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WORLD ECONOMIC FORUM

Next Generation Bio-Innovation: Delivering Commercial Value

BRIEFING PAPER

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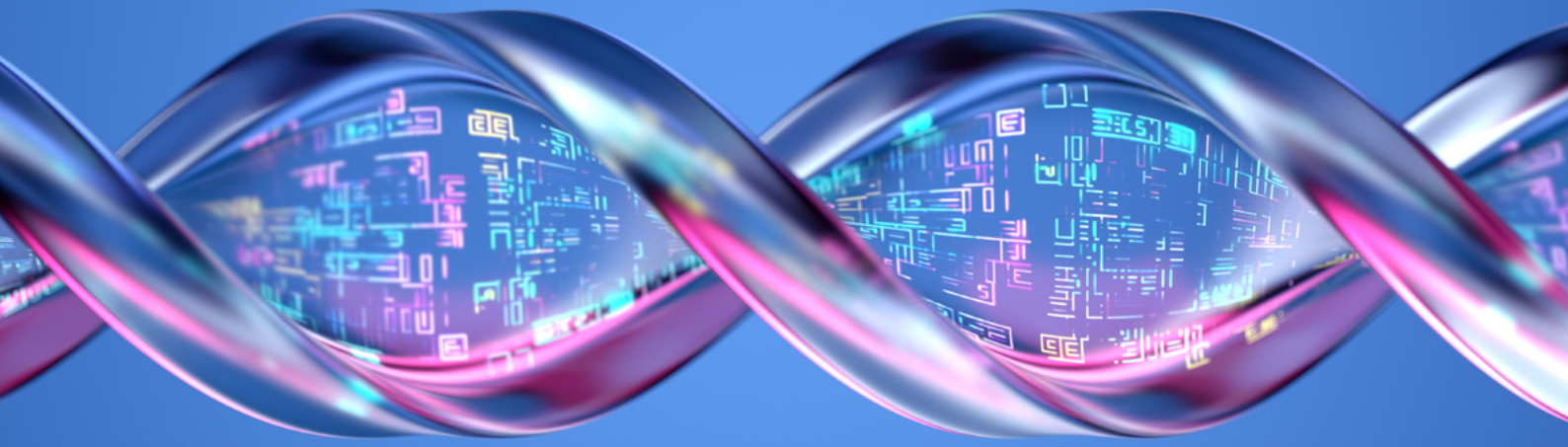

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Contents

A focus on commercial value	3
Reframing bio-innovation for differential customer value	6
Beyond the customer: Production system value is fundamental to unlocking value-chain transformation	9
Moving forward: Designing for greater commercial viability	11
Contributors	12
Endnotes	13

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A focus on commercial value

Biology is poised to drive commercial value. A shift towards differentiated value creation can transform the bioeconomy.

With potential for far-reaching implications in virtually every industry, bio-innovation holds promise for a better world. In many cases, biology offers distinctive commercial advantages unmatched by other approaches. Despite compelling attributes, the bioeconomy has yet to drive meaningful transformation for both consumers and businesses. Building technology is not enough – a fundamental shift from the current technology-push mindset to a deliberate focus on market pull and differentiated value creation is essential. In the absence of this shift, bio-innovations will continue to face an uphill battle to break through industries and become true drivers of transformational change.

