The broader product ecosystems—such as the app stores and operating systems created by Google and Apple —are critical to their success in the smartphone era. Conversely, European companies' failure to create affiliated products has contributed to their loss of leadership in the mobile telephony market.

American companies' dominance is built on the early investments in mobile network infrastructure by other companies in the US. The success of Google's and Apple's devices, operating systems, and other products would not have been possible if mobile operators had not built 4G networks that created the necessary foundation that allowed other companies to innovate and thrive.

A global approach was also key to American tech companies' global leadership. While Japan also matched the US in rolling out 4G networks, its providers were tied to technologies specific to the Japanese market and could not evolve dynamically to compete for the global customer.

The experience of 2G and 4G networks underscores how timely regulatory action (2G standard setting in Europe) and being an early adopter of technology (4G network rollout in the US) can enable businesses in establishing themselves as global leaders.

[24] Recon Analytics, "How America's 4G leadership propelled the US economy" (2018).

Mascarenhas (1992)[25], in an analysis of international markets for mechanical equipment, found that the international benefits far exceeded the effects nationally. Nakata and Sivakumar (1997)[26] found that the characteristics of the market—market size and regulatory policy—can strongly influence the benefits of pioneering at the national and international levels.

First mover advantage in the cultivated meat industry

To what extent the cultivated meat sector will be marked by a significant level of first mover advantage is, of course, uncertain. However, it seems plausible that the optimal conditions identified in the literature—a relatively gradual rate of technological development and market expansion—will hold.

For the former, technological progress and experimental development have helped to progressively reduce production costs to-date. In 2013, a University of Maastricht researcher—Mark Post—produced the first cultivated meat burger for an astronomical $300,000. Technological advancements have significantly reduced the costs of production since: Aleph Farms was able to produce a small steak for $50 in 2018.[27]

Similarly, on the rate of market expansion, various factors suggest that, in the near-term, it is unlikely that there will be a rapid *uniform* market expansion. Chief among these is regulatory approval with little prospect that we will see synchronous international developments. This should sow the seeds for first mover firms (who secure high levels of market share in origin markets) to scale up by entering new markets sequentially. In the longer-term, one of the key drivers of the rate of growth will be the rate of technological progress, which will govern changes in production costs and hence competitiveness.

3.2 THE ROLE OF UK REGULATORY DECISIONS

Taken together, this suggests that the establishment of first-mover advantage for UK businesses, and the associated benefits to the wider economy, is, to some extent, in the hands of the UK government. By opening up the market early, UK-based cultivated meat producers will be better placed to acquire market expertise, build on their technological know-how, and achieve cost viability more quickly. Although it is of course feasible for these businesses to also operate and sell into international markets (through the establishment of a foreign presence), there would be natural advantages for any cultivated meat producer when selling into their domestic market (lack of language barriers, more established connections with customers etc.).

Singapore—which is the only country to have granted regulatory approval for cultivated meat currently—has been working to attract cultivated meat companies to the country with various forms of support and incentives to reduce its reliance on food imports. In January 2019, a Singapore government

[25] Mascarenhas, Briance. "Order of entry and performance in international markets." *Strategic Management Journal* 13, no. 7 (1992): 499-510.
[26] Nakata, Cheryl, and Kolachalam Sivakumar. "Emerging market conditions and their impact on first mover advantages: an integrative review." *International Marketing Review* (1997).
[27] Medium, 'Why your steak costs more than you think: a cost comparison of farmed meat vs. cultured meat' (August 21, 2020)

investment agency announced S$90 million investment to support various agri-tech start ups. As a small island country importing most of the food it consumes, Singapore has been investing heavily in the agri-tech sector not just to ensure its future food security but also to make it a global hub for this sector.[28,29]

The UK has also demonstrated success with a similar policy in other markets. For example, the UK's forward-thinking approach to regulatory policy since the financial crisis has been a driver in the emergence and continued development of a thriving fintech ecosystem in the UK. Fintech entrepreneurs were able to test their ideas in a policy and regulatory environment that enabled them to succeed. The Financial Conduct Authority (FCA) Advice Unit—through various schemes such as Project Innovate, the Regulatory Sandbox, and the Advice Unit—has helped bring many new propositions to market with the aim of making financial services accessible and affordable. Similarly, the UK's success in developing and bringing Covid-19 vaccines to market at historic speeds was achieved through decisive and timely government support for research institutions and the private sector.

