

S Y S T E M I Q

# A TASTE OF TOMORROW

How protein diversification can  
strengthen Germany's economy

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## Report objectives

This report aims to quantify how protein diversification can generate economic growth, future-proof jobs and environmental benefits for Germany. It explores the opportunities presented by alternative proteins while addressing key concerns, such as their effects on livestock farmers and dietary health.

Recognizing the significant role alternative proteins could play in shaping the future food system, Systemiq has previously collaborated with GFI Europe to explore the potential of one alternative protein solution, cultivated meat and seafood, in Europe. Given Germany was found to be among the most promising markets, this report further explores the future of protein diversification in Germany, including the full range of alternative protein solutions.

The analysis evaluates the potential benefits of alternative protein adoption across three scenarios—Business-as-Usual (BAU), Medium Ambition, and High Ambition—and considers how these developments could enhance Germany's economy and food system. For a detailed description of the quantitative methodology, see the Technical Annex.

Finally, the report provides specific policy recommendations Germany should implement to reap the benefits of a growing alternative proteins market. Protein diversification is highly relevant to ongoing political discussions about realising Germany's economic potential in strategic sectors, strengthening the resilience of its food system, and delivering on sustainability and health objectives.

## Novel contributions of this report

This report builds on the foundations of GFI Europe's Alternative Proteins in Germany Report 2023 and their analysis of the German plant-based market, but moves beyond the current state of the industry to provide forward-looking projections. It is the first study to develop a comprehensive quantification of the impacts of alternative proteins for Germany, encompassing economic, environmental, and social dimensions.

The focus is on the economic potential, shaped by Germany's unique circumstances, with concrete policy and investment recommendations backed by quantitative analysis. The report adopts a practical timeframe, examining the potential impacts of alternative proteins between 2030 and 2045, aligned with Germany's net-zero emissions target.

## Sources used for this analysis

The analysis is based on a range of assumptions, gathered from two main types of sources:

- Interviews with ~20 experts from various stakeholder groups in the food and alternative protein sector (e.g. scientists, academics, start-ups, established corporates, investors, NGOs, etc.)
- Scientific studies and industry reports – A comprehensive list of key sources is provided in the Technical Annex, while specific uses are listed in the end notes

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## Citation

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# Contents

- 5** Executive summary
- 9** Protein diversification is a powerful lever to support multiple German policy priorities
- 15** Germany is well positioned for seizing the market opportunity and maintaining European alternative protein leadership
- 21** At current course and speed, progress on protein diversification in Germany falls short of its transformative potential, as barriers remain
- 25** With increasing support, protein diversification benefits for the German economy could be up to ~€65 billion GVA by 2045
- 35** Policymakers play a critical role in providing the enabling environment for protein diversification in Germany and achieving full benefit potential
- 45** Call to action: Germany can lead protein diversification, by driving innovation and investment to meet consumer price and performance expectation
- 46** Technical Annex
- 53** References





# Executive summary

**Germany's food system sits at the nexus of significant challenges and transformative opportunities.** Domestically, economic stagnation, rising food prices, and the urgency of addressing environmental and public health goals highlight the need for a more sustainable and resilient food system. Globally, food systems are strained by growing demand, with livestock production disproportionately responsible for 15-20% of global greenhouse gas emissions<sup>1,2</sup>. Alternative proteins present a compelling solution, offering sustainable food options, boosting Germany's economic competitiveness through innovation-driven export, creating future-proof jobs and new income opportunities for farmers and manufacturing industries, while strengthening domestic food security.

**Alternative proteins replicate the taste and texture of animal-based foods through technologies such as plant-based foods, biomass and precision fermentation, and cultivated meat and seafood.** These foods align with consumer preferences, offering health and environmental benefits while enabling dietary shifts at the scale and pace needed to meet climate and biodiversity goals. As Europe approaches 'peak meat' by 2030, Germany has a significant opportunity to tap into the global market, which is projected to grow to €70–280 billion by that year<sup>3</sup>.

**This report provides projections of the economic, environmental, and social impacts of alternative proteins in Germany under three scenarios: Business-as-Usual, Medium Ambition, and High Ambition, by 2030, 2035, 2040, and 2045.** It outlines key strengths, existing challenges, and actionable policy recommendations to unlock the sector's transformative potential while advancing national priorities.

**Germany, Europe's largest plant-based protein market (~€2.2 billion in retail sales in 2023<sup>4</sup>), is uniquely positioned to lead Europe in scaling alternative proteins.** Established German meat and dairy companies are successfully diversifying into alternative proteins, leveraging their expertise to drive innovative solutions. Germany boasts advanced research infrastructure and robust industrial capabilities that provide a solid foundation for growth. In 2024, the country's dynamic alternative protein ecosystem has already grown to include over 100 diverse companies, with farmers beginning to integrate into these





Image: Bluu Seafood

value chains to expand their income streams. The government has laid important groundwork, establishing funding schemes across different federal ministries (e.g. the ‘Chancenprogramm Höfe’<sup>5</sup>, which supports domestic protein production) and founding the Competence Centre Proteins of the Future in 2024<sup>6</sup>.

**Despite these strengths, Germany’s alternative protein market faces significant barriers that risk stifling growth and global competitiveness.** German companies lack support to navigate a stringent and time-intensive process to bring innovative products to market under the EU Novel Foods regulation. Limited cooperation between companies slows innovation, while underinvestment in research, development, and scale-up infrastructure keeps production costs high. For example, Germany’s public R&D investment totalled €55 million from 2020 to 2024—ranking fifth in Europe in absolute terms and seventh in per capita terms<sup>7</sup>. While consumers are open to alternative proteins in international comparison, scepticism about health and nutritional value hinders adoption. Although farmers are integral to diversification, they sometimes face insufficient incentives and support to diversify into alternative protein supply chains.

**Therefore, under a Business-as-Usual scenario, where challenges remain unaddressed, the domestic market is expected to reach ~€8 billion by 2045.** Adoption of novel technologies like precision fermentation and cultivated meat or ingredients would remain limited, constraining the sector’s ability to innovate and causing adoption of plant-based products to plateau. Even under this scenario, the total market opportunity including export, could create roughly 100,000 jobs and add €30 billion in gross value by 2045, however, Germany shifts from leadership in plant-based solutions to lagging global adoption.

**Under a Medium Ambition scenario, with moderate regulatory, policy, and investment support, the domestic market could grow to ~€14 billion by 2045, keeping pace with global trends.** This outlook focuses on expanding plant-based alternatives while selectively advancing technologies such as biomass and precision fermentation. Up to 180,000 jobs could be created by 2045.

**In a High Ambition scenario, significant regulatory and investment support positions Germany as a global leader in protein diversification. The domestic market could grow to ~€23 billion by 2045, equalling ~10% of today’s food and drinks industry revenues<sup>8</sup>.** Export opportunities, particularly related to production infrastructure (e.g. food processing machinery), reach ~€35 billion in total by 2045, with the industry expected to create ~250,000 future-proof jobs by that year. Of these, alternative protein production accounts for



~35,000 jobs, food processing equipment manufacturing ~70,000 jobs, and commodity input production, including by farmers, ~40,000 jobs.

Germany's economic potential includes producing sustainable food to meet the demands of its robust domestic market. However, an even greater opportunity lies in leveraging its expertise in manufacturing machinery, such as extruders, fermenters, and other B2B inputs. As a global leader in mechanical engineering and exports, Germany is uniquely positioned to become a cornerstone of the international alternative protein sector, extending its influence far beyond its borders.

**In addition to direct economic impacts, protein diversification will deliver environmental and nutritional benefits.** Alternative proteins promise to address costly dietary health concerns by providing foods with lower cholesterol and saturated fats, while addressing deficiencies of dietary fibre. Estimates of relative environmental impacts of alternative proteins are at an early stage. Based on best available impact factors and officially reported impacts, we estimate emissions could be reduced by ~4.8 to 8.1 million tons of CO<sub>2</sub>e (equal to taking 1 to 1.8 million cars off the road) under the Medium and High ambition scenarios, respectively. Similarly, land use could be decreased by ~1.2 to 2 million ha (three-quarters the size of Schleswig Holstein or larger than Saxony-Anhalt, respectively). Finally, freshwater use could be lowered ~76-129 million m<sup>3</sup> (equivalent to annual consumption of between 420,000 and 720,000 households).

**Policymakers play a pivotal role in creating an enabling environment for protein diversification, ensuring Germany capitalizes on its potential for economic growth, innovation, and food system resilience.** An overarching action is developing a cohesive National Protein Strategy of the entire federal government to integrate alternative proteins across all relevant ministries. Further, five strategic interventions are required, which align with national policy priorities:

- 1. Government support in the regulatory approval of novel foods:** Providing targeted support to enable corporates to file high-quality applications for novel solutions like precision fermentation and cultivated meat.
- 2. R&D funding:** Significantly increasing R&D funding, from ~€13 million annually today, to ~€140 million annually on average, ramping up from 2025-2045<sup>9</sup>. Of this, ~€20-30 million should be spent to set up an innovation cluster, complemented with matching funding from the private sector, where academia, industry, policy makers and civil society can efficiently co-develop open access research and commercialize solutions for mutual benefits.





Image: Formo

- 3. Infrastructure:** Scaling production to lower costs also demands dedicated public investment and de-risking for infrastructure, including for shared-use facilities and retrofitting existing assets. While the private sector is expected to fund the vast majority of the €1 billion in average annual investment required between 2025 and 2045, the German government should deploy ~€120 million annually to enable this investment, including through low-interest loans, guarantees and similar mechanisms.
- 4. Community catering:** Public authorities hold significant procurement power, presenting a major opportunity to drive the uptake of alternative proteins. Around 16 million meals are served daily in settings such as daycare centers, schools, senior facilities, and public workplace cafeterias<sup>10</sup>. Policymakers should ensure that plant-based meat and other alternative proteins are included in public procurement and promoted attractively. This would provide purchase guarantees for producers and farmers, supporting market growth. Currently, the German Nutrition Society (DGE)'s nutritional guidelines limit the inclusion of plant-based alternatives to a significant extent, a situation that needs to change.
- 5. Incentives for farmers:** Lastly, strengthening the domestic protein supply chain through crop rotation incentives can position farmers as key players in protein diversification while enhancing food security and reducing reliance on imports.

These measures are designed to strongly incentivize both investor and corporate action, positioning Germany to maintain its leadership in the European market while establishing itself as a global forerunner in critical protein diversification. By capitalizing on this opportunity, Germany can unlock substantial domestic economic growth, seize lucrative export prospects, create future-proof jobs, and achieve far-reaching benefits for public health and food system resilience. Failing to act decisively would not only forfeit these opportunities but also risk leaving Germany behind in a transition that is both urgent and widely beneficial.



# 1. Protein diversification is a powerful lever to support multiple German policy priorities

## Germany needs a food system that supports national government priorities

Germany is facing a range of pressing domestic and international challenges, many of which are deeply interconnected with its food system. These include protecting citizens from the current cost-of-living crisis, bolstering economic prosperity, and reclaiming global leadership in innovation on key technologies. At the same time, Germany must deliver on its ambitious environmental commitments while safeguarding farmers' livelihoods. Equally important is the need to secure domestic food production and address pressing public health concerns. A resilient, innovative, and sustainable food system is essential for supporting Germany's broader national priorities.

## The global imperative for a sustainable food system

Globally, food systems are at capacity, with six of nine planetary boundaries—critical thresholds for maintaining Earth's stability and within which humanity can continue to thrive—already exceeded<sup>11</sup>. These boundaries are essential for the proper functioning of ecosystems that underpin economic prosperity.

Food production is both a driver of and highly vulnerable to challenges such as climate change, water stress, and biodiversity loss. Meat and dairy products, in particular, play a disproportionate role. For example, they require extensive land use, with ~40% of tropical deforestation driven by beef production<sup>12</sup>. Livestock supply chains account for ~15-20% of global greenhouse gas emissions, of which



Image: Formo

cattle (beef, dairy) are responsible for about two-thirds, mostly due to methane emissions from the digestive process<sup>13,14</sup>. In comparison, total aviation accounts for only ~2% of global emissions<sup>15</sup>. Under a Business-as-Usual trajectory, meat and dairy consumption is projected to grow globally by at least 20-25% by 2050<sup>16</sup>, exacerbating these challenges.

Transforming the food system is therefore essential to meet rising demand for food and protein while staying within planetary limits. This development hinges on three critical shifts: reducing overconsumption of carbon-intensive foods, especially meat and dairy, adopting sustainable agricultural practices which regenerate soils, and minimising food waste. Together, these actions are key to feeding a growing population, ensuring long-term economic resilience, and safeguarding the health of the planet.

### **Alternative proteins are a powerful lever to support these goals**

In Germany, shielding citizens from rising costs of living is essential. Escalating food prices, driven by factors like inflation and climate change, are placing significant pressure on households. For instance, average food prices in Germany between June 2021 and July 2024 have increased by ~30%<sup>17</sup>. The price of essentials such as butter has surged in 2024 by 40% compared to the previous year<sup>18</sup>, with meat and dairy product costs projected to rise further. Currently, most alternative proteins are still more expensive than their animal counterparts, but in the medium to long term protein diversification can help make sustainable food options more affordable to German consumers. For example, plant-based products are increasingly expected to reach price parity with animal-based products, with the price premium across all categories having dropped from 53% in 2022 to just 16% in 2024<sup>19</sup>. If prices continue to

drop at this rate, alternative proteins will be a viable option for households facing growing financial pressure.

Additionally, Germany's economic prosperity hinges on its ability to foster growth and innovation. With projected GDP growth at a mere 0.1-0.2% in 2024<sup>20</sup>, the country must strategically strengthen existing and emerging industries to create new value pools and revitalize economic momentum. At the same time, regaining its global leadership in innovation is critical, as Germany's export-driven growth model is sputtering amidst trade and competitiveness pressures<sup>21</sup>. Germany can build on its strengths in advanced manufacturing, biotechnology, and research to excel in the alternative protein market and drive innovation in this sector. With plant-based retail sales reaching €2.2 billion in Germany in 2023 and a five-year average growth rate of 17%<sup>22</sup>, this rapidly evolving market offers new value pools and the potential to create future-proof jobs.

Germany's ambitious public commitments—such as achieving net-zero emissions by 2045 and implementing the 2030 National Biodiversity Strategy—depend on a sustainable food system. Meeting these goals will require optimising land use and improving agricultural practices, to also align with Europe's carbon neutrality and nature preservation objectives. The production of alternative proteins requires significantly less land and water, and produces lower greenhouse gas emissions than conventional agriculture. As livestock farming accounts for ~55% of Germany's agricultural land use<sup>23</sup> and ~5% of its total emissions (~70% of agricultural emissions)<sup>24</sup>, these foods can be critical to reducing environmental impacts and achieving national sustainability targets.

Ensuring good livelihoods for German farmers and vibrant rural areas is likewise essential.



Over the past decade, the number of pork farms, for example, has declined by 40%<sup>25</sup>. Domestic demand for meat and dairy is decreasing steadily, and though this is partially offset by exports, per capita meat consumption dropped by 16% from 2014 to 2023 (from 62 kg to 52 kg)<sup>26</sup> and dairy consumption fell by 11% (from 93 kg to 83 kg) during the same period<sup>27</sup>. Economically, farm workers are in a precarious position, earning an average of only €20,000 annually—half of the national average salary—and working an average of 47 hours weekly, considerably higher than the 40-hour average across the broader economy<sup>28</sup>.

However, protein diversification offers new opportunities for farmers – they can grow local crops for plant-based foods and earn new sources of income by providing under-utilized byproducts needed for alternative protein production. This would also reduce reliance on imported feed crops and strengthen farmer’s roles in domestic supply chains. Livestock farmers can partner with alternative protein producers to reduce their environmental footprint and align with evolving consumer preferences. For instance, in addition to cultivating legumes for plant-based protein, farmers could diversify their income by collaborating with manufacturers to develop blended products<sup>29</sup>.

Strengthening the robustness of domestic food production is critical in the face of climate

change. Declining water availability on German farmland, with plant-available water dropping from 70% in 2015 to 55% in 2018<sup>30</sup>, highlights vulnerabilities that could lead to significant yield declines. A survey found that 75% of farmers globally are already impacted by climate change or worried about its consequences, of which 71% report reduced yields as a major concern<sup>31</sup>.