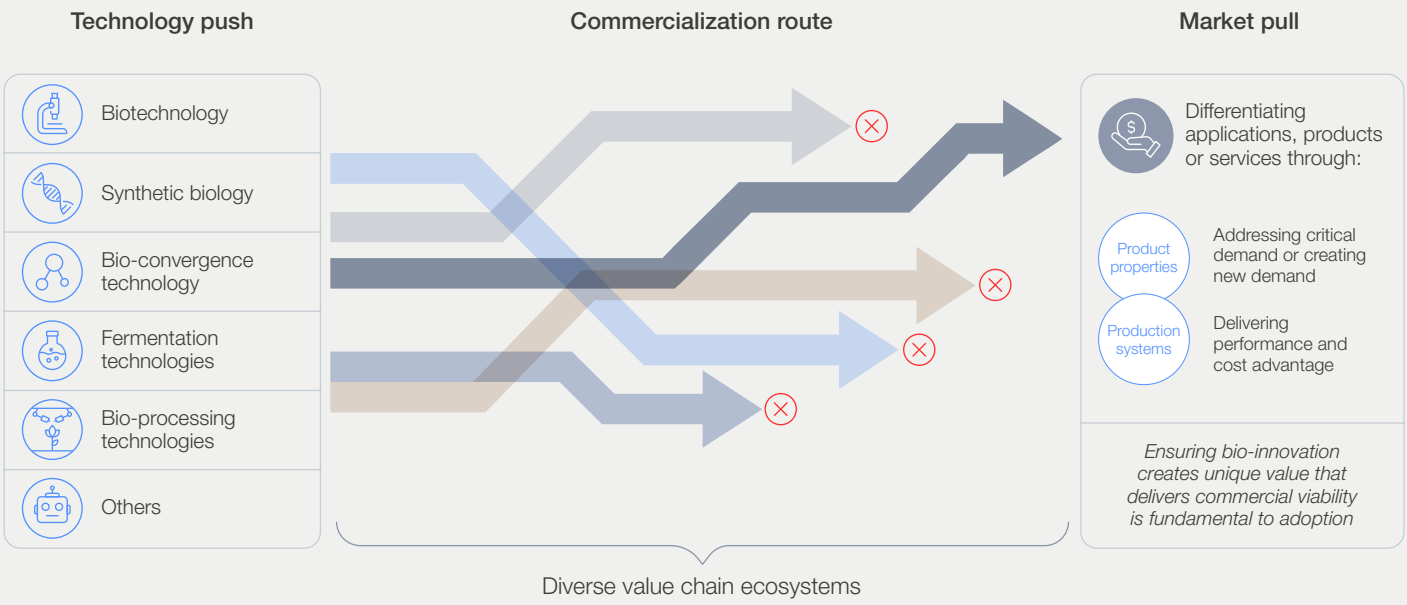
Shifting towards differentiated value creation to transform the bioeconomy. Bio-innovation lacks a compelling articulation of value that would resonate with diverse stakeholders. To gain market traction, bio-innovation must not only be technically achievable at scale, but also deliver sufficient value. Furthermore, bio-innovation must solve the right customer problem while simultaneously driving commercial viability. Adding to the complexity, bioeconomy perceptions differ across regions and industries, making the required articulation of value and alignment on the potential ecosystem-wide transformation challenging. This paper proposes a reframing of the value of bio-innovation that can unite policy-makers, investors, regulators, consumers and business leaders around an inspiring vision of what is possible when employing biology as commercial technology.

Biology's commercial value is under delivering. Still struggling to successfully navigate the "valley of death" (i.e. scaling and overcoming commercial pressures to achieve profitable growth), bio-innovation must refocus on unique value creation that delivers commercial viability, so that it can achieve widespread adoption across industries (see Figure 1).

Since the early 2000s, the rapid expansion of biotechnology tools – alongside the convergence of complementary technologies – has driven significant investment aimed at unlocking the commercial potential of biology. The combined biotechnology industries of the United States (US) and Europe, for example, secured approximately $81.1 billion in capital in 2023,[1] and the recent investments of SGD (Singapore dollar) 44.8 million into Singapore's Sustainable Bio-manufacturing Technology Platform (SBTP),[2] $7 billion from the Ministry of Economy, Trade and Industry of Japan (METI) to support Japanese start-ups[3] and over $200 million into two BioMADE US pilot facilities[4] further underpin regional commitments to commercial bio-innovation.

Up to this point, biotech investments have largely resulted in a technology-push environment that is ill-aligned to existing demand or has failed to create the necessary demand. Where successful, bio-innovations have met significant market needs and struck the right balance for commercial viability – highlighting the potential for exploring various value types and real-life examples of commercial success.

FIGURE 1 | **Shifting to a market pull environment requires focus on delivering commercial value**



Source: World Economic Forum analysis, Bioeconomy Community input

Biology will deliver differentiating value. Biology offers unique value, enabling businesses to innovate and address significant challenges. Earlier positioning around how bio-innovation value addresses demand will shape the corresponding impact. To clarify positioning, two distinct yet interconnected lenses for differential value creation through biology can be applied: product properties and production systems (see Figure 2).