3.3 THE IMPLICATIONS FOR UK PLC

For UK producers to benefit from first-mover advantage, therefore, the regulatory imperative is clear. Moreover, as demonstrated there are theoretical grounds to suggest that these competitive benefits could endure. But what would be the implications of this for UK plc? To assess this question, we believe that two points are of main relevance:

(1) The potential size of the global market for cultivated meat particularly in markets where UK producers would be able to access more seamlessly.
(2) To what extent the R&D activities of cultivated meat producers could support the development of other UK sectors.

On the first point, as shown in chapter two, available consensus projections testify to the vast potential value of the global market in the long-term. In general, we would expect UK producers to capture this by establishing facilities overseas (to minimise transport and logistics costs for local processors). This would technically not act as a boost to UK merchandise exports but the economic benefits from repatriated profits or licence revenues from intellectual property could be considerable.

On the second point, there is widespread evidence of the positive spillover benefits that are generated by R&D.[30] These occur as other firms in the economy apply the knowledge and innovation generated by this investment to their own products and ways of working. Indeed, making the economy more R&D-intensive is a stated objective of government policy.

[28] The Business Times, 'Seeds Capital, partners to co-invest over S$90m in agri-food tech startups' (January 15, 2019).
[29] The Financial Times, 'Singapore grans world's first approval to lab-grown meat' (December 2, 2020).
[30] Badinger, Harald, and Peter Egger. Intra-and inter-industry productivity spillovers in OECD manufacturing: A spatial econometric perspective. No. 2181. CESifo working paper, 2008.

In theory, the strength of spillover benefits should depend on the 'distance' between sectors which is related to the similarity of the production process and applied technology. In this context, the case for cultivated meat would appear promising given the potential of the UK's wider agri-tech industry that has long been cited by the Department for International Trade (DIT) as a sector with strong export prospects. Moreover, other businesses in the value chain—processors, wholesalers, and retailers—could also benefit from being able to transfer their learnings from the UK market to international markets when regulatory approval is subsequently granted. This has the potential to help reverse the UK's deficit in meat trade and turn the country into a net exporter.

We have not attempted to formally quantify the benefits associated with first-mover advantage. However, the existence of these effects provides a strong additional economic rationale to support the development of the cultivated meat industry and implies that the projected economic footprint results presented in chapter two simply scratch the surface.

4. SOCIAL AND ENVIRONMENTAL BENEFITS FROM CULTIVATED MEAT

As well as the economic benefits there is a wider set of arguments for why cultivated meat production can contribute positively for UK society. These include tackling climate change by reducing harmful emissions, delivering health benefits to consumers, improving national food security, and reducing instances of mistreatment of animals. In this section, we explain these in turn.

4.1 THE ENVIRONMENT

The size of the global meat production industry and the agricultural output needed to support it, as set out in the Introduction, inevitably has huge implications for the environment. Food production is *currently* among the biggest human environmental impacting activities. Animal agriculture accounts for nearly 15% of all greenhouse gas emissions, with emissions estimated at 7.1 gigatonnes of CO_2-equivalent a year, according to the United Nations Food and Agriculture Organization (FAO).[31]

Cattle—raised for both beef and milk, as well as for inedible outputs like manure and draft power— are the animal species responsible for the most emissions, representing about 65% of the livestock sector's emissions. Looking at all activities and all species, the consumption of fossil fuel along supply chains accounts for about 20% of the livestock sector's emissions. Meanwhile, in most regions of the world, more than 70% of available freshwater is used for agriculture.

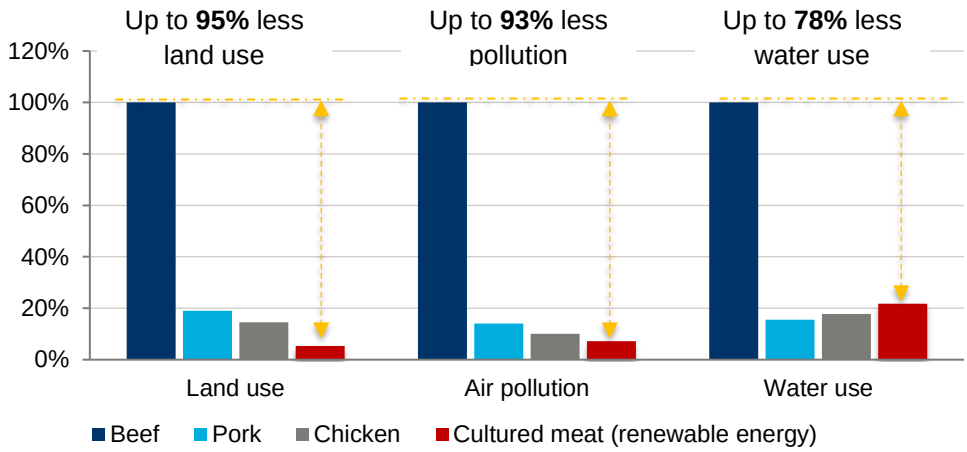
Finding ways to reduce the environmental footprint of conventional farming will, therefore, be high on the agenda for the 190 heads of state and government in Glasgow in November at the 26th Conference of the Parties (COP26) to reach agreements on how to tackle climate change. Research has indicated that there is a potential gain in terms of overall emissions from replacing traditional meat production with cultivated meat.