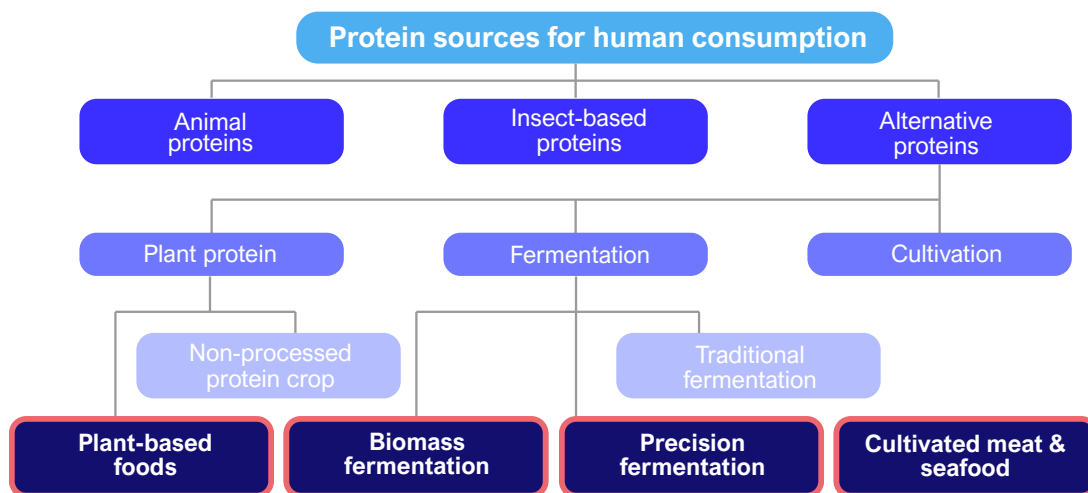
Integrating alternative protein production into the agricultural system offers a pathway to greater stability. For example, transitioning away from conventional livestock feed towards regional legumes could significantly reduce Germany’s reliance on non-EU feed imports, mitigating the risk of supply chain shocks and enhancing local food security. Additionally, a shift towards plant-based, cultivated and fermentation-made food could enable farmland to be used for carbon storage, expanded to regenerative agriculture or to restore nature, contributing to a more sustainable agricultural landscape<sup>32</sup>.

Diet-related public health issues are a growing challenge in Germany. With 50% of the population affected by overweight or obesity, the nation incurs significant healthcare costs, including €57 billion annually for cardiovascular diseases alone<sup>33</sup>. Innovations in alternative proteins may offer substantial public health benefits, as these products can be made

without cholesterol, antibiotics, or excessive saturated fats, providing healthier alternatives to conventional processed meat and seafood. Expanding access to nutritious, sustainable food options could help alleviate rising health concerns and reduce the associated economic burden.

Alternative proteins are foods that aim to provide the same taste, texture, and nutrition as animal meat, seafood, dairy and egg products. There are four types of alternative proteins analysed in this study, each offering unique solutions and target applications (see figures 1 and 2):

**Figure 1:** The four main types of alternative proteins covered in this analysis



**Figure 2:** Overview of alternative protein types



**Plant-based foods (PB)**

- Foods derive **proteins from crops such as soy, peas, or beans**
- Processed and structured to **mimic texture, flavor, and nutritional profile** of animal-based products
- Plant-based foods are the **only AP-solutions available on markets** at scale today
- **Example:** plant-based steak based on pea protein



**Biomass fermentation (BF)**

- Process utilizes **fast-replicating natural microorganisms**, such as 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
- **Example:** mycoprotein meatballs



**Precision fermentation (PF)**

- Microorganisms such as yeast or bacteria **produce specific target molecules**, such as casein or whey, which **occur in meat and dairy**
- Proteins are **often indistinguishable** from their animal-derived counterparts
- **PF-made foods are used as ingredients** and offer the potential to drastically improve the performance of AP products
- **Example:** PF-made egg white proteins used in bakery items



**Cultivated meat and seafood (CM)**

- **Real animal cells** are cultivated under controlled conditions to **replicate the growth of muscle, fat, or other meat and dairy tissue**
- Technology aims to deliver the sensory and nutritional properties of conventional meat and seafood, mostly combined with other AP
- **Examples:** sausages with cultivated beef or fish fingers with cultivated trout



In addition, there are hybrid and blended products that combine different approaches to meet consumer preferences and enhance functionality.

**Hybrid products** integrate components from various alternative protein sources to optimise taste, texture, and nutritional value. For example, a plant-based burger can be enriched with heme from precision fermentation, an ingredient that mimics the aroma of meat by replicating the iron-containing compound found in animal tissue.

**Blended products**, on the other hand, combine alternative proteins with conventional animal-based ingredients. For instance, minced beef may consist of 60% beef and 40% plant-based pea protein, such as launched by LIDL in the Netherlands<sup>34</sup>. These blended options provide a timely solution for consumers seeking to eat more varied or sustainable diets without entirely forgoing animal products.

## Alternative proteins are a massive global economic opportunity

Estimates of the global market size vary widely and depend on a whole range of influencing factors. According to available studies, the global market for alternative proteins is projected to grow from its current size of around €20-30 billion to an estimated €70-280 billion by 2030. While this remains much smaller than the conventional protein market, valued at ~€1 trillion today and expected to reach ~€1.2 trillion by 2030<sup>35</sup>, alternative proteins' growth trajectory is strong. By 2035, alternative proteins could account for 11–22% of global meat, dairy and seafood consumption, according to BCG, with production volumes increasing from ~13 million tons today to ~65 million tons by 2030<sup>36</sup>.

Recognition of the sectors' potential has surged in recent years, reflected in growing public and private sector investments. In 2024, Europe accounted for around half of global private investment in alternative proteins. Worldwide, private venture capital (VC) investments in the sector have recently declined in line with the general market trend, but European investments have not been affected to the same extent. Alongside VC investments, many established companies from the food industry have invested and evolved from meat or dairy companies into diversified protein companies.

## Alternative proteins are essential to accelerating dietary change

One critique of alternative proteins within protein diversification is that instead, people should be encouraged to eat more plant-based whole food protein sources, such as unprocessed chickpeas. While these are both healthy and environmentally beneficial, they are unlikely to achieve the scale or speed of dietary change required to address the pressing climate and biodiversity crises.

By closely replicating the taste and texture of animal-based foods, alternative proteins therefore play a unique and essential role – supplying qualities that consumers will continue to strongly desire. As diets are extremely personal and deeply rooted in culture and habits, alternative proteins can appeal to individuals conscious of the need to reduce animal-based food consumption while not wanting to change current behaviour fundamentally, thus targeting consumers beyond just vegetarians or vegans. The real opportunity for alternative proteins lies not in these small groups of vegetarians or vegans, but in the much larger groups of flexitarians and omnivores.

In other words, these foods provide a seamless way for people to shift their diets without having to make wide changes to ingrained eating habits. For example, switching from a beef burger to a plant-based or cultivated burger is a convenient and much lower barrier to entry than expecting people to overhaul their diets or cook more plant-based meals from scratch. By focusing on a broad

market and offering like-for-like replacements that align with consumers' preferences, plant-based, fermentation-made and cultivated foods provide a pragmatic and scalable solution to driving meaningful change in our food systems and supporting national economic targets (see also Section 4 on public health impacts).



## 2. Germany is well positioned for seizing the market opportunity and maintaining European alternative protein leadership

### Europe's market potential for protein diversification

Europe holds significant market potential for alternative proteins. European countries are well positioned to capitalize on this growing sector by producing plant-based and other alternative protein products for local consumption, exporting premium alternative protein foods, and producing the specialized processing machinery to scale production. Today, the region's strong ecosystem of innovative food companies provides a solid foundation for growth.

Timing is critical as Europe approaches "peak meat", which is anticipated between 2025 and 2030<sup>37</sup>. This juncture presents an opportunity for European countries to accelerate the adoption of alternative proteins and strengthen their market position. However, Europe is in strong competition with other regions, and within Europe, Germany is also subject to fierce competition. In 2023, private investment in German alternative protein companies accounted for just 3.5% of all investment in the European alternative protein sector. Although this changed in 2024, where around a quarter of the total European private investment went into German companies, this was largely concentrated in bigger funding rounds for a few companies (e.g. Infinite Roots, Formo, ProteinDistillery), while new market entrants struggled to attract private capital<sup>38</sup>. Without increased private and public investment and political support, Europe and Germany risk falling behind.

Germany is currently a leader in the development of plant-based food value chains in Europe, which is supported by several key factors listed below. However, in terms of novel foods such as precision fermentation and cultivated meat, Germany lags behind its potential and behind other European countries. Therefore, it risks losing its leading position, if insufficient strategic enabling policies are put in place (further elaborated on in Section 3 on challenges, and in Section 5 on policy recommendations).

### 1. German consumers are choosing alternative proteins

German consumers demonstrate a strong inclination towards alternative proteins, supporting the country's position as the largest plant-based market in Europe. In 2023, plant-based product retail sales reached €2.2 billion, marking an 8% growth from 2022 and a 21% increase compared to 2021. Globally, 2023 retail sales were ~€28 billion, of which the U.S. comprised ~€7.7 billion<sup>39</sup>, showing that while the U.S. is the largest global market, per capita consumption is comparatively higher in Germany. Plant-based meat and milk currently dominate the market, with plant-based milk accounting for approximately 10% of total milk market sales in Germany, and meat and seafood alternatives representing roughly 2% of meat market sales. Growth was driven by increased consumer demand and by plant-based options becoming more affordable<sup>40</sup>.

German consumers are notably more open to alternative proteins compared to neighboring countries such as France<sup>41</sup>. In 2023, over 35% of German households purchased plant-based products, and among these, 70–75% went on to repurchase, indicating strong consumer satisfaction and repeat demand<sup>42</sup>. Only 20% of the German population consume animal-derived meat and dairy daily, while around half aim to reduce their meat intake. Looking ahead, 45–60% of Germans are willing to try precision fermentation-made dairy and eggs, and purchase cultivated meat if available<sup>43,44,45</sup>. This openness reflects the nations' broader health and ethical concerns, with animal welfare, nutritional risks, and food safety ranking as top motivators for adopting alternative proteins<sup>46,47</sup>.

German retailers are actively responding to this demand by expanding their alternative protein offerings and by investing in the space. For instance, LIDL has set a goal for plant-based proteins to comprise 20% of its total protein sales by 2030 in Germany, aligning with global sustainability targets such as the EAT-Lancet Planetary Health Diet. Additionally, initiatives like pricing parity between plant-based and conventional products—such as LIDL's move to equalise prices for its plant-based private label products—have boosted sales of these products by 30%<sup>48,49</sup>. Innovations like the introduction of fermentation-made foods, such as Formo's "micro-fermented" cheese by retailer REWE, further diversify the options available to consumers, demonstrating a strong retailer commitment to protein diversification.



Image: Infinite Roots



## 2. Germany has a forward-looking conventional meat, dairy & agriculture sector

Germany's conventional meat, dairy and agricultural industries are actively investing to align with protein diversification needs, leveraging their expertise and resources to develop novel solutions. Most established players in the meat production and processing sector are now diversifying their portfolios to include plant-based brands and position themselves as broader protein companies. The prevalence of family-owned and 'Mittelstand' firms in Germany may also prove advantageous to this new industry. These companies, focused on long-term strategies rather than the quarterly cycles of publicly traded firms, are well-positioned to invest in and support the development of alternative proteins.

For example, Rügenwalder Mühle introduced plant-based products in 2014. Since 2022, the majority of the company's revenue comes from plant-based alternatives (~60% of total revenue in 2024)<sup>50</sup>. Similarly, PHW Group, InFamily Foods and Hochland have made strategic investments in plant-based, precision fermentation and cultivated meat - for example, by establishing new divisions or investing in domestic and foreign start-ups. Tönnies, which has maximised efficiency in conventional meat production, is also exploring opportunities in alternative proteins to maintain growth. Although profitability from some alternative protein investments may take multiple years, these efforts indicate the sector's long-term vision and commitment to diversifying revenue streams.

The German agricultural sector is also well-suited to play a key role in protein diversification. With arable land ideal for cultivating legumes, such as peas, Germany can be a main European producer for required

ingredients for alternative proteins<sup>51</sup> (see more opportunities for farmers in Section 4 below).

## 3. Germany has a vibrant alternative protein ecosystem & innovation scene

Germany boasts a dynamic and rapidly growing alternative protein ecosystem, with over 100 companies actively working on alternative protein solutions. This ecosystem encompasses start-ups driving innovation and established industry actors leveraging their expertise and infrastructure. Leading-edge German players span all alternative protein categories, with companies like Formo, Infinite Roots, Bluu Seafood and Project Eaden positioned as pioneers. Many additional start-ups are on the verge of market entry or already launching protein products domestically and internationally<sup>52</sup>.

The German alternative protein ecosystem is characterised by its complete value chain, encompassing biotechnology and strain development, machinery and equipment manufacturing, food ingredient production, fermentation innovation, and end-product marketing. This robust distribution of expertise enables cooperation across the ecosystem, including for example production with contract manufacturing organisations (CMOs), and strategic mergers and acquisitions. Additionally, there is increasing cross-sector collaboration to reuse assets for alternative protein production. For example, Nosh.bio, a Berlin-based biomass fermentation start-up, shares facilities with breweries, supported by public funding<sup>53</sup>. Similarly, Infinite Roots is cooperating with Bitburger to use the beer industry's side streams and fermentation capacity<sup>54</sup>.

Between January 2023 and November 2024, €158 million in private investment were invested in German companies for

alternative proteins, more than in the previous ten years combined. In addition to venture capital investments, there were also strategic investments by corporates<sup>55</sup>. For example, Munich-based BayWa has invested in multiple plant-based companies, including German companies Greenforce and Neggst<sup>56</sup>. This reflects readiness to drive innovation in the alternative protein space and recognition of the market's potential.

#### 4. Germany generates high quality research

Germany's research ecosystem forms a cornerstone of its innovation capabilities, supported by over 400 higher education institutions, including around 110 universities and more than 200 universities of applied sciences. These institutions foster talent across diverse academic disciplines, enabling the country to build expertise in emerging fields such as alternative proteins. Initiatives like cultivated meat research at Hochschule Reutlingen and the world's first Professorship for Cellular Agriculture (working on fermentation-derived proteins and cultivated meat applications) at the Technical University of Munich, among others, highlight a growing academic focus on protein diversification.

Between 2019 and 2023, over 280 researchers from German institutions contributed to publications on plant-based, fermentation-derived, and cultivated meat proteins<sup>57</sup>. Beyond universities, specialized research institutes such as the Fraunhofer Society and Deutsches Institut für Lebensmitteltechnik (German Institute for Food Research) play a critical role in bridging academic research and practical applications, collaborating closely with corporates and start-ups to advance alternative protein products.

Germany's research and development (R&D) landscape is among the strongest globally. In 2022, total R&D spending

reached approximately €121 billion, with 67% of investments driven by the private sector<sup>58</sup>. Around 785,000 full-time equivalent (FTE) R&D professionals contribute to this ecosystem, creating a highly skilled talent pool that fuels scientific and technological advancements.

Germany also hosts unique research infrastructure, such as the Leibniz Institute DSMZ (German Collection of Microorganisms and Cell Cultures), a global leader in biological resources. With one of the largest collections of microorganisms and cell cultures worldwide, it provides essential support for advancements in fermentation and cultivation technologies.

Public and non-profit funders are increasingly recognizing the need for action. In 2023, at least €24 million was allocated to fund alternative protein research<sup>59</sup>, underlining growing support for innovation in this field.

#### 5. Germany is a leading biotech nation with strong manufacturing capabilities

Germany is a global leader in biotechnology and advanced manufacturing. As the world's second-largest medical biotech nation after the United States, Germany is home to the largest number of biotech companies in Europe and has the continent's largest pharmaceutical market. It has led the world in innovation, from aspirin in the 1890s to the first U.S.-approved mRNA-based COVID-19 vaccine in 2020<sup>60</sup>. In 2023, the German pharmaceutical industry generated revenues of approximately €60 billion and was a leading exporter of medicinal products<sup>61</sup>.

Established manufacturing players in Germany are now entering alternative protein B2B supply chains, contributing their technical expertise and infrastructure to support production. Companies such as Handtmann



and Planteneers lead in plant-based manufacturing innovations, while firms like Merck, GEA, Eppendorf and Wacker Biosolutions provide cutting-edge technology, machinery and infrastructure for fermentation and cultivation. These companies bring advanced manufacturing capabilities and efficiency to the already vibrant alternative proteins ecosystem, supporting innovation and commercialisation.