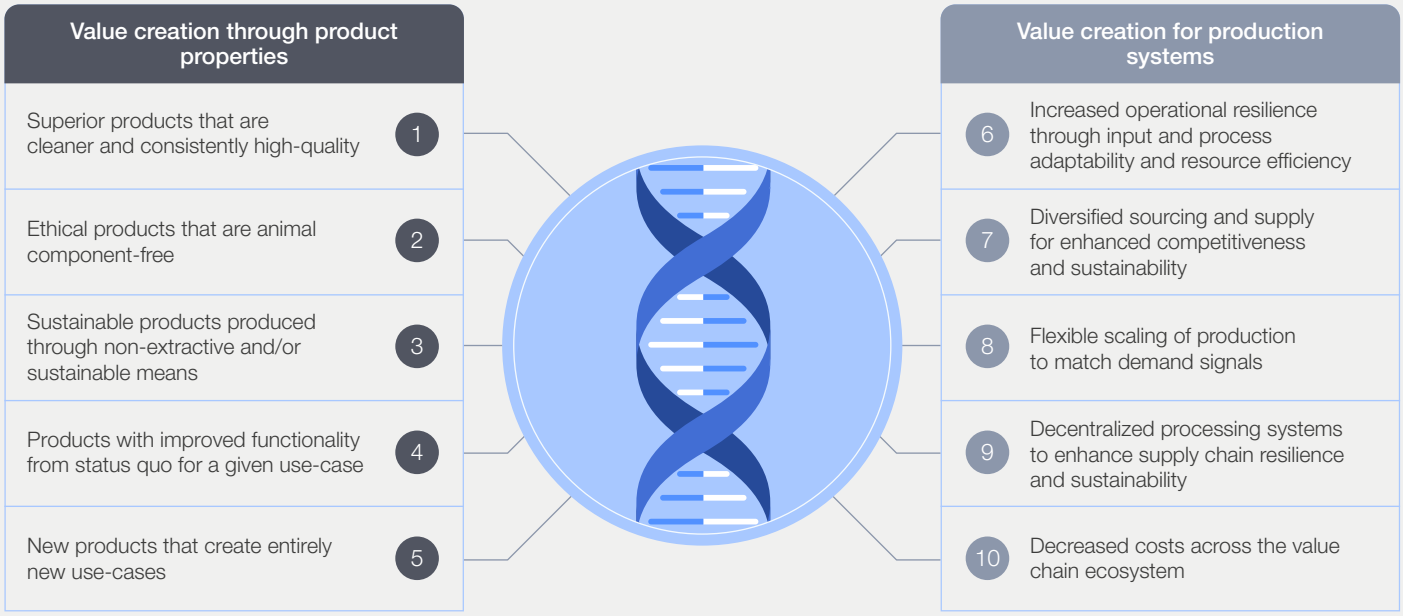
- **Value creation through product properties.** Bio-innovation is capable of replacing existing inputs or products with responsibly produced bio-based alternatives. Bio-innovation is also producing fundamentally novel products that transform how businesses operate and/or how people experience daily life. Such benefits must be readily perceivable for customers, including both businesses and end-consumers, and perceived as superior for a given use case.

- **Value creation for production systems.** Biology-driven processes and approaches present value for businesses that incorporate them into their production systems. By enhancing operational environments and reshaping value chains to deliver innovative products and services, bio-innovation provides more flexibility and resilience in the face of market pressures, and within regulatory and policy boundaries, to better respond to market demands.

These categories are not mutually exclusive, but rather synergistic – improving production systems will benefit customers, and differential bio-based products will benefit all players in the production system. Bio-innovations span a wide range of industries and are diverse in how they integrate into value chains; thus, they will vary greatly in how, and the extent to which, they deliver value.

Commercial success depends on how different types of value are combined and leveraged to enable business models that meet market needs or reshape markets through differential value creation for customers.