A life-cycle assessment by consultancy CE Delft also found that cultivated meat produced using renewable energy reduced land use by 63%, 72% and 95% compared to conventional chicken, pork, and beef, respectively. Cultivated meat was also found to be less polluting than conventional meat production. When produced using renewable energy, cultivated meat led to up to 93% less particulate matter formation (air pollution). Cultivated meat also required 78% less water than beef, but slightly more than chicken or pork.[32]

[31] Food and Agriculture Organization. Tackling climate change through livestock. (Rome. 2013)

[32] CE Delft. LCA of cultivated meat: future projections for different scenarios (2021)

Fig. 17. Land use, air pollution and blue water use



Source: CE Delft, recreated by Oxford Economics

There are additional benefits that can be realised. Cultivated meat may also reduce transportation and refrigeration costs, and possibly also waste products, because it is expected that cultivated meat should have a longer shelf life than conventional meat. Cultivated meat production also does not raise issues of carcass waste management.[33]

While the figures above are compelling, the significant advantage that cultivated meat has in terms of helping countries such as the UK meet their climate targets, is that it does not involve a sacrifice by consumers. While one response to concerns about the environmental impact of meat production would be to give up meat, so far, the response has been meagre. An official survey in the UK found that 2% of both adults and children reported that they were vegetarian while fewer than 1% of participants reported following a vegan diet.[34][35]

What cultivated meat offers is a technological solution which will help populations to decarbonise without having to make sacrifices or trade-offs in the way of life or pay the transition cost that seem inevitable in other areas such as, for example, domestic heating and transport.

[33] Treich, Nicholas. Cultured Meat: promises and challenges (Environmental and Resource Economics (2021) 79:33–61)

[34] National Centre for Social research. National Diet and Nutrition Survey. Headline results from Years 1 and 2 (combined) of the Rolling Programme (2008/2009 – 2009/10)

[35] Whilst the aforementioned data are not particularly timely it does represent the most recent estimate from an authoritative source and the *Vegetarian Society* has stated that more recent estimates which point to higher rates of vegetarianism among the UK adult population are not credible. See https://vegsoc.org/info-hub/facts-and-figures/ for more details.

4.2 HEALTH

The theme of the 2021 World Food Safety Day, which was set up by the United Nations in 2018, was "Safe food today for a healthy tomorrow". Its message was that production and consumption of safe food had immediate and long-term benefits for people, the planet, and the economy. The contribution that a good diet can make to human health is of increasing concern to policymakers in the light of the growing impact of conditions such as obesity, cancer, and diabetes.

Research at Harvard University identified no fewer than 24 health advantages of cultivated meats versus its conventional alternative.[36] One group related to the avoidance of contamination during production, as cultivated muscle cells do not have the same opportunity to encounter intestinal pathogens such as E. coli, salmonella, or campylobacter—three pathogens that are responsible for millions of episodes of illness each year.

The decoupling of meat production from slaughter will also eliminate faecal contamination as well as the risk of botulism infection that arise from consuming meat from an animal carcass. Another positive aspect related to the safety of cultivated meat is that it is not produced from animals raised in a confined space, so that the risk of an outbreak is eliminated and there is no need for expensive vaccination programmes against diseases like influenza.

Cultivated meat also avoids the need for antibiotics, whose overuse in agriculture has led to concerns of antimicrobial resistance by humans that will leave people more vulnerable to infections. A report commissioned by the UK government found that it could lead to more than 10 million deaths per year by 2050 and inflict a global cumulative economic toll of $100 trillion by the middle of this century.[37]

Without farming animals for animal products, cellular agriculture can eliminate the risk of zoonotic outbreaks such as swine and avian flu. Cultivated meat also offers the potential to create healthier cellular agriculture products with greater nutritional density such as lower fat and higher protein content by avoiding unsaturated fats.

The EAT-Lancet Commission on Food, Planet, Health found high risks of cardiovascular disease and other outcomes associated with high consumption of red meat. This was probably partly due to multiple food constituents of animal sources of protein. The high ratio of saturated to polyunsaturated fat and high levels of heat-induced carcinogens and haem iron may contribute to higher risks of cardiovascular disease, diabetes, and some cancers in people who eat red meat than in people who eat plant sources of protein.[38]

In 2015, the International Agency for Research on Cancer has stated that the consumption of processed meat was carcinogenic to humans, while red meat was a probable carcinogen to humans although the evidence was limited.