## 6. German government started to support protein diversification

The German government has shown initial support for the development of alternative proteins and protein diversification. Between 2020 and the first quarter of 2024, the government invested approximately €55 million in alternative proteins R&D across several federal ministries—more than some other European countries, such as France<sup>62</sup>.

Germany also launched a protein crop strategy in 2012, which has been further emphasised under recent governments. The 2021 coalition agreement between the Social

Democrats, the Green Party, and the Liberals committed to strengthening plant-based alternatives and advocating for the approval of innovative alternative proteins products, within the EU regulatory framework. This has been implemented, for example, through the establishment of a Competence Centre ‘Proteins of the Future’, based at the Federal Office for Food and Agriculture (BLE) in autumn 2024.

In addition, there are individual funding measures such as the “Chancenprogramm Höfe”, which aims to support livestock farms in their transition to alternative proteins, as well as a call for research as part of the innovation funding of the Federal Ministry of Food and Agriculture (BMEL) and the funding of the “NewFoodSystems” innovation room by the Federal Ministry of Education and Research (BMBF). However, these are rather limited in scope. In a report published in 2023, the Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI) found that Germany’s funding measures have so far been moderate at best and are not sufficiently coordinated<sup>63</sup>.



## Germany's potential

In summary, Germany's health- and sustainability-conscious population, active participation by retailers and the private sector, robust supply chain infrastructure, world-class manufacturing capabilities, and strong innovation ecosystem provide a solid foundation for accelerating the development and scaling of sustainable protein solutions. Despite political and economic uncertainties and some backlash against the green transition, Germany remains committed to driving green economic growth. Shared priorities across political parties, such as fostering innovation, reducing market uncertainty, and improving resilience while meeting environmental targets, continue to resonate with a significant portion of the electorate.

However, Germany risks losing its leadership position in the European alternative protein sector. In terms of private VC investments, Germany underperformed significantly in

Europe in 2022 and 2023, but performed strongly again in 2024. Still, Germany is at risk of being left behind regarding novel food categories such as cultivated meat and precision fermentation, as the number of start-ups active in these areas is smaller and public investment significantly lower than in countries like the Netherlands or the UK, for example.

To maintain its leadership and competitiveness nationally, regionally, and globally, Germany must address current domestic barriers. The incoming German government has a crucial opportunity to implement wider and more strategic enabling policies. Without decisive action, Germany risks falling behind in alternative protein adoption and missing the transformative potential these solutions offer for its economy, food system, and sustainability goals. The next section outlines the key challenges to overcome, with specific policy recommendations provided in Section 5.



Foto: Planted

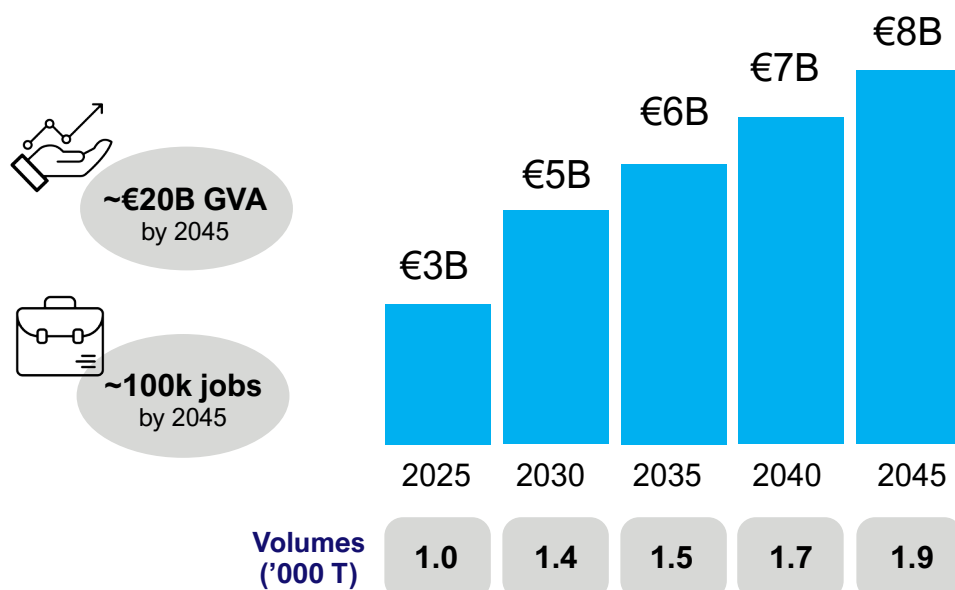


### 3. At current course and speed, progress on protein diversification in Germany falls short of its transformative potential, as barriers remain

The adoption of novel alternative protein technologies is expected to remain slow in a Business-as-Usual scenario, limiting advancements and causing plant-based products to stagnate as they approach their current performance ceiling. Emerging technologies, such as precision fermentation and cultivated foods and ingredients, are essential for driving the next growth phase beyond 2030 by significantly enhancing the performance and appeal of alternative proteins. In a regulatory environment that severely constrains these products, investment and innovation risks migrating elsewhere. In addition, while Germany has a good foundation in intellectual property developed by start-ups, there is a pressing need for smarter collaboration to collectively strengthen the sector and enhance its global competitiveness.

Our analysis projects that, without policy intervention, Germany's alternative protein market could reach only €5 billion by 2030, €6 billion by 2035, and €8 billion by 2045, significantly lagging behind estimated global growth rates<sup>64</sup>. Growth in plant-based foods would remain relatively healthy to 2030 at 9.7% per year. This is a slowdown compared to the rate over the past five years of around 17%, but a recovery over the 8% seen in 2022-23. However, as plant-based products reach their performance potential, growth would plateau with annual growth rates to 2045 expected to fall to 4.3%. Such stagnation would erode Germany's market share and hinder its ability to compete globally. This shows that the market remains fragile, with its trajectory and growth potential heavily dependent on addressing the following critical challenges.

**Figure 3:** German alternative protein market outlook under Business-as-Usual scenario



Source: Systemiq analysis based on German industry expert interviews, external sources & GfI Europe, 2024: "Germany plant-based food retail market insights" based on Circana sales data.

## 1. Policy is not sufficiently supportive and regulatory approval is challenging

Europe's broader regulatory environment poses some challenges, with approvals for alternative proteins products lagging behind regions like Singapore, Israel, and the United States<sup>65</sup>. These factors have pushed some companies to establish operations outside Europe in more favourable markets such as the United States. These regions offer greater regulatory predictability and market security, enabling faster commercialisation. In Germany specifically, despite initial political willingness to support plant-based solutions, the advancement of novel alternative proteins has been slow<sup>66</sup>.

Under the EU's gold standard 'Novel Foods' framework, food innovations undergo a rigorous, evidence-based assessment to ensure their safety and nutritional quality before they can be marketed in any of the 27 member states. This precautionary principle is valuable, as it strengthens consumer confidence and has demonstrated, in numerous cases, the ability to balance food safety with innovation. However, in practice, regulatory approvals are sometimes lengthy, with approval timelines for products such as precision fermentation and cultivated meat extending up to four years—far exceeding the intended 18-month timeframe. A major bottleneck is the lack of support for submitting high-quality applications, with German companies often providing substandard dossiers that contribute to these delays.

Additionally, there is a lack of upfront clarity on whether a product falls under novel food regulation in the first place, creating uncertainty for producers. While the approval process for novel foods is at EU level, the process of checking whether a product is a novel food at all is at national level and is being

enforced by German authorities. For instance, some biomass fermentation applications face complicated consultation processes on the national level. These points, combined with limited concrete public positioning on alternative proteins by the government, are hindering the sector's progress.

Some German companies are already starting to position themselves to compete on the global stage, beyond European markets. Without strategic regulatory support, Germany risks not being the country of choice for building these industries.

## 2. Limited value chain cooperation hindering innovation progress

The German alternative protein sector is highly competitive, with numerous start-ups working in parallel on similar challenges. This often results in limited cooperation, as many seek to protect intellectual property while racing to achieve price parity and bring products to market. This siloed approach leads to inefficiencies in knowledge sharing and slows the progress of innovation. For instance, the speed of achieving breakthroughs in optimized protein extraction or reduced complexity of additives, due to limited value chain integration is holding back the sector's potential.

Insufficient R&D funding is another key barrier. Despite being the largest economy in Europe, Germany ranks only fifth in total public R&D spending on alternative proteins across the EU, with €55 million allocated between 2020 and April 2024. The majority of this funding has been directed toward plant-based proteins, while other innovative solutions, such as precision fermentation and cultivated meat, were largely neglected<sup>67</sup>. Start-ups, particularly in advanced alternative protein technologies, often struggle to access sufficient R&D capital to trial go-to-market volumes.

### 3. Insufficient investment for production at scale

Germany's alternative protein sector also faces challenges in scaling production due to insufficient investment in large-scale infrastructure and later-stage development. While early-stage funding (for technologies below technological readiness level 5, meaning validated but not yet fully operational) has generally been available, there is a critical gap in financing for scale-up<sup>68</sup>, particularly for production capacity in precision fermentation and cultivated meat and seafood solutions. This lack of infrastructure and investment is preventing the industry from transitioning from expensive, ultrapure pharmaceutical-grade production equipment to cost-effective, food-grade alternatives, a shift necessary to achieve competitive pricing and wider adoption.

High production costs therefore remain a key barrier to scaling. Germany's higher labour and energy costs compared to other EU regions, such as Poland or Spain, further exacerbate the issue, making it harder to compete on price. Achieving price parity—or even falling below conventional meat and dairy prices—will be essential to attracting food manufacturers and cost-sensitive consumers.

Market competition has intensified, with private-label brands entering the space and shelf-space limitations driving the need for differentiation. Many businesses are struggling to either innovate enough to stand out or achieve the scale required to reduce costs. Without significant funding for large-scale infrastructure and advanced production, the market risks stagnation.

### 4. Consumer scepticism and perceived health concerns

Despite the generally supportive consumer outlook, some perceptions remain barriers to the widespread adoption of alternative proteins. For these solutions to succeed in the mass-market, they must match or exceed conventional products not only in price, but also in taste, texture, and nutritional value.

While plant-based milk is already nearing price parity with cow's milk in Germany (just 3% more expensive per kilogram in 2023, with some products, like plant-based cream, already cheaper)<sup>69</sup>, other categories, such as plant-based meat, must reduce costs to compete with animal proteins in the future. Moreover, alternative protein products must deliver additional advantages over conventional proteins to build trust and drive consumer adoption in the German market.

Taste remains a key driver of consumer choice. For example, German cheese consumers place significant importance on flavour<sup>70</sup>, which most plant-based proteins have not yet managed to meet. Health and nutritional value are equally pivotal, with a GFI Europe and Accenture study showing that 41% of consumers, including those in Germany, cited health benefits as a top reason for their willingness to try precision fermentation dairy<sup>71</sup>. Despite this, concerns persist about a perceived lack of "naturalness" and the so-called "ultra-processing" of some alternative protein products (see Section 4 on public health impacts).

Another challenge is the lack of awareness and understanding of alternative proteins. Many products remain largely unknown to the public; for example, a German study found that 80% of respondents were unfamiliar



with precision fermentation for food manufacturing<sup>72</sup>. This unfamiliarity, combined with scepticism around health, can hinder wider consumer acceptance—particularly in Germany, where transparency and trust are crucial.

## 5. Fear of loss of farmers' livelihoods

The alternative proteins sector faces push-back due to its limited engagement with farmers in its early development stages, resulting in low buy-in from the agricultural community. A widespread perception across society persists that the growth of alternative proteins will lead to income losses for German farmers<sup>73</sup>, further compounding resistance. Some meat and dairy industry players and farmers remain hesitant to embracing protein diversification, fearing direct competition of alternative proteins with their produce and market share. There is limited research and

awareness on how this diversification could affect them or how to mitigate associated risks.

Beyond the German protein crop strategy and the funding scheme “Chancenprogramm Höfe”, which was announced in early 2024, there remain few tangible incentives or resources to support farmers in diversifying towards alternative protein-related opportunities, leaving many concerned about risks to their livelihoods.

Today, there are growing indications that the industry is beginning to acknowledge the need for change, primarily driven by competitive pressures and the potential for profit opportunities in the alternative protein market. However, without clear pathways, resources, and incentives, farmers remain vulnerable to economic disruption, coming from a range of sources. Farmer's benefits from diversification are further explored in the following Section 4.





## 4. With increasing support, protein diversification benefits for the German economy could be up to ~€65 billion GVA by 2045, roughly 8% of manufacturing sector GVA today<sup>75</sup>

Depending on the level of support, the German alternative proteins market could stagnate, or thrive to reap its full potential.

In this analysis, Systemiq modelled three scenarios:

- 1. Business-as-Usual scenario**, with a good head-start, but missing pieces in an enabling regulatory environment, cooperation, investment and awareness, as described in Section 3 above.
- 2. Medium Ambition scenario**, with increasing regulatory, policy and investment support, focusing on embracing plant-based alternatives while selectively advancing technologies such as biomass and precision fermentation, enabling steady market growth.
- 3. High Ambition scenario**, where there is significant regulatory and investment support, to create an enabling environment, positioning Germany as a global leader in protein diversification.

In other words, the future of Germany's alternative protein market depends heavily on the level of policy support, regulation, and investment.

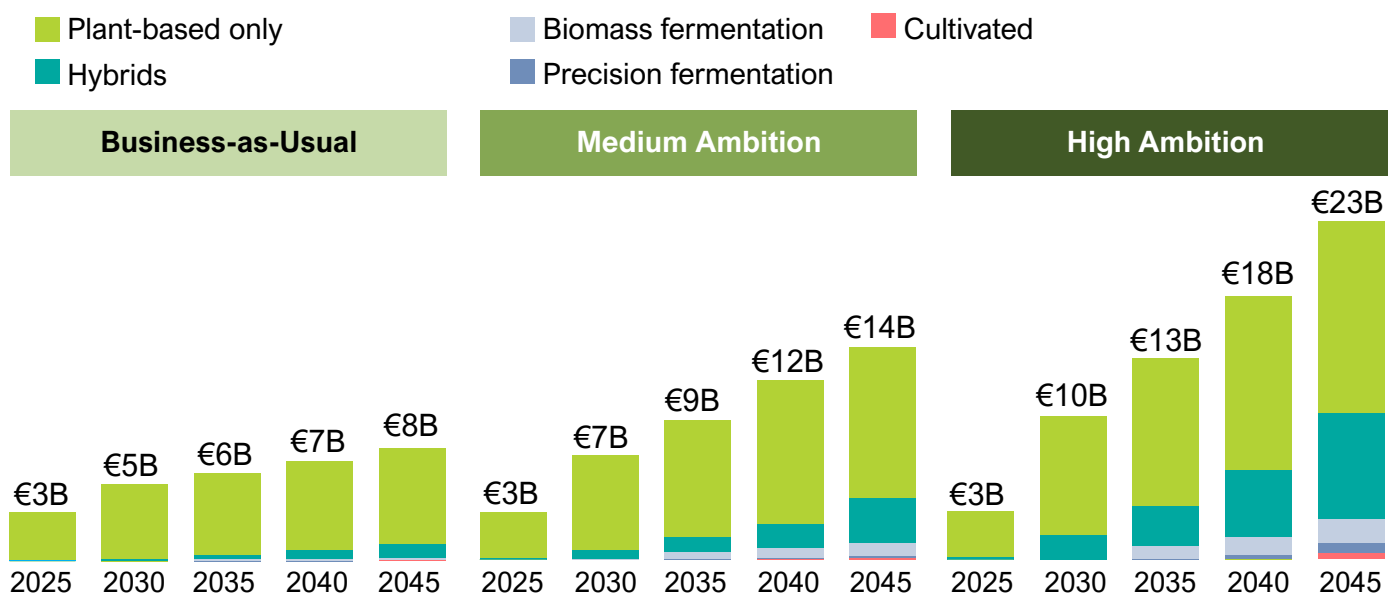
Our analysis shows that under a **Medium Ambition scenario**, the market could reach approximately ~€7 billion by 2030, ~€9 billion by 2035, and ~€14 billion by 2045, as

Germany keeps pace with global alternative protein trends.