FIGURE 2 | **Forms of differential value creation enabled through bio-innovation**



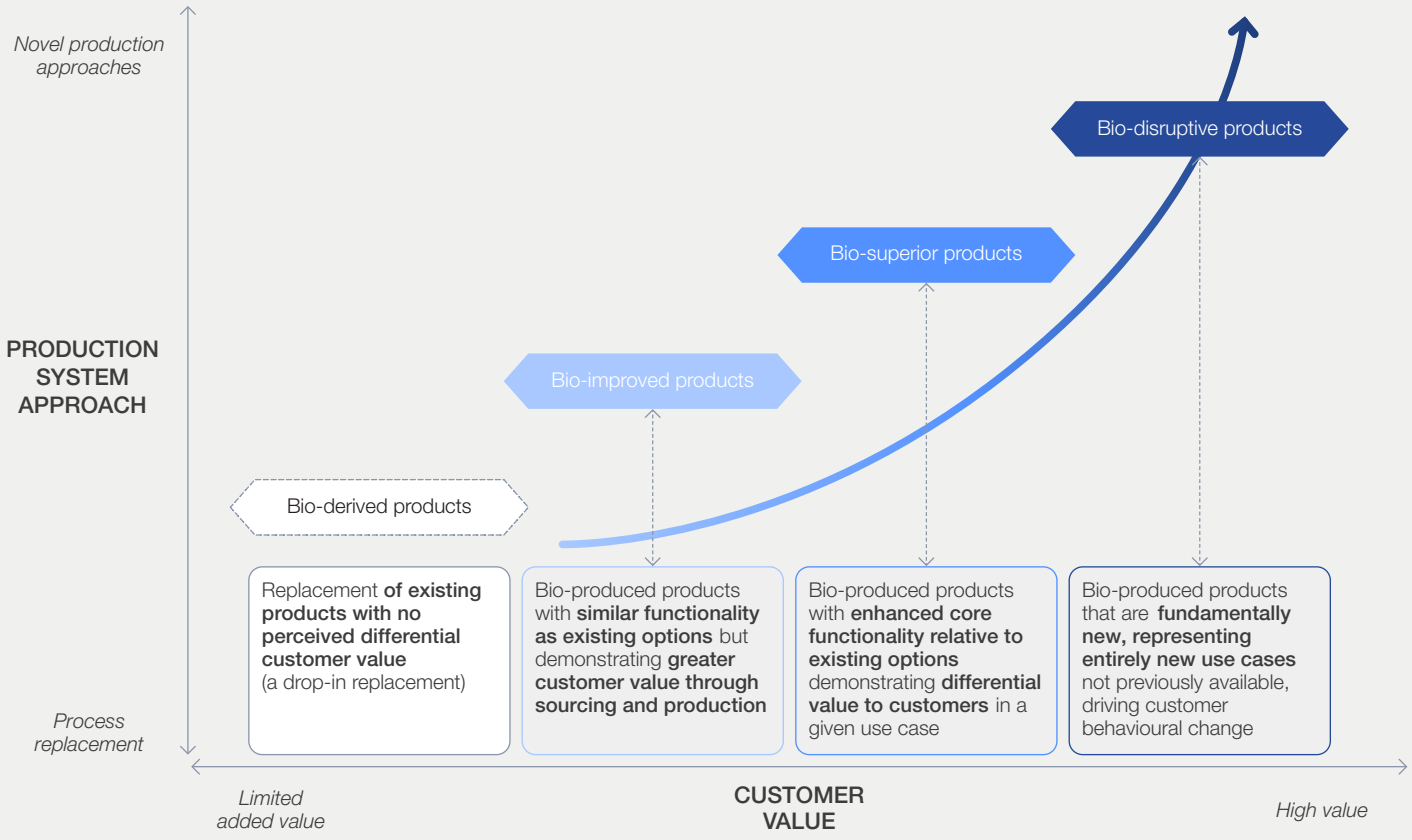
Source: World Economic Forum analysis, Bioeconomy Community input

Reframing bio-innovation for differential customer value

To better position bio-innovation for widespread commercial success, a transformative shift in mindset re-centred around value creation is needed. Bio-innovations have been historically categorized as either drop-in replacements or entirely novel products. While framing the value chain contribution of bio-innovation in this way can be useful, it emphasizes a process-centric view rather than the value created.