[36] Gasteratos, Kristopher. 90 Reasons to Consider Cellular Agriculture. (Harvard. 2019)

[37] Review on Antimicrobial Resistance, chaired by Jim O'Neill. Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations. May 2016

[38] The EAT-Lancet Commission on Food, Planet, Health. The Lancet 393(10170). (2019).

Here again, cultivated meat offers a good alternative for consumers who want to be more responsible but do not wish to change their diet. Cultivated meat has the potential to replace saturated fats in minced meat with healthier fats such as Omega-3 and Omega-6. Using potentially more nutritious cultivated meat in burgers, sausages and meatballs—popular food choices in the UK—could improve the country's health.

4.3 FOOD SECURITY

Without the development of alternatives, feeding the world's growing human population with increased consumption of livestock products will require a huge expansion in agricultural production. This raises the question of whether governments will be able to guarantee households will have access to sufficient and safe food.

Recent studies have shown that current trends in yield improvement will not be sufficient to meet projected global food demand in 2050 implying that a further expansion of agricultural area will be required.

The UK is far from self-sufficient in food production. The UK is a net importer of pig meat, currently importing around 60% of all the pork it consumes. It imports around 35% of the beef and veal, and around a third of the lamb.[39]

The UK's Agriculture Act 2020 introduces a duty for the Government to report to Parliament on food security in the UK. It also legislates for a major reform of the agricultural subsidies that used to come from the EU's Common Agricultural Policy. Under the new system, farmers will be paid to produce "public goods" such as environmental or animal welfare improvements rather than according to the acreage of land. If cultivated meat were to become a significant part of consumers' diets, that would require less farmland needed for production, which could then be used for other purposes.

Conventional meat farming is potentially vulnerable to a number of threats. Firstly, changing climatic conditions may affect the ability of certain countries and regions to maintain herd animals or to produce the arable drops needed to feed them. For example, too much or too little rain can destroy harvests while natural disasters such as hurricanes and floods can lead to the deaths of animal herds. Following Hurricane Florence in 2018, the North Carolina Department of Agriculture in the US reported the deaths by drowning of 3.4 million chickens and turkeys and 5,500 hogs.

A second threat comes from emerging exotic diseases such as bluetongue and African swine fever that have the potential to devastate livestock industries. One outbreak of African swine flu in China in 2018 triggered a shortage of pork meat and a spoke in prices as the flu—which is deadly to pigs but harmless to humans—led to the death or culling of half the country's livestock.

Third, the food supply can be interrupted by a shock to the supply chain, as was witnessed during the recent coronavirus pandemic. Following the detection of the outbreak of a coronavirus in China in December 2019, policies adopted to contain the spread of the virus led to major disruptions to the food supply

[39] British Meat Processors Association. Meat Industry Brexit Impact Report. Accessed 26 August 2021

chain. Covid-19 delivered a shock to all segments of food supply chains, simultaneously affecting farm production, food processing, transport and logistics, and final demand. The Organisation for Economic Cooperation and Development found that disruptions in processing, in particular for meat, caused a "disconnect" between supply and demand, creating simultaneous surpluses for producers and shortages for consumers.[40]

Political instability can also lead to a rupture in supply chains. The outbreak of war or civil unrest can lead to a fall in exports, as can decisions to impose export embargos to protect domestic supplies. Closer to home, there have been claims that the departure of the UK from the European Union in January 2020 has led to shortages of food products in restaurants and supermarkets due a shortage of foreign labour in the haulage industry. In August 2021 the British Retail Consortium and Logistics UK trade bodies wrote to the Department for Business, Energy and Industrial Strategy. They warned that Brexit and the Covid-19 pandemic had led a shortfall of around 90,000 HGV drivers that was placing unsustainable pressure on retailers and their supply chains.[41] There have also been report of lost sales and increased waste of chilled foods as a result.

4.4 ANIMAL WELFARE

More than 80 billion sentient animals are reared in industrial conditions globally in order to produce meat.[42] Intensive animal farming is associated with a systematic disregard for their welfare. In 2012 the Humane Society International said that the majority of egg-laying hens, pregnant sows, and calves raised for veal are reared in battery cages, gestation crates, and veal crates, respectively.