In a **High Ambition scenario**, the market could even reach up to ~€10 billion by 2030, ~€13 billion by 2035, and ~€23 billion by 2045. In 2045, it would be around 10% of German food and drinks industry revenues today<sup>75</sup>. Faster adoption and innovation through targeted support would improve product quality more rapidly, driving higher market shares and enabling the sector to reach its full potential.

Under all scenarios, plant-based products will dominate the market, with standalone offerings from biomass fermentation, precision fermentation, and cultivated meat and seafood representing a relatively small fraction. However, there is a growing trend of plant-based products being enhanced with ingredients from fermentation and cultivated to improve taste, texture, cooking properties, and nutritional value—resulting in so-called hybrid products. These hybrid solutions, which combine the strengths of all technologies, are crucial for driving continuous improvement in alternatives and sustaining strong market growth. Therefore, while the direct market sizes of novel technologies beyond plant-based may appear small, their impact is disproportionate as they provide critical ingredients that enhance flavor, texture, and overall product quality.

**Figure 4:** German domestic alternative proteins market size projections, based on level of policy support and investment, *retail & food service, in €B, current prices*



Sources: Sources: Systemiq analysis based on German industry expert interviews and external sources. See Technical Annex for details.

The modelling assumes price parity across all technologies; however, these essential ingredients could command a meaningful price premium. Under such a scenario, the overall product price could be maintained by lowering the costs of the remaining ingredients to remain competitive with animal-based products. The market value would therefore shift from plant-based products to precision fermentation or cultivated solutions.

### Germany can seize significant domestic and export market opportunities, particularly for production machinery

Benefits to the German economy go beyond the market size. While German firms will meet a significant share of domestic demand for alternative proteins, as well as the inputs and machinery required to produce them, imports will also make a contribution. Similarly, Germany will have significant opportunities from exporting these food products, production inputs (e.g., agricultural or specialized inputs) and particularly production infrastructure (e.g.

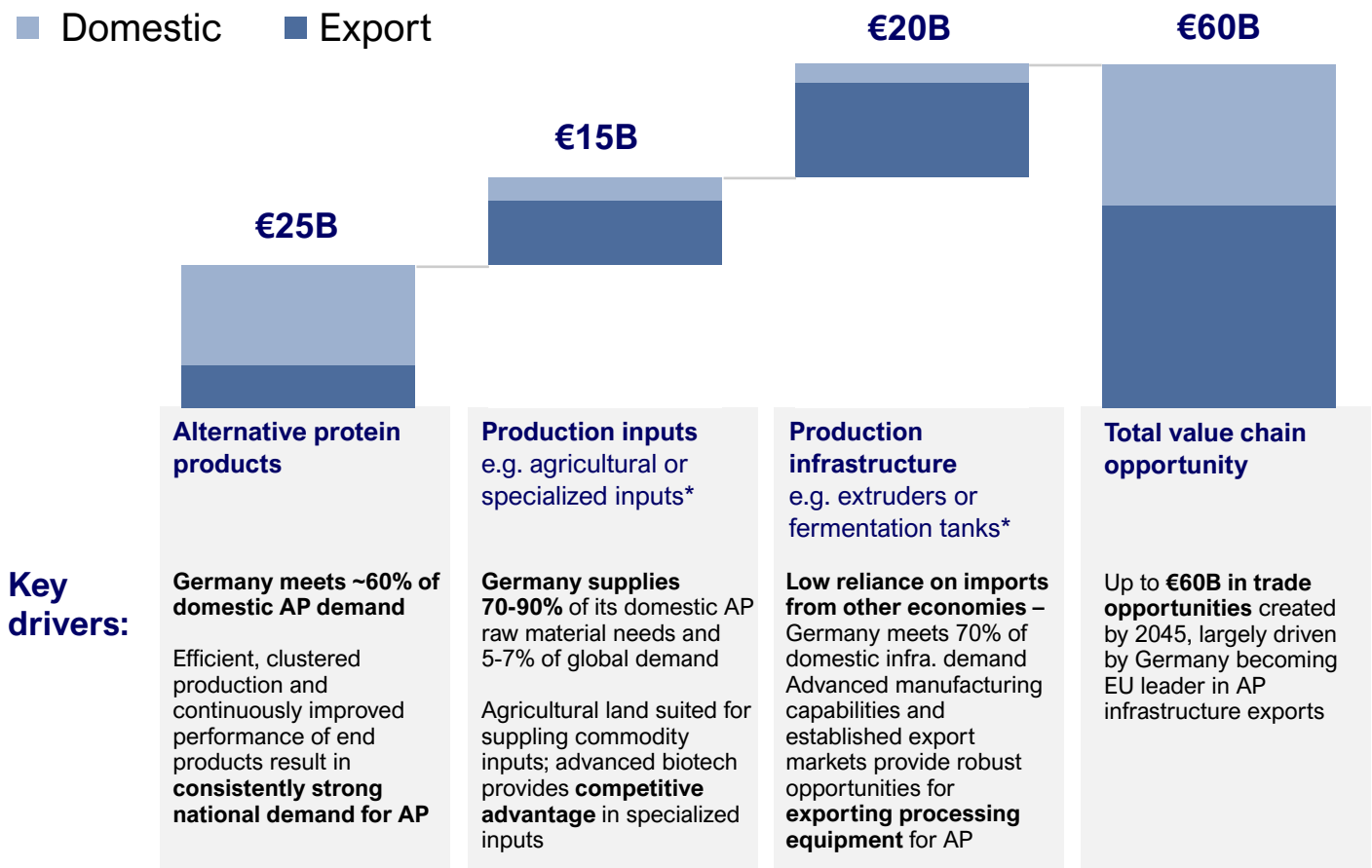
food processing equipment, fermentation tanks).

In the High Ambition scenario, the total domestic and export opportunity is €60 billion in 2045. Alternative protein end products make up the majority of this, at ~€25 billion, accounted for by meeting ~60% of domestic demand, plus exports to mainly the EU market.

Food from Germany is already a significant export market: one third of the total output of German agriculture goes into exports, and the food industry generates one third of its total revenue in export activities<sup>76</sup>. German food production stands for innovation, quality and safety, increasingly complemented by quality assurance systems. This is a good basis for further export success<sup>77</sup>. One key competitive advantage of the German food industry on foreign markets is high-quality processed products, with high value-add<sup>78</sup>, such as alternative proteins.

Production infrastructure represents the second largest opportunity at ~€20 billion.

**Figure 5:** German domestic & export alternative proteins opportunity projections, under 'High Ambition' scenario in 2045, in €B, current prices, rounded to nearest €5B



Sources: Systemiq analysis based on German industry expert interviews and Eurostat PRODCOM data utilizing existing industries as proxies to estimate future AP value chain opportunity for Germany, Prices estimated utilizing Future Foods TEA, expert interviews and Systemiq's cultivated meat analysis for GFI

While Germany is expected to meet 70% of domestic requirements for production infrastructure, exporting this machinery to international markets is expected to account for over 80% of the opportunity. The High Ambition scenario assumes that Germany maintains its average share of EU and global exports of machinery for food, beverage and tobacco processing.

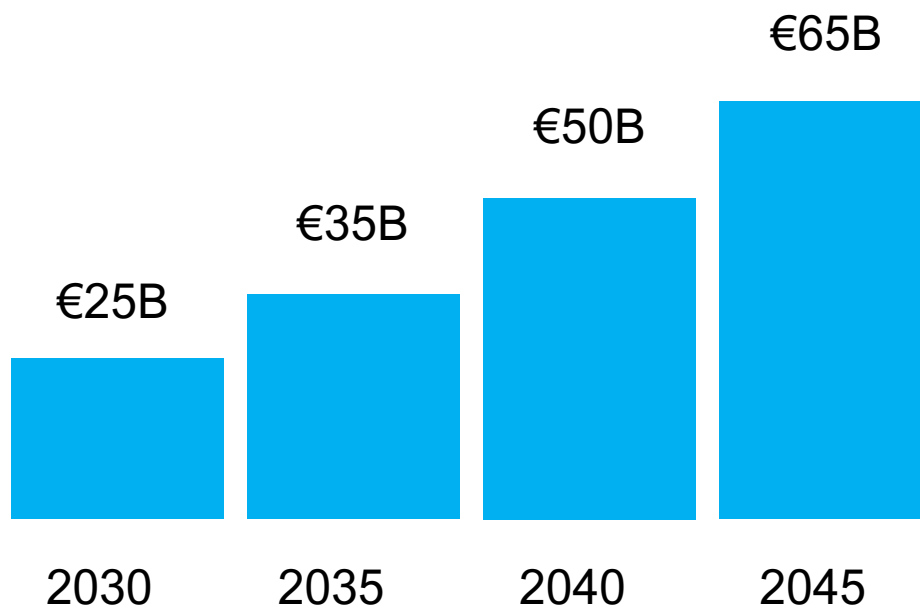
Lastly, production inputs represent ~€15 billion of the total opportunity, with commodity inputs (e.g. agricultural produce including legumes and sugars) driving most domestic potential, while specialized inputs (e.g. microorganisms, flavour enhancers) create significant export opportunities.

Overall, these opportunities translate into a potential Gross Value Added to the German economy of €65 billion, taking into account indirect effects on economic activity. This is roughly equal to 8% of the industry sector GVA, and 10% of trade and transport sector in 2023<sup>79</sup>.

### Protein diversification could generate up to 250,000 diverse jobs by 2045

The growth of the alternative protein sector in Germany has the potential to generate significant employment, from early research and development to large-scale production and commercialisation. These jobs will arise across a broad range of disciplines, including farming, manufacturing, business,

**Figure 6:** Annual gross GVA contribution of AP, 'High Ambition' scenario, *current prices, rounded to nearest €5B*



Sources: Systemiq analysis based on German industry expert interviews and external sources; 1) Destatis, National accounts - Gross value added (nominal/price-adjusted): Germany, years, industries, 2023; 2) Oxford Economics, 2021: "The Socioeconomic Impact of Cultivated Meat in the UK" 3) MTA, 2024: "The true impact of British manufacturing"

and science. Furthermore, the sector's expansion is expected to create significant spillover effects, where jobs created along the alternative proteins value chain will generate additional jobs elsewhere in the economy.

In the High Ambition scenario, the sector is expected to grow from up to ~95,000 direct jobs in 2030 to ~250,000 direct jobs in 2045. The production of alternative protein foods and ingredients could make up around ~15% of these, roughly 35,000 by 2045. For comparison, 2022 employment in all "manufacture of food" in Germany was 486,000 with employment in "manufacture of beverages" accounting for an additional 54,000 jobs<sup>80</sup>.

Along the value chain, ~40,000 jobs could be created in the production of commodity inputs, particularly through farming legumes and other agricultural inputs, such as fermentation feedstocks. Similarly, up to 45,000 jobs would focus on producing specialized inputs, such as growth media, requiring skilled expertise from food technologists, microbiologists, and process engineers.

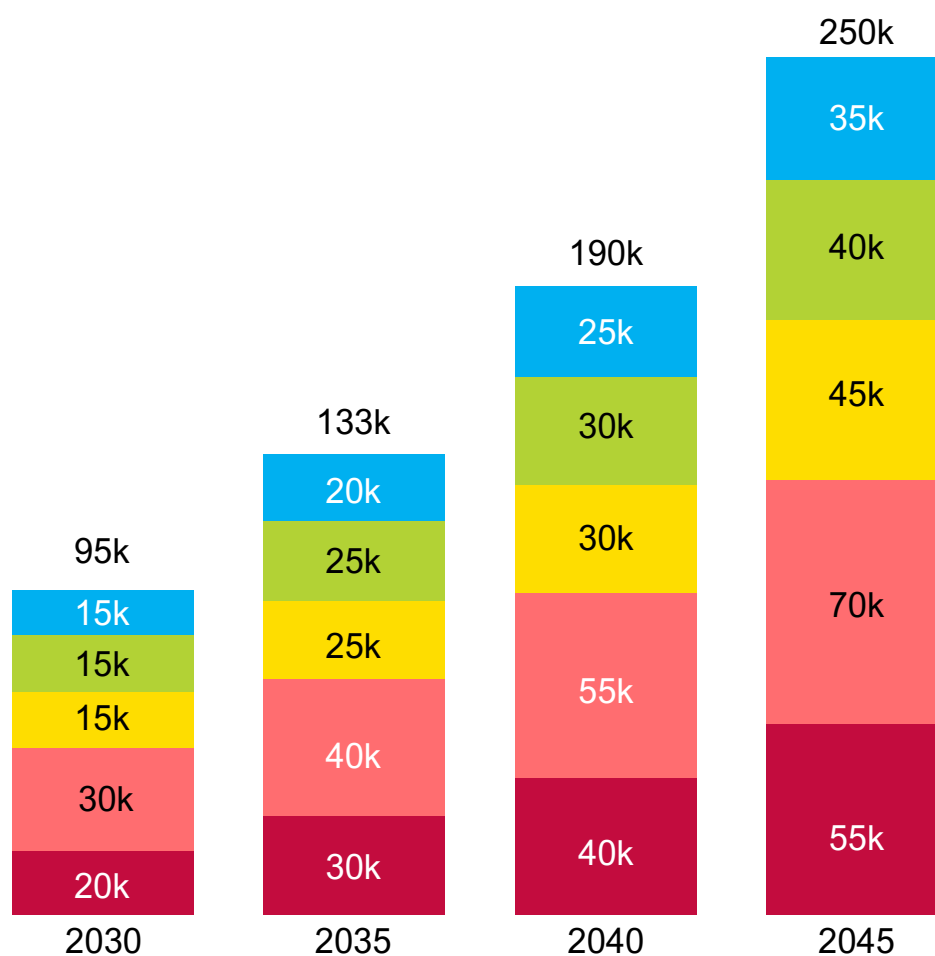
Additional technical and scientific skills are needed for manufacturing food processing equipment and specialized machinery, such as fermentation tanks. The former category accounts for ~70,000 jobs, representing the largest gross job creation, while the latter contributes over 55,000 jobs.

In the early market development stages, job creation will primarily focus on high skill and high-paying jobs in food and protein science, requiring expertise in areas such as protein extrusion. As the sector scales, focus will increasingly be on manufacturing roles, for example with positions for operators providing ongoing quality assurance, or downstream processing for product separation.

During the commercialisation stage, the focus will shift toward business and entrepreneurship. Roles in marketing, sales, and strategy will drive market adoption, while continuous innovation in product development, will ensure the sector remains competitive. Manufacturing and supply chain specialists will be critical to maintaining efficiency and meeting



**Figure 7:** Total gross job creation related to alternative proteins in Germany<sup>1</sup>, under 'High Ambition' scenario, number of jobs, rounded figures



Job creation category	Description	Examples	Average annual wage <sup>2</sup>
<b>AP Production</b>	Employees in AP companies, across roles	<b>Production and business roles</b> , incl., strategy & sales; supply chain managers	40-95k
<b>Commodity inputs<sup>3</sup></b>	Farmers to supply agri. produce at scale	<b>Farmers</b> supplying legumes & fermentation media (e.g., sugars); <b>agronomists</b>	20-40k
<b>Specialized inputs</b>	Scientists for sophisticated tech processes	<b>Microbiologists</b> and <b>food technologists</b> , general <b>lab technicians</b>	70-80k
<b>Food processing equipment</b>	General processing machinery manufacturers	<b>Operators scaling outputs</b> & increasing automation, ongoing <b>quality assurers</b>	60-90k
<b>Specialized equipment</b>	Highly specialized machinery manufacturers	<b>Bioprocess engineers</b> and fermentation specialists	60-95k

Source: Systemiq analysis based on German industry expert interviews and external sources; 1) Systemiq analysis, based on model outputs and ratio of employees per €1M turnover in proxy industries in 2023 using 2) Federal Statistical Office: "Persons employed and turnover of local units in manufacturing" and 3) Eurostat, 2023: "Crop production value at producer price" & estimated employment in crop production based on BLE, 2023: "Landwirtschaftlicher Produktionswert 2023" and Statista, 2023: "Number of employees in agriculture, forestry and fishery in Germany from 1991 to 2022"

growing demand. Importantly, a fundamental enabler of these developments across all stages of growth will be the scaling of agricultural inputs, which is further explained in the section on farmer opportunities below.