To reframe bio-innovation around value for the customer, four broad areas of value creation can be highlighted: bio-derived, bio-improved, bio-superior and bio-disruptive products (see Figure 3).

FIGURE 3 **Reframing bio-innovation in terms of differential customer value created, relative to the production system approach**



Source: World Economic Forum analysis, Bioeconomy Community input

Note: With higher customer value, a wider variety of production system approaches may be employed, but will be biosolution-specific, and is not articulated here.

Bio-improved value creation offers differential value to the customer: To produce bio-derived and bio-improved products, bio-enabled processes can be used to replace existing processes; the value lies primarily in enhancing the production system. The value in incorporating these approaches must be carefully articulated to businesses – this is addressed further in the upcoming section "Beyond the customer".

The distinction between bio-derived and bio-improved products lies in the value perception for end-customers. For consumers, bio-derived products are often "invisible" and hence fail to capture their attention and drive demand. Examples of these universal, under-the-radar bioproducts include citric acid, monosodium glutamate (MSG), xanthan gum and many detergent enzymes, to name a few. These examples underpin several industries and have been bio-produced at scale globally for decades.

Conversely, bio-improved products can drive demand by capturing consumer desires such as being animal component-free, cleaner, consistently high-quality, sustainably produced or more ethical than existing end-products of similar core functionality (see chymosin, Table 1). For business customers, bio-improved products can enable new ways of achieving end goals, delivering benefits for the production system (such as getting the product to market faster) in addition to increased perceptible value for end-customers (see hyaluronic acid, Table 1). Communicating the inherent value of bio-improved products through sales and marketing channels will define and drive demand generation.

Unique product performance through biology: Both bio-superior and bio-disruptive products create differential functional performance through biology. For consumers, bio-superior products are improved everyday products such as food, household items or health supplements (see Sicilian Rouge tomato, Table 1). For businesses, bio-superior products can enhance production systems, such as maize seeds developed for superior growth characteristics (see TELA maize, Table 1), or the improvement of final product formulations, such as the incorporation of spider silk products, like those produced by AMSilk, into diverse, high-performance materials. By creating differential value for customers, better-performing products can create new product niches or acquire market share by substitution within existing categories.

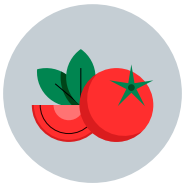
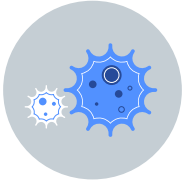
Bio-disruptive products represent an entirely new use case or solution in the eyes of the customer. By creating fundamentally new value for customers, their evolving needs and preferences can be addressed; the corresponding value is determined by how a product impacts their daily lives. The mRNA Covid vaccine, for example, is disrupting how vaccines are produced and delivered for consumer benefit. CAR-T therapies also represent an entirely novel approach to immune therapy, and while they currently face cost and scaling challenges, they provide significant value to patients (see CAR-T therapies, Table 1). For businesses, disruptive products can transform their production, modify commercial models and create value downstream for end-consumers (see Nitrogen-fixing microbes, Table 1).

Bio-convergent technology to enhance value creation: The spectrum of production system approaches is not correlated with technology sophistication across these four areas – the development of a drop-in replacement may require novel, advanced technologies; conversely, an entirely novel product could result from replacement with bio-based approaches.

By combining rapidly expanding capabilities in biology with convergent technologies – such as advances in synthetic biology, artificial intelligence (AI), data approaches, bio-sensing, additive manufacturing and robotics – bio-innovation can drive value by transforming production systems and creating unique, impactful products and services, while at the same time servicing unmet needs. For example, ongoing research into bio-engineering approaches for hyaluronic acid (HA) are demonstrating the potential for enhanced production and functionality, moving beyond cosmetics into diverse biomedical applications.[5]

Value creation is fluid and evolves as technologies change, enhancing the ability to target value during solution design. Therefore, bio-innovation must be framed around the value itself, with technology reframed as a fundamental enabler, instead of the ultimate driver of value.