It said that the intensive confinement of these production systems severely impaired the animals' welfare, as they were unable to exercise, fully extend their limbs, or engage in many important "natural behaviours". It cited extensive scientific evidence that is said showed that intensively confined farm animals were frustrated, distressed, and suffering.[43]

Animal rights campaigners claim that welfare measures are often reduced to an absolute minimum or largely ignored in factory farms. One example is the "broiler chicken", a chicken breed optimised for morbid obesity and rapid maturity. Kept in intensive farming conditions throughout the industrialised world, these birds frequently experience lifelong suffering from their legs collapsing under their own weight and from chronic sickness due to poorly ventilated, overcrowded, and/or tightly confined living conditions.[44]

[40] OECD. Food Supply Chains and COVID-19: Impacts and Policy Lessons. (June 2020)

[41] Logistics UK. Driver shortage crisis: UK business groups demand action. (August 2021)

[42] Ritchie, H. and Roser, M. (2017)/ "Meat and Dairy Production". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/meat-production'

[43] Humane Society International. An HSI Report: The welfare of intensively confined animals in battery cages, gestation crates, and veal crates. (2012).

[44] Effective Altruism Foundation. Cultured Meat: An Ethical Alternative to Industrial Animal Farming. (2016)

While agricultural standards will be much higher in the UK and European Union, there is no guarantee that imported meat, especially stocks that are sold at low prices in supermarkets, will not have been subject to such conditions.

5. CONCLUSIONS

The cultivated meat industry is in its infancy, both in the UK and in most countries around the world. But it clearly presents significant opportunities for entrepreneurs, investors, and other commercial partners to exploit the global potential of a move away from conventional farming towards more sustainable methods. However, the UK industry is currently not able to take advantage of the commercial opportunities while it awaits regulatory approval.

This report has sought to demonstrate that there is a strong economic rationale for allowing UK firms to move from research and development into production. As the report highlights, the UK cultivated meat market has the potential to grow into an industry with a total gross value added contribution to UK GDP of over £2 billion in 2030. The detailed analysis of the value of economic activity generated, the number of highly-skilled jobs created and supported, and the taxation revenue (up to £523 million) generated shows the industry has the potential to become an important sectoral driver of growth during the next decade.

It is harder to estimate the export potential while so few countries have passed enabling legislation, but those countries— and therefore domestic industries— that are among the first to allow cultivated meat to operate are likely to benefit from first-mover advantage. UK firms will be able to leverage their existing market knowledge and networks to further develop their technological know-how in anticipation of the global market opening up. The associated knowledge spill overs could help establish an ecosystem of technologically advanced businesses in the UK who will, therefore, be better placed to attain market share overseas.

The report has also shown how the growth of the cultivated meat sector in the UK would help the government achieve other policy goals. Reducing carbon emissions, supporting food security, reducing our reliance on imported meat, maintaining high levels of animal welfare, and reducing the prevalence of chronic health conditions are all targets to which cultivated meat can contribute.

In the short term, a gradual shift away from conventional farming and towards cultivated meat production could create some disruptions, although we believe these are limited during the first decade. However, the socioeconomic rationale is compelling. As a high-tech innovative sector, cultivated meat has the potential to create new well-paid jobs as well as supporting existing jobs needed for the manufacturer, supply, and distribution of products.

While cultivated meat has the potential to deliver economic and societal benefits to the UK, the footprint in this country will not be that large simply based on the size of the British population. Regulators should therefore look to the global opportunity that would come from the UK being at the forefront of the industry's technical and commercial development. The global market for meat is huge and if cultivated meat can capture even 10% of the estimated $1 trillion annual volume, that clearly presents an immense opportunity.



OXFORD ECONOMICS

Global headquarters
Oxford Economics Ltd
Abbey House
121 St Aldates
Oxford, OX1 1HB
UK
Tel: +44 (0)1865 268900

London
4 Millbank
London, SW1P 3JA
UK
Tel: +44 (0)203 910 8000

Frankfurt
Marienstr. 15
60329 Frankfurt am Main
Germany
Tel: +49 69 96 758 658

New York
5 Hanover Square, 8th Floor
New York, NY 10004
USA
Tel: +1 (646) 786 1879

Singapore
6 Battery Road
#38-05
Singapore 049909
Tel: +65 6850 0110

Europe, Middle East and Africa

Oxford
London
Belfast
Dublin
Frankfurt
Paris
Milan
Stockholm
Cape Town
Dubai

Americas

New York
Philadelphia
Boston
Chicago
Los Angeles
Toronto
Mexico City

Asia Pacific

Singapore
Hong Kong
Tokyo
Sydney
Melbourne

Email:
mailbox@oxfordeconomics.com

Website:
www.oxfordeconomics.com

Further contact details:
www.oxfordeconomics.com/about-us/worldwide-offices