Among individual alternative protein solutions, the level of complexity and specialization increases progressively from plant-based to fermentation-based, and further to cultivated foods and ingredients. For example, in cultivated meat, jobs are expected to be well paid with workers earning an average of €95,000 annually<sup>81</sup>.

### **There are widespread opportunities for farmers and the agricultural economy through a growing alternative protein market**

As some pillars of protein diversification have a technology focus and are seen to pose risks to farmers by some stakeholders, opportunities for this group are often overlooked. However, the rise of alternative proteins could present German farmers with significant prospects in this emerging value chain. By embracing these, farmers could unlock new revenue streams and support domestic protein supply while contributing to sustainability of farmland and economic innovation. Exploring how to valorise commodities for use in alternative protein production is a neglected research area, but holds promising potential.

Firstly, farmers could supply ingredients to the growing alternative proteins markets. Beyond plant-based proteins from legumes and other protein crops, for which demand is expected to rise<sup>82</sup>, novel alternative proteins can provide additional income options. Many of the required ingredients are presently traded as low value commodities or non-valorised byproducts.

For instance, fermentation requires a continuous supply of substrates which typically consist of nutrient-rich liquids like sugars or starches, which could be derived from feedstocks such as potatoes or wheat. Cultivated meat relies on organic inputs, namely proteins, sugars, amino acids, and fibrous polymers, e.g. from cereal or soy waste. Plant-based meat is based on basic biological building blocks as key inputs, making any agricultural sidestreams possible inputs for plant-based meat. While much more research is needed to give farmers solid insights and tools to start supplying crops and by-products, the increasing demand for alternative proteins presents an emerging opportunity<sup>83</sup>. This enables moving towards a more cost-effective, circular economy in agriculture.

While Germany is a net exporter of animal origin products, in terms of value, it is heavily reliant on imports for goods of plant origin, including fruits and vegetables, both in terms of value and volume<sup>84</sup>. This is also partly true for legumes, where Germany has high imports of products like soy, suggesting room to scale the cultivation of this crop and similar ones, such as peas, lentils, and fava beans. Initial positive experiences in 2023 with locally grown soy demonstrate potential for high, stable yields and upcoming marketing opportunities through contract farming, long-term agreements, and price premiums, as more processors and consumers are likely to demand high quality plant proteins, produced domestically<sup>85</sup>. A study also found that around half of German consumers prefer novel foods which are produced in Germany<sup>86</sup>, again pointing to an opportunity for farmers.

Additionally, the German government announced a target to increase the share of legumes on arable land from ~2% today to ~10% in 2030<sup>87</sup>. With the majority of these legumes (~90%) being grown for animal feed, there is potential to not only reduce import

reliance and shorten feed supply chains, but also increase legume supply for higher-valued human consumption. Incorporating legumes into crop rotations also improves soil health, reduces fertilizer requirements, and enhances resilience to extreme weather shocks, creating environmental and economic co-benefits<sup>88,89</sup>.

## Alternative protein consumption can bring public economic and health benefits

Conventional meat poses both advantages and disadvantages to health. Generally, meat is a valuable source of essential nutrients, including iron, zinc, and high-quality protein, making it an important dietary component for many.

However, the fat content of meat varies significantly, to up to 40% in pork, with saturated fatty acids comprising 40–50% of total fat content. There are also high levels of cholesterol and purines found in meats. Excessive meat consumption, especially of these high-fat or processed varieties, such as sausages, has been linked to numerous health challenges, imposing societal and economic burdens<sup>90</sup>. These include higher risks of cardiovascular disease, Germany's highest healthcare cost at €57 billion annually (on a per capita basis, this equates to approximately €680 per person annually)<sup>91</sup>.

Additionally, obesity in Germany, partly driven by high-calorie diets rich in processed meats<sup>92</sup>, results in direct costs of at least €17 billion annually and indirect costs of €33 billion due to, for example, reduced productivity<sup>93</sup>. Studies have also shown a positive association between high red meat intake and increased risks of various cancers<sup>94</sup>, and for developing type 2 diabetes<sup>95</sup>. To put these figures in context, the current meat

consumption in Germany is ~1,000 grams weekly, while the German Nutrition Society (DGE) recommends only up to 600 grams maximum<sup>96</sup>.

Antibiotics are also a critical concern, with approximately 65% of all antibiotics in Europe used in livestock, of which 75-90% are excreted, contributing to growth of antimicrobial resistance<sup>97</sup>. On the production side, intensive animal farming and human-wildlife interaction from land use change both contribute to the spread of disease and zoonotic spillover.

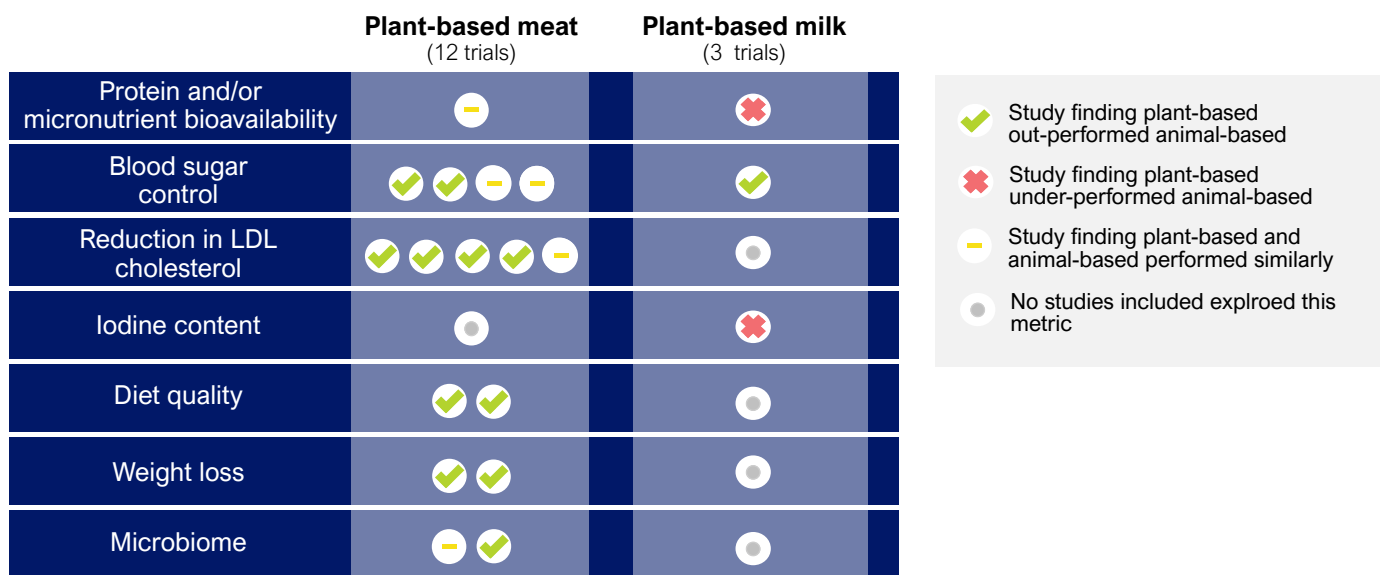
## Alternative protein consumption brings potential health benefits.

While the nutritional profiles of alternative protein products and their long-term implications are still being studied, initial findings suggest they are on par with or even superior to conventional processed meat in most areas. For example, plant-based meats have demonstrated positive effects on gut microbiome health, cholesterol levels, and weight management<sup>98</sup>. Plant-based meat alternatives are generally lower in calories, saturated fat, and salt while also being a valuable source of fibre, missing from processed animal products<sup>99</sup>. Plant-based dairy alternatives show mixed results, with some studies highlighting, e.g., lower calcium bioavailability compared to conventional dairy<sup>100</sup>. However, the German Nutrition Society (DGE) recently made a supporting statement for the consumption of plant-based milk, if fortified with nutrients like calcium, or if these are received through other foods<sup>101</sup>.

Today, many alternative protein companies are prioritising health and nutritional value in their innovation process. They are focusing on reducing ingredient complexity and increasing health benefits. For example,



**Figure 8:** Overview of key findings from interventional trials exploring health impacts of replacing animal meat/milk with plant-based meat/milk



Sources: Sarah Nájera Espinosa, et al., 2024: „Mapping the evidence of novel plant-based foods: a systematic review of nutritional, health, and environmental impacts in high-income countries”. Rubén Fernández-Rodríguez et al., 2024: “Plant-based meat alternatives and cardiometabolic health: a systematic review and meta-analysis”.

some companies use traditional fermentation processes to produce nutritious foods without additives from just a few ingredients (for example, the new steak from the Swiss company Planted, which is soon to be produced in a new German plant in Memmingen). In Addition, some plant-based food companies fortify products with micronutrients such as B12, which are critical for a healthy diet.

Also, research efforts are concentrating on creating healthier fats with reduced risks of cholesterol-related diseases. Advances in precision fermentation may also pave the way for allergen-free proteins, broadening the appeal of alternative protein products for consumers with specific dietary needs. Such efforts are crucial to building consumer trust and acceptance of these alternatives as mainstream food options.

A common criticism against alternative proteins is the concern around so-called

‘ultra-processing’. These are products characterized by high levels of processing to promote convenience and palatability, and frequently high content of ingredients such as sugar, salt and fat. In general, ‘ultra-processed foods’ are associated with negative health outcomes such as excess calorie intake and weight gain<sup>102,103</sup>. However, the evidence linking ultra-processed food with negative health outcomes has not found elevated risk associated with plant-based meat consumption<sup>104</sup>. Instead, the biggest risks are typically associated with consumption of processed meat and sugary drinks<sup>105</sup>.

From a nutritional criteria standpoint, alternative proteins products do not share many of the characteristics of traditional ‘ultra-processed foods’<sup>106</sup>.

Beyond nutritional value, alternative proteins offer food safety advantages. These alternatives do not require antibiotics, reducing the

**Figure 9:** Comparison of plant-based meat and conventional processed meat against common UPF criteria



Source: GFI Europe, 2023: "Is plant-based meat ultra-processed?"

risk of antimicrobial resistance. They also require significantly less land and avoid intensified forms of animal farming, thus mitigating zoonotic disease risks.

Still, more research is needed to study the long-term health impacts of alternative proteins. Key industry goals should be further reducing salt content, exploring fat minimization and fortification with nutrients not usually found in plants, such as Omega 3 oils. With annual per capita consumption of alternative proteins in Germany having grown by ~40% from 2021 to 2024 (~10kg/capita in 2024)<sup>107</sup>, there are opportunities to improve public health outcomes as uptake increases.

### There are wide-ranging environmental benefits of scaling alternative proteins

Estimating relative environmental impacts of alternative proteins relative to animal-based foods is complex, particularly as novel technologies and their applications are still emerging. While there is significant uncertainty about the precise figures, available evidence indicates that protein diversification has numerous positive effects on climate change mitigation and environmental protection and

<sup>i</sup> Note: An earlier version of this report featured only the Medium Ambition Scenario environmental results. Relevant sections have since been updated to ensure the High Ambition Scenario results are also included.

can contribute significantly to biodiversity and healthy ecosystems.

In this study, we modelled the effects of protein diversification on greenhouse gas emissions, land use and freshwater consumption. The calculations are based on life cycle analyses for the different production methods by GFI (2023), Blue Horizon (2020) Sinke et al, (2023) and Poore and Nemecek (2018) to assess the impact reductions compared to a purely animal-based consumption. To account for differences in underlying methodologies, these relative reductions were applied to official impact estimates reported by official German agencies.

### In the Medium and High Ambition scenarios, protein diversification could reduce emissions by the equivalent of taking 1 to 1.8 million cars off the road in 2045.

In 2022, animal husbandry in Germany accounted for ~35 million tons of carbon dioxide equivalents emissions (MT CO<sub>2</sub>e), around two-thirds of emissions from agriculture or almost 5% of overall emissions<sup>108</sup>. Compared to animal meat and seafood, dairy and eggs, alternative proteins could reduce emissions by ~4.8 to 8.1 MT CO<sub>2</sub>e by 2045, under the Medium and High Ambition scenarios, around 14% to 23% of animal husbandry emissions. This reduction is sizable in the context that even under the

High Ambition scenario animal-based foods would still account for around 60% of protein consumption in Germany by 2045. While agriculture emissions are not currently in scope for the EU Emissions Trading Scheme, at prices of €60 to €100 per tonne, this would translate into an economic value of €290 to €810 million in 2045. According to a study by BCG, alternative proteins offer the highest CO<sub>2</sub>e savings per dollar of invested capital of any sector<sup>109</sup>.

**Adopting alternative proteins reduces the need for land-intensive animal agriculture, enabling alternative uses such as low-intensity farming, peatland restoration, and supporting natural carbon sinks.** It could also reduce imports of fruits and vegetables by favouring home-grown alternatives. Under Medium and High Ambition scenarios, domestic animal agriculture land use could shrink by 1.2 to 2 million hectares—an area roughly equivalent to three-quarters of Schleswig-Holstein or larger than Sachsen-Anhalt, respectively—representing 10% to 18% of Germany’s land used for crop cultivation<sup>110</sup>.

This land reduction offers multiple societal benefits. Restoring land to a natural state could enhance carbon sinks, indirectly cutting emissions. Peatlands, which make up ~8% of German agricultural land, are currently degraded, contributing ~7.5% of Germany’s GHG emissions. Restoring these could yield significant climate benefits. Additionally, land could support organic farming, agroecology, semi-natural habitats, and regenerative

agriculture, improving carbon storage, biodiversity, and natural beauty.

More available land could also be used to reduce reliance on imports, such as soy imported for animal feed, and boost resilience to supply shocks by increasing domestic production of legumes and other crops, enhancing food security. This shift benefits biodiversity by reducing deforestation abroad and restoring habitats domestically for wildlife.

**The adoption of alternative proteins could reduce fresh water use by 76 to 129 million m<sup>3</sup> annually, roughly equal to the consumption of 420,000 to 720,000 households, under the Medium and High Ambition scenarios.** This corresponds to 17% to 29% of fresh water use from agriculture. A recent study on the impacts of climate change on water availability in Germany found that the decline in water supply over the last decade is statistically significant, but spatially variable<sup>111</sup>. It outlines that the current scientific understanding indicates that droughts and dryness will occur more frequently and for longer periods in the future. While water withdrawal from agriculture has been at a relatively low but increasing level<sup>112</sup>, the sector, and some regions in particular, will need to contend with these persistently drier conditions. The study recommends measures, including the adapted selection of crops and crop rotation for better water retention. Adoption of alternative proteins can play a significant role in reducing water use from agriculture.



# 5. Policymakers play a critical role in providing the enabling environment for protein diversification in Germany and achieving full benefit potential

## Policy recommendations in a tight fiscal environment

To address barriers, leverage existing strengths, and capitalize on the growing market opportunity for protein diversification, five key policies and support mechanisms are proposed below. In the currently tight fiscal environment, these interventions aim to demonstrate a strong return on investment and represent prudent use of public funds. Policies prioritise a just diversification by integrating farmers into new value chains. A systems approach that balances economic growth, sustainability, and equity is essential to ensure widespread benefits and long-term success.

### Overarching: Develop a cross-government National Protein Strategy, including goals, actions and financial support for alternative proteins

To improve the framework conditions for legume cultivation in Germany, the Ministry of Food and Agriculture (BMEL) published the protein crop strategy in 2012 and developed it further in subsequent years. This aims to support the expansion of both the cultivation and utilisation of legumes and pulses, to improve resource conservation, strengthen regional value chains, and increase the protein supply from domestic products. The BMEL has announced in early 2024, that it will refine the protein crop strategy into a comprehensive protein strategy and that it will publish this strategy in 2025. This is an important step but, however, it is not a

strategy for the entire federal government, but a departmental strategy of the BMEL.

While this is an important foundation, expanding it into a comprehensive, overarching national protein strategy of the entire government is now essential. This evolution is a critical opportunity to integrate alternative proteins as a central focus, maximizing their economic, societal and environmental potential.

To ensure success, the strategy must be developed collaboratively at the national level, enlisting multiple ministries. Key stakeholders should include the Ministry of Food and Agriculture (BMEL), the Ministry for Economic Affairs and Climate Action (BMWK), the Ministry of Education and Research (BMBWF), and the Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), complemented by the Ministry of Health (BMG) and Ministry of Finance (BMF). This cross-sectoral approach would reflect its far-reaching relevance, which intersects with multiple governmental priorities. This also requires setting time-bound quantitative goals, specifying strategic actions, and providing dedicated funding support (see more on funding support below).

Germany would not be the first country to formally integrate alternative proteins into a national strategy. For example, in October 2023, Denmark published the world's first Plant-based Action Plan, developed through cross-party consensus with input from agriculture and the food industry. Among

its measures, the plan includes embedding plant-based options in community catering to boost demand. Additionally, Denmark launched an accompanying funding program, the Plant-based Food Grant, allocating around €100 million over several years to support universities, the food industry, trade, and gastronomy<sup>113</sup>.

Similarly, in January 2022, China's Ministry of Agriculture and Rural Affairs incorporated cultivated meat and plant-based eggs and meat into its national five-year plan, the country's highest-level socioeconomic policymaking document<sup>114</sup>. This plan, which sets long-term goals for economic development across sectors, emphasizes diversifying protein supply to enhance food security and promote sustainable agriculture. This move signaled a clear public commitment to supporting innovative future technologies<sup>115</sup>.

Germany could draw inspiration from these examples by defining its own comprehensive strategy to make alternative proteins a cross-cutting priority, thereby strengthening its global leadership in this rapidly growing market.

### 1. Supporting companies in the regulation of alternative proteins, in particular in the authorisation of novel food products

The European Food Safety Authority (EFSA) is responsible for developing validation and inspection rules and procedures, including those under the 'Novel Foods' regulation, to facilitate the development of new products such as alternative proteins. Generally, the standard is perceived as rigorous, and valuably balancing food safety with innovation.

While this framework also has some challenging aspects—for example, requiring companies to disclose sensitive details of their manufacturing processes—there is broad consensus within the industry that the

regulation is fundamentally well suited for the regulation of novel foods. However, there is also potential to improve the efficiency and transparency of the procedure while maintaining the same safety standards, to strengthen the innovative power of the sector.

In general, there is still potential to make the procedures within the existing legal framework more efficient and transparent. These are sometimes very long and often difficult for companies to predict. For example, the mere determination of whether a product falls under the Novel Food Regulation at all, which in Germany is done by national authorities, can significantly exceed the actually planned duration of four months, which leads to uncertainties.

This is exacerbated by the fact that companies often lack sufficient clarity about the requirements for a novel food dossier for the respective technology and which data must be submitted. As a result, many of the applications submitted by companies to the EFSA are of insufficient quality, which can lead to further delays. The resulting need for improvements means that the originally planned 18-month procedure usually takes three to four years in practice. This delays the market launch of new products, with the consequence that investors are less willing to finance young companies that have not yet generated any revenue.

Germany should support companies in understanding the requirements of the procedure and in submitting high-quality marketing authorisation applications. This requires targeted advice for companies, with start-ups being helped to compile the necessary information in accordance with EU regulations. For this, Germany should establish a dedicated small team of experts. This would enable more products to reach the market in the coming years. This is

particularly critical for scaling precision fermentation and cultivated proteins, which are most clearly subject to regulatory approval. Given Germany's important role in shaping the EU regulatory system, support for streamlining evidence-based regulatory approval would also send positive signals to the rest of the EU. This could translate into significant benefits, as companies operating in more friendly regulatory environments are also better funded<sup>116</sup>.

In addition, there should be pragmatic guidelines for the legally compliant organisation of tastings of products that have not yet been approved, which would enable companies to obtain feedback from consumers at an early stage. This is done, for example, as part of the UK's 'regulatory sandbox' approach, which gives companies access to regulatory expertise and the opportunity to test products in a controlled environment.<sup>117</sup>

#### *Potential ways to go further:*

Multiple experts stated that policies in Germany could aim to create a level playing field between alternative and conventional proteins, for instance through minor adjustments in the design of the German VAT. Currently, animal products are taxed at a reduced rate of 7%, while plant-based milk is taxed at 19%. Reversing this disparity could increase consumer uptake, reflect environmental externalities and ensure fair competition. A study found that reducing taxes on plant-based dairy could result in modest tax revenue losses (~€40 million, less than 0.01% of total tax revenue) but would deliver significant climate-related savings, estimated at ~€62 million annually, thus potentially generating ~€22 million savings<sup>118</sup>.

## 2. Increase R&D investments and initiate an innovation ecosystem cluster for public-private cooperation

**Germany's R&D spending for alternative proteins must increase** to address critical technical bottlenecks. Germany currently ranks only fifth in Europe for public alternative protein research funding, with total spending from 2020 to April 2024 amounting to €55 million (approximately €13 million annually). This lags behind Denmark (€96 million), the UK (€90 million), Finland (€68 million), and the Netherlands (€67 million) over the same period<sup>119</sup>.

With ~€0,7 spend per capita, Germany ranks 7th, behind Denmark (~€16), Finland (~€12), Norway (~€7), Netherlands (~€4), Sweden (~€2), UK (~€1). It is worth noting that the German government estimates its funding for human protein consumption during this timeframe to be higher, at approximately €88 million, partially due to the inclusion of initiatives such as insect-based protein development<sup>120</sup>. Nonetheless, it is encouraging that the top three German funders were BMEL, BMBF, and BMWK<sup>121</sup>, demonstrating cross-ministry interest in the topic.

Most German funding was for plant-based proteins, while other solutions such as fermentation and cultivated meat only made up a fraction of the investment. For example, Finland spent an estimated ~€54 million on fermentation-made foods alone, during that time. And the Netherlands has specifically funded the field of cellular agriculture, i.e. cultivated meat and precision fermentation, with more than ~€60 million euros in order to build up an ecosystem in this area.

Going forward, to join the top three per capita European spenders, Germany would need to increase annualized R&D funding by tenfold to approximately €130 million annually (up



from the ~€13 million annualized funding today). This is roughly in line with the €140 million Germany would have to spend on average between 2025 and 2045, to meet its estimated share of global public R&D support based on a Global Innovation Needs Assessment (GINA) conducted in 2021<sup>122</sup>.

Public research funding is a catalyst for more private investment in this area. Private R&D funding is expected to be four times larger than this public R&D support. Based on R&D spending as a share of revenues in similar, so-called proxy industries, average annual private sector R&D spending would amount to around €680 million between 2025 and 2045<sup>123</sup>. That means public R&D funding would on average contribute 20% of the total. Initially, the public share of R&D spending would be higher, providing critical early support to the industry, and falling to less than 10% by 2045.

Public R&D funding should prioritize collective industrial research that is pre-competitive and openly available. A part of increased R&D funding should flow to **establishing a dedicated innovation hub for alternative proteins**, to further accelerate Germany's leadership. This is essential for connecting isolated R&D efforts and accelerating the commercialization of research. This opinion was shared by most experts interviewed.

Drawing inspiration from the successful Wageningen ecosystem in the Netherlands, or Ghent agribiotech cluster, such a hub could serve as a centre for collaboration among industry, academia, and public institutions. Other examples include four research centres in the UK<sup>124</sup>, €7 million support by the Catalan government for a 'Center for Innovation in Alternative Proteins' (CiPA)<sup>125</sup>, and Israel's center for alternative protein research, the 'Cultivated Meat Consortium'<sup>126</sup>.

A German hub would facilitate public-private partnerships, shared access to R&D facilities, and multidisciplinary applied research. It could also support start-ups through consulting and funding strategies while fostering connections with large corporates and agricultural stakeholders. This would promote synergies, such as using agricultural waste streams as inputs for alternative protein manufacturing. Multiple studies find green patenting is associated with regional specialization in innovation hubs, and robust partnerships between academia and industry<sup>127</sup>, pointing towards greater innovation potential.

Government funding should explicitly draw in **matching private sector funding** to enable the hub's development. If the public sector would provide ~€20-30 million in seed funding, private sector capital could match that to get to €60-70 million, which would be a competitive sum to establishing a cluster. The ongoing costs of the cluster should be jointly funded from the €140 million average annual R&D funding as well as private contributions, e.g., membership fees.

In summary, the total public investment required for R&D is estimated at around €130 million annually between 2025 and 2045, complementing around four times that amount in private R&D. Initially, using ~€20-30 million of this to set up an innovation cluster, with matching private sector funding, could unlock research progress and commercialization.

#### *Potential ways to go further:*

Government could also help **address talent and educational gaps** in this emerging sector. Training systems could increasingly be adapted to include alternative protein-specific content, offered through universities and apprenticeship programs. Targeted initiatives,

such as career seminars, on-campus hiring, and fellowship opportunities, would attract students and professionals, including those transitioning from other fields. Efforts could also focus on rural talent development to help decentralize opportunities and strengthen local economies. Additionally, corporate-led training programs in food science and advanced manufacturing, coupled with international recruitment efforts, would ensure that Germany attracts top talent to support the sector's growth<sup>128</sup>. Surveys indicate that 60% of global alternative protein professionals are willing to relocate for job opportunities, with 80% favouring Europe<sup>129</sup>.

### 3. Production at scale: Earmark dedicated sums to scaling alternative protein sector, especially through de-risking infrastructure investments

Scaling alternative protein production in Germany also requires **significant infrastructure investments**, to move from demonstration to commercial scale, in particular in the fields of fermentation and cultivated meat and seafood. As this involves financial risk which private lenders and

institutional investors alone can't fully mitigate, strategic government support helps to reduce funding gaps and de-risk investments in this capital-intensive sector.

Most crucial are more and larger manufacturing facilities to reap benefits from economies of scale to bring down costs and boost availability. This is particularly important for more nascent alternative protein companies, which often struggle to secure funding pre-revenue. Further strategic financial support is now needed, to establish Germany as a leading investment location for alternative protein production.

Under the High Ambition scenario, roughly ~€120 million in average annual public sector funding is required to de-risk private investment between 2025 and 2045. Private capital expenditure in the sector is expected to grow from around €300 million in 2025 to around €1.7 billion by 2045, averaging €900 million between 2025 and 2045. Public capital represents around 12% of this overall investment, with a higher share expected initially when de-risking novel facilities is most critical, declining to 5% by

**Figure 10:** Investment requirement for innovation & capital expenditure (CapEx) investment for infrastructure  
Annual average, ramping up between 2025 and 2045, in €M, current prices, rounded to nearest €10M



Source: 1) GFI Europe, 2024: "Research and Innovation funding landscape analysis"; 2) Vivid Economics, 2021: "Global Innovation Needs Assessments Protein diversity"; See next slides for additional detail. Additional sources: Systemiq analysis based on German industry expert interviews and external sources

2045. Public financing mechanisms such as loan guarantees, concessional capital, and blended finance models could be powerful de-risking levers, catalysing greater capital flow into novel solutions while using limited public funds. More direct financial incentives, such as public grants for pilot plants or tax credits, could further ignite growth across the economy by creating a more attractive environment for private investing, to help alternative proteins reach price parity with conventional options faster. This also includes leveraging the European Investment Bank (EIB), as a climate bank to extend its support to the alternative protein sector.

The average total public and private investment of roughly €1 billion annually equates to a sixth of total investment in capital assets for the manufacture of food products, beverages and tobacco in 2023<sup>130</sup>. In comparison to such a mature and efficient sector, the scale up of this new industry is a sizeable investment. However, next to the total investment required for decarbonizing the German economy, which Agora Energiewende estimates to average €540 billion annually from 2025 to 2045<sup>131</sup>, it is a miniscule figure given that animal agriculture is contributing to 5% of German GHG emissions.

There is significant potential to lower this expenditure by retrofitting existing facilities (brownfield investment). Estimates in this study assume facilities are newly built “greenfield” sites. However, retrofitting could reduce costs by at least 30%<sup>132</sup>, and up to 80%<sup>133</sup>, while accelerating construction lead times compared to building new facilities. Retrofitting is particularly well-suited for the plant-based and biomass fermentation sectors, which account for the vast majority of expected capital expenditure due to their share in total alternative protein volume. For

plant-based products, facilities that currently produce pet food, pasta, breakfast cereals, or dry snacks could be retrofitted for extrusion, or existing meat processing facilities for post-processing. For biomass fermentation, breweries, ethanol plants, and wineries offer potential for retrofitting. Such collaboration is not merely hypothetical: Hamburg-based Infinite Roots has had a partnership with Bitburger since 2022, to not only utilize the fermentation capacity of Germany’s fourth largest brewery, but also repurpose its spent grains as a source of feedstock<sup>134</sup>. The Berlin-based start-up Nosh.bio also wants to use the existing infrastructure in a brewery in Großröhrsdorf, Saxony, in a project funded by the Saxon Ministry of Economic Affairs.

The public sector could help map existing assets and assess their adaptability for alternative proteins production, as done by the Catalanian government<sup>135</sup>. Similarly, existing funding programs at EU-level, e.g., focused on reindustrialisation or circular value chains, can be leveraged as a cost-effective way to facilitate retrofitting and enhancing capacity.

Shared pilot and demonstration facilities represent another area of focus. Facilities like the GEA New Food Application and Technology Center of Excellence in Hildesheim (Lower Saxony), which provides fermenters for testing and optimizing production, demonstrate the value of shared-use assets that reduce barriers for smaller companies. Government support for such collaborative infrastructure would promote innovation and enable more companies to enter the market.

By employing this level of public funding to mobilize a much larger share of private investment, Germany could firmly establish a leading role on protein diversification. This is the level of ambition envisioned under the High Ambition scenario, providing significant



and reliable funding alongside wider enabling policies.

#### 4. Integrate alternative proteins in community catering through public procurement

Public authorities hold significant procurement power, presenting a major opportunity to drive the uptake of alternative proteins. Around 16 million meals are served daily through community catering in settings such as daycare centers, schools, hospitals, senior facilities, and public workplace cafeterias<sup>136</sup>. Policymakers should ensure that plant-based meat and dairy analogues, and other alternative proteins are included in public procurement and promoted attractively.

As an instrument for healthier and more sustainable nutrition, community catering was already anchored in the National Food Strategy, which was published at the beginning of 2024<sup>137</sup>. However, it did not incorporate plant-based meat and other equivalents to animal products, which make it easier for many consumers to swap animal products for more sustainable options. Integrating these plant-based products into public procurement for community catering would not only secure off-take demand for producers and farmers but also raise consumer awareness of these solutions, supporting market growth. Integrating alternative proteins into menus could help normalise their consumption and foster long-term behavioural change. Young people, particularly ‘Gen Z,’ represent a significant opportunity for increased alternative proteins adoption, where encouraging uptake can help promote healthier and sustainable habits for the future.

This could also include supporting procurement of blended products, which incorporate alternative proteins with conventional meat. Although such products have gained traction

in the Netherlands<sup>138</sup>, consumer acceptance remains low in Germany.

One obstacle to the integration of plant-based meat and other alternative products into community consumption and public procurement is the recommendations of the German Nutrition Society (Deutsche Gesellschaft für Ernährung/DGE). The DGE published dietary recommendation updates in 2024, which brought some positive aspects, such as reducing the amount of animal products. However, it did not include alternative proteins, claiming insufficient data—a position that is increasingly untenable, also given the inclusion of recommended products that have proven negative health impacts. The adoption of alternative proteins through public procurement in Germany could be accelerated by **updating national nutrition guidelines** to build awareness and demand.

Even though greater openness may come in the next revision, this may not be timely enough for supporting the alternative proteins market’s growth, as updates are only made every few years. Therefore, the recommendations may need to be revised earlier, to expand beyond legumes and include the full spectrum of alternative proteins. Other countries have already integrated alternative proteins into their national dietary guidelines, providing a model for Germany to follow. For example, the UK’s NHS recommends: “Have some dairy or dairy alternatives (such as soya drinks)”<sup>139</sup>, while the Netherlands’ Nutrition Centre states: “Eat more plant-based products, and don’t eat too much meat”<sup>140</sup>.

The DGE standards should also become mandatory at the state level, moving beyond the few “Modellregionen” currently implementing them with limited funding. Additionally, phased rollouts including robust evaluation may offer a way to monitor health and consumption impacts of such updated guidelines.

This would ensure that the adoption of these foods is closely researched, and the evidence base of potential benefits strengthened.

### 5. Continue to incentivize farmers' crop diversification

Incentivising crop diversification with legumes and other protein crops and supporting farmers to integrate more deeply into alternative protein value chains are essential for a fair and sustainable protein diversification. German farmers need to be positioned to supply larger quantities of key inputs for alternative protein production, particularly plant-proteins like peas, as well as fermentation and cultivation feedstocks, including sugars and starches. Policies such as long-term off-take agreements, price premiums, and price floors (minimum guaranteed price) can serve as powerful tools to provide the stability farmers need to invest in diversification and protect their livelihoods. These measures would also help the government achieve its target of 10% legumes on arable land by 2030 and enhance domestic food security.

Strengthening regional processing infrastructure, such as facilities for soy milling, is equally critical to reducing reliance on cheap imports of protein isolates and concentrates from countries like China, fostering more resilient and sustainable domestic supply chains. To ensure the success of these efforts, regional supply chain managers may be needed to connect farmers with processing industries and food manufacturers, enabling all parts of the value chain to operate efficiently and sustainably. By raising farmer awareness of the additional revenue opportunities in alternative proteins, these measures can strengthen the agricultural sector's role in the wider protein diversification.

Generally, ensuring this diversification is just requires direct consultation with farmers and

other agricultural stakeholders to develop policies that address their needs. While EU initiatives, such as CAP eco schemes, are often perceived as too bureaucratic, additional, German-led schemes, could provide efficient and more targeted support to farmer's needs. These may also include partnerships for upskilling farmers, including training programs, tailored to help farmers adapt to new market demands.

#### *Potential ways to go further:*

The funding scheme "Chancenprogramm Höfe" launched in 2024 by the Federal Ministry of Food and Agriculture (BMEL) and the Federal Office for Agriculture and Food (BLE), which aims to support livestock farms in converting to alternative proteins, offers the opportunity to advance the transformation of agriculture towards sustainable and economically viable new business models. This program should be continued by the new federal government and provided with more funding. In the further development of the program, it should be ensured that it is open to technologies other than plant-based foods and that cooperation with processing companies is also supported, so that the product's further development is also promoted.

### Powerful examples of state-led projects in Germany

Germany's federal states are emerging as key hubs for alternative proteins, each with distinctive strengths and initiatives that contribute to the sector's development. A selection:

**Baden-Württemberg** is a hub for both university and non-university research in alternative proteins. With innovative companies like The Cultivated B (cultivated meat and precision fermentation infrastructure) and Protein Distillery (fermentation from beer brewing by-products), the state exemplifies how alternative proteins can integrate with existing

industries. Research institutions such as the Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB), the Karlsruhe Institute of Technology (KIT), the University of Hohenheim and Reutlingen University, where cutting-edge work in animal-free cell media and 3D-printed cultivated meat takes place, are pivotal to advancing alternative protein technologies.

**Bavaria** leverages its strong research and start-up environment to drive alternative protein innovation, particularly in plant-based proteins. The Technical University of Munich (TUM) hosts Europe's first professorship in cellular agriculture, along with leading researchers in plant-based nutrition and biotechnology. Public initiatives, like Bavaria's food cluster, provide guidance, finance, and networking for start-ups. The state is already home to major providers of ingredients like growth media for cellular agriculture (Wacker and PAN Biotech), as well as innovative plant-based startups like Greenforce and Happy Ocean Foods, while new entrants signal growing diversity in the state's alternative proteins landscape.

**Berlin** stands out as Germany's start-up capital, hosting industry leaders like Formo (precision fermentation), Project Eaden (plant-based meat), vly Foods (plant-based dairy), Bettaf!sh (plant-based seafood) and numerous others. The city's abundance of VC and international talent makes it an attractive base for emerging alternative proteins companies. Infrastructure like KitchenTown and the upcoming Food Campus Berlin provide guidance and networking opportunities. Research at the Technical University of Berlin, particularly in plant-based proteins, supports the ecosystem and ensures a steady pipeline of experts.

**Hamburg** is positioning itself as a hub for innovation and collaboration in the alternative

proteins field. With start-ups like Bluu Seafood (cultivated seafood), Infinite Roots (biomass fermentation) and The Raging Pig (plant-based meat), the city is a centre for innovative approaches in the sector. Hamburg's publicly funded innovation cluster includes the Future Food Campus, combining cultivated meat, fermentation, and indoor farming; Foodlab, supporting pre-seed start-ups with €200,000 in funding; and Food Harbour, an accelerator program providing €500,000 to scale-ups. The city aims to enhance networking and cooperation between stakeholders, strengthening its ecosystem. On 2nd September 2024, the Food Cluster Hamburg GmbH, which will support innovations in the food industry, officially launched, with 160 member companies from the food sector.

**Lower Saxony** is a frontrunner, balancing a strong conventional meat and dairy industry with cutting-edge alternative proteins innovation. The state is home to several alternative protein companies, ranging from start-ups like Kynda (fermentation infrastructure) and Cultimate (cultivated fat) to established companies like Rügenwalder Mühle, which has successfully diversified much of its product range to alternatives. Its research landscape is bolstered by the German Institute of Food Technologies (DIL) in Quakenbrück, which bridges science and practice, and universities in Hannover, Göttingen, Vechta and Osnabrück, which work on technical aspects of alternative protein innovation or conduct empirical research on consumer attitudes. Public support is strong, with five state ministries collaborating on bioeconomy initiatives, e.g. targeting cultivation and fermentation projects.

**North Rhine-Westphalia (NRW)** combines its legacy in conventional agriculture with a growing focus on bioeconomy. NRW is home to plant-based brands like Berief Foods, Garden Gourmet and Like Meat as well as



the Fraunhofer Institute for Molecular Biology and Applied Ecology which is leading the FutureProtein project jointly launched by six Fraunhofer-institutes to research alternative protein sources for human nutrition. Additionally, food hub NRW offers further resources and networking opportunities for stakeholders and businesses in the sector. Moreover, the

“Launch Center for the Food Economy” is just around the corner. With funding just short of €6 million the centre for technology and knowledge transfer will focus on plant-based foods, other alternative proteins and the utilisation of plant-based raw materials and residues along the entire production chain.<sup>141</sup>



## 6. Call to action: Germany can lead protein diversification, by driving innovation and investment to meet consumer price and performance expectation

The alternative protein market is still in its early stages, with some uncertainty remaining, e.g. when novel products like cultivated meat and fermentation-based products will achieve mass-market adoption. Over the next five years, developments in regulation, public and private investments, and technology will play a critical role in shaping the market's trajectory and reducing this uncertainty. Transforming the food system will require actions on par with those for decarbonizing energy and mobility systems. Experts estimate that food system changes will take a similar timeframe to energy and mobility transitions—40 to 50 years—with significant progress already made in the first decade.

German policymakers have a unique opportunity to make the nation a front-runner in protein diversification. By leveraging Germany's fundamental strengths and enacting the five key policy recommendations outlined above, they can seize leadership in the alternative protein market.

Additionally, support from other system actors is required. Investors can drive innovation across the value chain, especially supporting the scale-up of new solutions and building portfolios that span the entire alternative protein ecosystem. Corporations must integrate

alternative proteins into their corporate strategies, from R&D and product reformulation to resource allocation and marketing, ensuring alignment with public health outcomes. Private long-term off-take agreements with farmers can incentivise legume cultivation, while transparency about ingredients, processes, and product origins can build consumer trust. Greater collaboration across the value chain—including partnerships with start-ups, agriculture companies, food manufacturers, and retailers—is essential to driving growth.

These actions will help make sustainable protein alternatives more appealing to consumers, driving higher demand. The good news is that protein diversification often involves smaller economic and personal trade-offs compared to other lifestyle changes, such as reducing air travel, making it an accessible and impactful way to contribute to sustainability goals.

With concerted efforts from all stakeholders, and the right policy support, Germany can position itself as a leader in protein diversification, driving strong innovation to secure future-proof jobs, economic growth, sustainability, and more – crucial in a challenging context that is calling for new opportunities.

# Technical Annex

## Model objectives

This study estimates the opportunity for scaling alternative proteins in Germany by 2045 across three different scenarios—Business-as-Usual (BAU), Medium Ambition, and High Ambition—under varying levels of policy support.

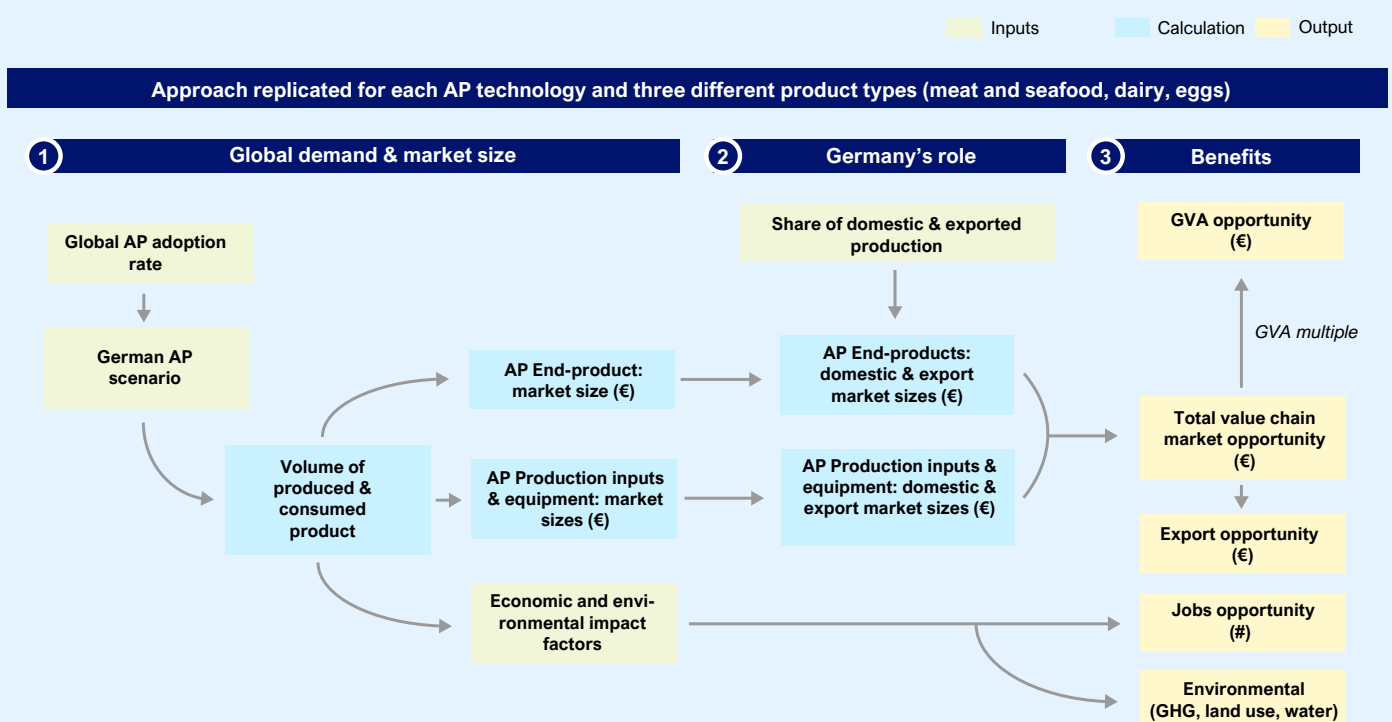
It aims to:

- Quantify the potential market size for alternative proteins in Germany while assuming static global adoption rates and assessing the share Germany could capture under each scenario.
- Evaluate the impact of various kinds of AP (e.g., cultivated meat, biomass fermentation, precision fermentation) alongside plant-based foods on market growth and adoption.
- Estimate economic opportunities arising from these new markets, including potential export growth, domestic Gross Value Added (GVA), and job creation.
- Estimate the level of investment required to unlock these opportunities at scale under different scenarios.
- Assess the environmental benefits of shifting from animal-based products (meat, seafood, eggs, and dairy) to plant-based alternatives on the basis of available lifecycle analyses.

## Scope

The model assesses four alternative protein technologies, plant-based, biomass fermentation, precision fermentation and cultivated. For each, the potential in three categories of food is assessed: meat & seafood, dairy and eggs.

**Figure A1:** Overview of analytical methodology





## Scenario breakdown

The model explores three scenarios to evaluate the potential for scaling alternative proteins in Germany by 2045.

## Global and German market sizes

### Volumes of meat & seafood, dairy and egg consumption

For each of the three categories of food, global and German consumption volumes from 2025 to 2045 were estimated. Current and forecast demand for animal-based foods were estimated for Germany, the

**Figure A2: Overview of scenario assumptions**

German AP scenarios	Business-as-Usual	Medium Ambition	High Ambition
German AP adoption	<b>Germany falls behind</b> from leader in plant-based to laggard in global AP	<b>Germany keeps pace with global AP growth</b> , innovation & production	<b>Germany amongst leaders of global AP adoption</b> , including novel AP
Regulatory support	<b>Restrictive regulatory stance</b> towards new technologies limits growth	Regulation <b>embraces plant-based alternatives</b> , improved with other AP	<b>Significant efficient &amp; streamlined support</b> and permissive regulation
Public investment	<b>Low public investment</b> given scepticism regarding novel solutions	<b>Increased public funding</b> in R&D and some on infrastructure development	<b>Material public spending &amp; de-risking</b> on R&D and infrastructure scale-up
Private investment	<b>Limited</b> private funding; migrates to more welcoming EU/global jurisdictions	Funding and reg. approvals <b>attract additional private investment</b>	<b>Significant private investment</b> crowded in to rapidly scale production
<b>Consistent assumptions across scenarios</b>			
Global AP adoption	All scenarios assume the <b>same global evolution of alternative protein technologies and uptake</b> (to focus on implications of different policy scenarios in Germany).		
German consumer acceptance	Consumers <b>remain generally open to alternative proteins</b> , as products improve and corporates optimize for nutritional benefits. Openness to individual technologies (e.g., cultivated) may vary but role could be met by remaining technologies.		
Costs & technology	Consistent <b>global price-performance parity</b> for biomass fermentation (2028), precision fermentation (2035) and cultivated (2040) (Price parity for AP required for uptake so assumptions on relative costs of technologies over time less critical)		

rest of Europe, and the rest of the world, based on FAO data<sup>142</sup>. Consumption figures for Germany were adjusted based on detailed market data for plant-based consumption and market shares, resulting in a downward revision of 2023 baseline values relative to FAO estimates. As detailed German data is only available for retail sales, a 20% uplift was applied to account for food service sales. This rough estimate is based on the food service sector share in food waste (24%)<sup>143</sup> and revenue shares (24%)<sup>144</sup>, rounded down to be conservative and account for likely higher rates of food waste and price points. Adjusted German volumes were projected to 2045 based on FAO forecasts.

### Uptake of alternative proteins

Global adoption of alternative proteins for the three categories of food was estimated using a medium range scenario from existing studies. The studies included in the composite estimates were: Boston Consulting Group (2021)<sup>145</sup>, Credit Suisse (2021)<sup>146</sup>, and Bloomberg (2021)<sup>147</sup>.

For the German scenarios, these rates were adjusted based on the level of political support (see Figure A2 for rationale and S-curve assumption Figures A3-A5 below), informed by expert interviews and subsequent expert validation.

### Adoption of novel alternative protein technologies – S-curve approach

Reflecting current market realities, the starting assumption was that almost all current demand for alternative proteins is met by plant-based products (most of the other products have not yet been approved for human consumption in the EU). To model the uptake of the other technologies, an S-curve approach based on the historic uptake of novel technologies was employed.

The adoption patterns for alternative proteins follow an S-curve characterised by three phases:

- Initial phase: slow adoption due to high costs and limited awareness.
- Growth phase: accelerated uptake as novel food processes become more efficient and public acceptance increases.
- Saturation phase: market maturity and adoption plateau as the maximum market potential is realised.

The S-curve parameters— tipping point, growth rate, and maximum market potential—are tailored to reflect the global and Germany-specific market and technological trajectory.

- Tipping point: Represents the point in time which a given technology reaches price-performance parity. For the purpose of this analysis, we assumed globally fixed tipping points, i.e., the year in which a given technology reaches price-performance parity does not vary based on the German scenarios.

The assumed tipping points were estimated based on expert interviews and secondary research as:

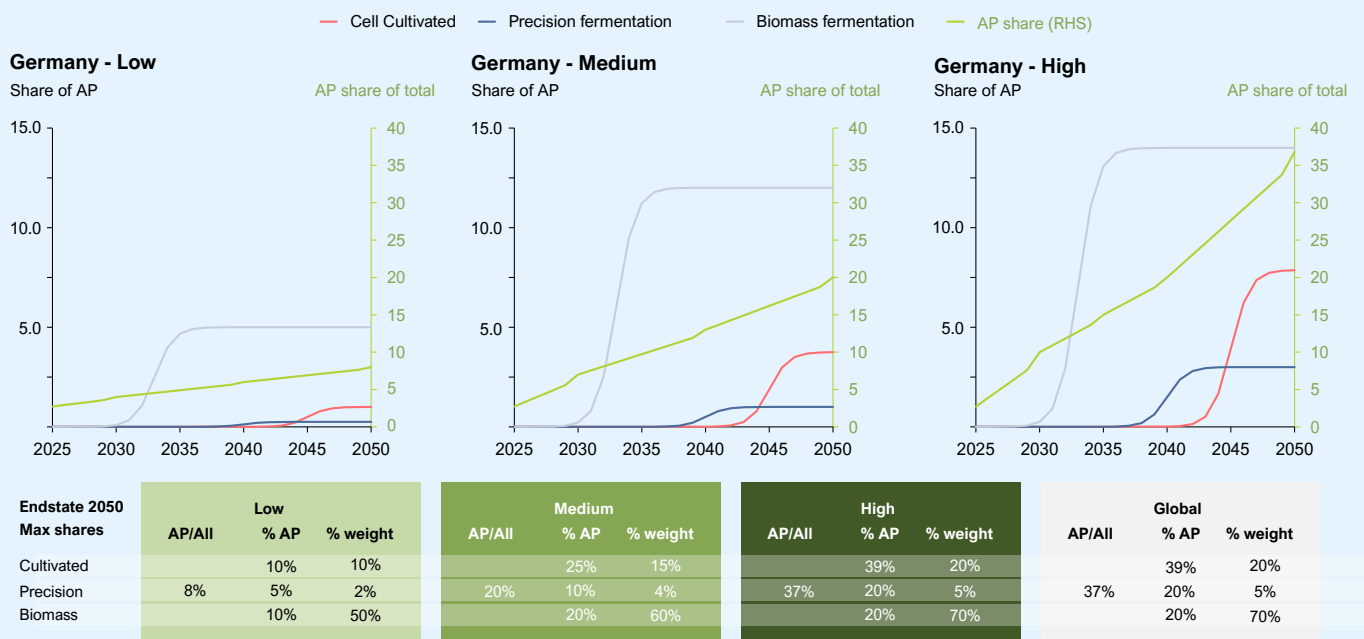
- Biomass fermentation: 2028
- Precision fermentation: 2035
- Cultivated: 2040
- Once parity is reached, S-curve growth kicks in over a period of 12 years.
- At the end of this period, the technology reaches its maximum market potential as a share of the overall alternative protein market in a given food category (e.g., share of biomass fermentation as part of alternative protein meat & seafood). This share is based on two parameters:
  - Percentage of alternative protein foods including a given technology at all (e.g., 25% of alternative meat & seafood includes any cultivated)
  - Percentage of average weight in alternative protein products that include the given technology (e.g., 15% of the weight of alternative meat & seafood is made up of cultivated cells)

Note that this approach can account for products combining multiple technologies without specifically prescribing the precise mix of all possible combinations.

Figures A3 to A5 illustrate the main assumptions for the three product categories, including assumptions for the three German scenarios and global adoption.

**Figure A3: S-curve assumptions for meat category**

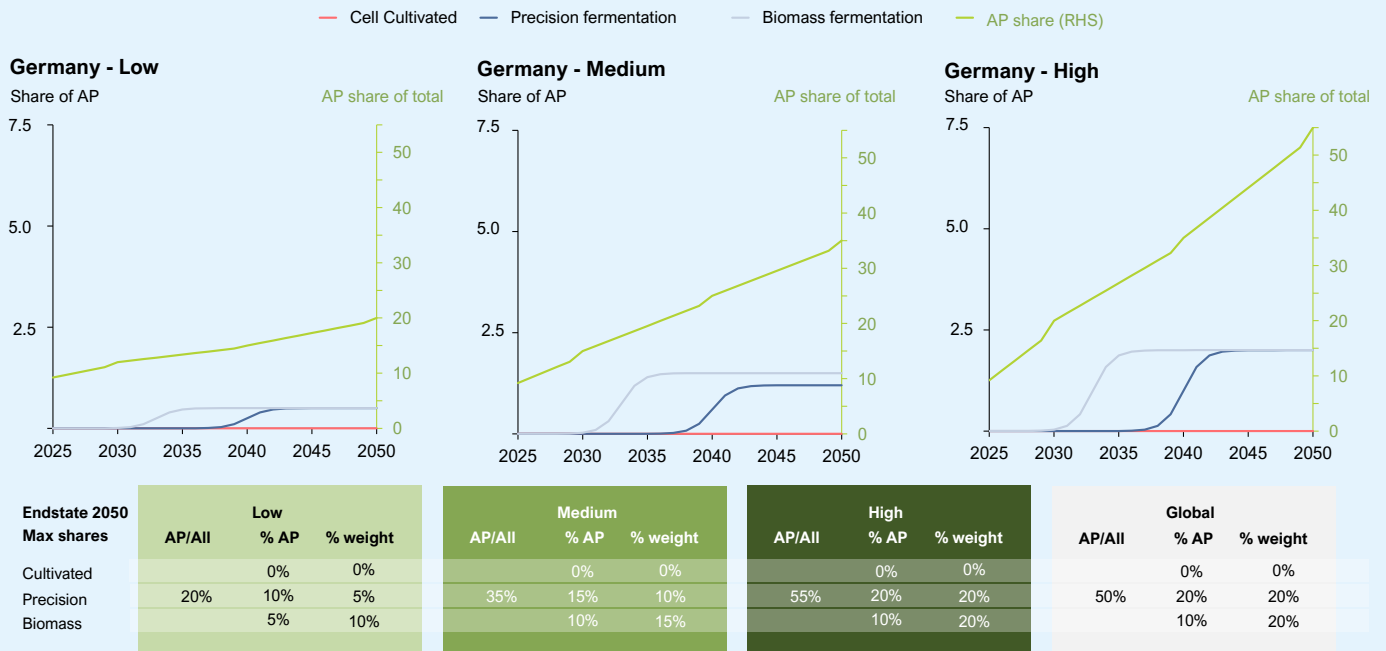
## S-curves Meat



Sources: AP uptake varies by scenarios, informed by global AP uptake predictions from existing studies and expert interviews. Maximum adoption of cultivated, biomass and precision fermentation based on expert interviews and assessment of relevant addressable market (e.g., fat / protein share of traditional products suitable for replacement).

**Figure A4: S-curve assumptions for milk category**

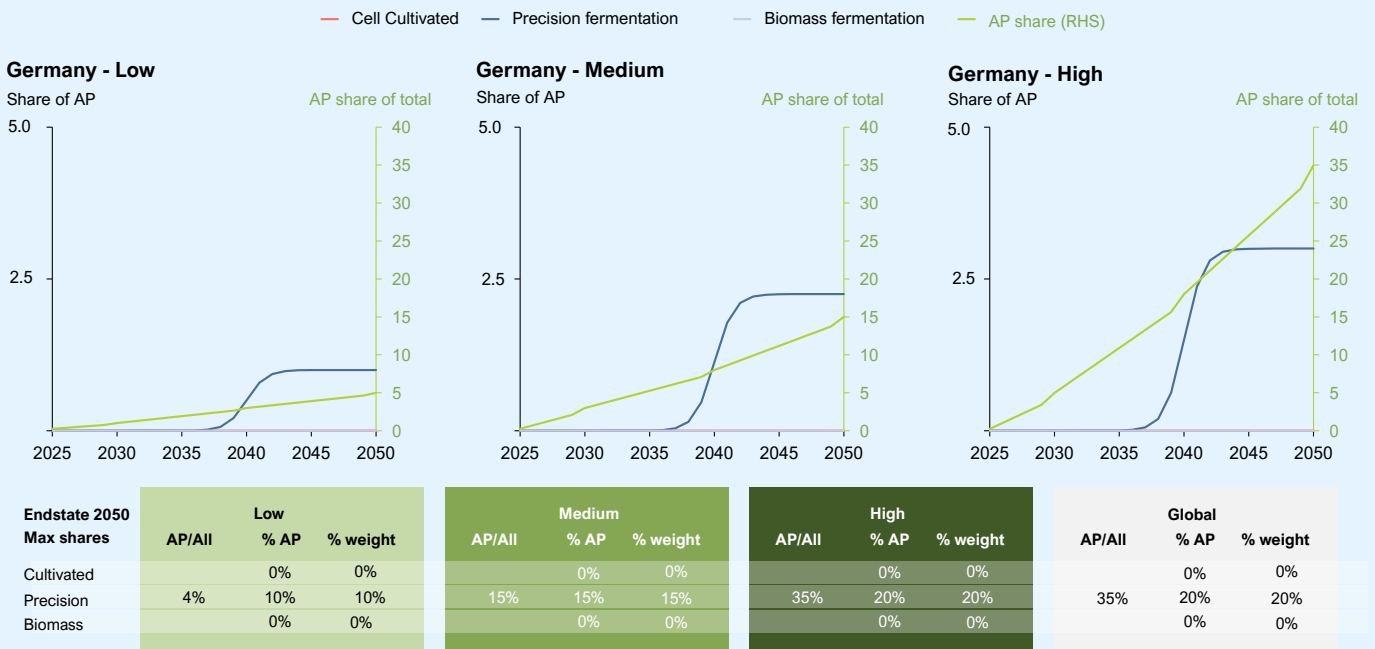
## S-curves Milk



Sources: AP uptake varies by scenarios, informed by global AP uptake predictions from existing studies and expert interviews. Maximum adoption of cultivated, biomass and precision fermentation based on expert interviews and assessment of relevant addressable market (e.g., fat / protein share of traditional products suitable for replacement).

**Figure A5: S-curve assumptions for egg category**

## S-curves egg



Sources: AP uptake varies by scenarios, informed by global AP uptake predictions from existing studies and expert interviews. Maximum adoption of cultivated, biomass and precision fermentation based on expert interviews and assessment of relevant addressable market (e.g., fat / protein share of traditional products suitable for replacement).

## End-product market size

To calculate the market size for alternative protein foods, we estimated current price points based on production costs today<sup>148</sup>. Price points for plant-based products were based on the reported weighted average category prices in 2023 based on GFI Europe (2024)<sup>149</sup>. For plant-based products, we assume that plant-based products will eventually become cheaper than their animal-based counterparts, reaching 80% of the current cost of animal-based foods.

For all other technologies, we assume price parity with animal-based alternatives is reached in the year of tipping points, with costs coming down linearly from today. The precise shape of this price evolution is less critical, as significant scale-up is only reached after parity is achieved.

Note: The direct market sizes of novel technologies understates their disproportionate impact, as they may provide ingredients that are critical for improved flavour or texture, while accounting for a small share of products. The modelling assumes that all technologies achieve price parity, but these critical ingredients could plausibly command a meaningful price premium. This would shift market size from e.g., plant-based to precision fermentation or cultivated solutions, as the end product price would remain competitive to animal-based alternatives.

## Input market sizes

Estimated relative costs of production are central to estimating the market sizes of critical inputs to the alternative protein sector. Figure A6 below outlines the relative contribution of major categories of inputs. These were developed based on available reports, expert interviews as well as subsequent expert validation. Market sizes for commodity inputs, specialised inputs, food processing equipment and specialised equipment were computed based on the volume of products sold multiplied by the estimated share of the final product price.

**Figure A6: Cost assumptions and distribution**

	Plant-based	Biomass fermentation	Precision fermentation	Cultivated	
				(today)	(at parity)
Commodity inputs	25%	25%	20%	12%	6%
Specialized inputs	10%	10%	20%	77%	36%
Food processing equipment	10%	5%	10%	2%	10%
Specialized equipment	5%	10%	10%	4%	10%
Buildings	5%	5%	5%	1%	5%
Labour	25%	25%	25%	2%	15%
Utilities	5%	5%	5%	1%	15%
Other inputs	15%	15%	5%	1%	2%
Final product	100%	100%	100%	100%	100%

## Domestic and export market sizes

To estimate domestic markets, historical trade data<sup>150</sup> was analyzed for proportion of the AP value chain markets that could be met domestically. For export markets, historical data for proxy markets was examined, identifying the existing exports from specific countries or regions to both the EU and the rest of the world (RoW). In light of the challenging global trade environment, the analysis assumes that Germany retains its export share under the high-ambition scenario. Under the medium scenario, this share is reduced by 25%, while in the BAU scenario, it is halved to reflect the assumption that Germany loses competitiveness in this sector to lower-cost production markets. Proxy markets were used for each part of the AP value chain (commodity inputs, specialised inputs, food processing equipment, and specialised



equipment) across each AP type (cultivated meat, biomass fermentation, precision fermentation, and plant-based). Further details on the proxy markets used can be found in Figure A7 below.

**Figure A7:** Overview of proxy industries and relevant trade potential

Proxy industry	Estimated proportion of domestic market met through domestic production	Estimated exported (for EU)	Estimated exported (for RoW)
Sugar and vitamins	75%	10%	1%
Pharmaceutical manufacturing	95%	5%	2.5%
Machinery and machinery for food, beverage and tobacco manufacturing	75%	10%	5%
Animal-based proteins	60%	5%	0.1%

All figures rounded and averaged, a range of % were used, varying by different product types

## Economic impact

### GVA

The total GVA contribution from the AP value chain was estimated based on - the direct economic contribution from the domestic AP market, additional export opportunities, and the indirect and induced GVA (such as total spending in the economy). The direct GVA contribution was calculated using an estimated average GVA rate, while the indirect and induced impact was derived from direct GVA multipliers for proxy industries<sup>151</sup>.

### Jobs

Estimated employment along the value chain was computed considering the employment intensity in proxy sectors. Specifically, the number of employees per €1 million revenue was used. For manufacturing sectors, these were based on Destatis (2024)<sup>152</sup>. Similarly, the average salary per employee was based on the reported salaries and headcount for these proxy industries.

Estimates for crop agriculture employment and productivity was estimated using a combination of sources. Namely, Eurostat (2023)<sup>153</sup> as well as estimated employment in crop production based on BLE (2023)<sup>154</sup> and Statista (2023).<sup>155</sup>

### Capital investment

The amount of capital investment was estimated based on studies estimating the cost of building facilities for plant-based<sup>156</sup>, biomass and precision fermentation<sup>157</sup> as well as cultivated products<sup>158</sup>. For fermentation, the bottom-up estimates for whole biomass were used to estimate costs for biomass fermentation, while production of lipids was used as a proxy for precision fermentation. To make these comparable, we derived a cost per thousand tonnes of annual capacity. As these represented initial construction costs, we annualised the costs over a lifetime of ten years. This lifespan was chosen to err on the side of overestimating the required costs. As outlined in the report, this is likely an overestimate, as production costs could significantly be reduced using retrofitting. We were also unable to account for the net-capital investment taking into account capital expenditure that would also be incurred without protein diversification to maintain existing infrastructure.

## Environmental impact

To assess the relative reduction in GHG emissions, land use and freshwater use, we multiplied alternative protein volumes by relevant emission factors<sup>159</sup> for the given product category and technology (see table of emissions factors below). This was compared to the estimated impact of producing the same quantity of animal-based products to assess the net reduction. It is important to note that there is inherent uncertainty in estimating the impact of alternative proteins, particularly more novel technologies, and therefore, these results should be treated as directional.

Environmental impacts of animal products reported in official German statistics use different methodologies and impact factors, which cannot easily be translated into comparable estimates for alternative protein technologies. To ensure we used consistent methodologies across technologies, while also aligning with reported environmental impacts<sup>160</sup>, we computed the relative impact reduction from shifting to alternative proteins. Namely, calculating the estimated environmental impacts if all products were animal-based and the percentage reduction achieved by substituting alternative proteins. This percentage was then used to estimate the environmental impact in relation to the officially reported statistics.

**Figure A8:** Environmental footprint factors

	GHG emissions in CO <sub>2</sub> eq	Land use in m <sup>2</sup>	Water use in L
<b>Cultivated meat products</b>	4	2.5	85
<b>Biomass fermentation products</b>	2.5	4	150
<b>Precision fermentation products</b>	2.5-4	0.1-7	85
<b>Plant-based products</b>	1-2	2.5	10-160
<b>Animal-based products</b>	2.5-12	6-50	550-700

All figures rounded and averaged, a range of % were used, varying by different product types

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