TABLE 1 **Examples to highlight three key areas of differential product-driven value creation**

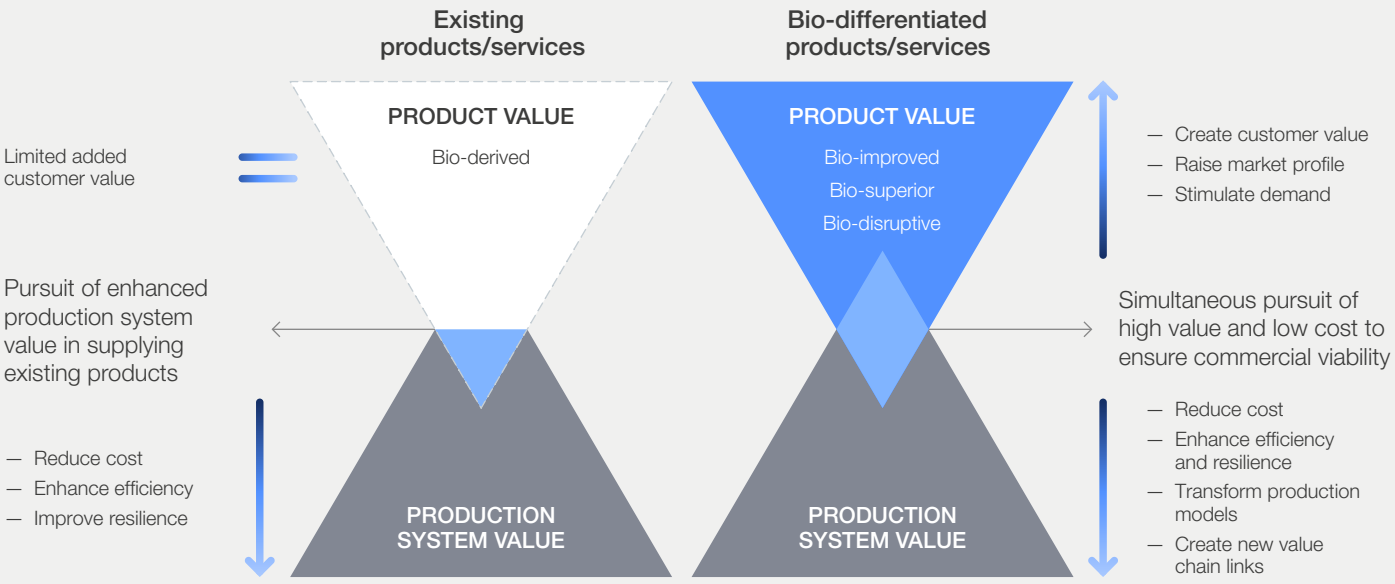
Product-driven value creation	Business value examples	Consumer value examples
Bio-improved product	**Hyaluronic acid** Traditionally extracted from rooster combs, hyaluronic acid (HLA) is now primarily produced by microbial fermentation. Bio-produced HLA is animal-component free, has lower production costs, reduced environmental pollution and tailorable molecular weights.[6] With growing consumer demand, the global HA market size is calculated to be $11.14 billion in 2025.[7]	**Chymosin** Chymosin gained US Food and Drug Administration (FDA) approval in 1990.[8] Originally sourced from calf rennet, chymosin is alternatively produced from engineered yeast. The majority of hard cheese in the US and the United Kingdom uses fermented chymosin,[9] providing a vegetarian, ethical alternative.
Bio-superior products	**Hybrid maize** TELA hybrid maize varieties are genetically engineered for improved insect resistance and drought tolerance, and up to 60% increase in yield. Most recently in February 2025, Ethiopia joined South Africa, Nigeria and Kenya to approve the commercialization of biotech maize, supporting millions of farmers across Africa.[10]	 **Sicilian Rouge tomato** Sanatech Seed's Sicilian Rouge tomato variety is engineered using the CRISPR-Cas9 technology to increase levels of gamma-aminobutyric acid (GABA), claimed to support lower blood pressure and promote relaxation. From development to commercialization in Japan in just two years, its online sales began in September of 2022.[11]
Bio-disruptive products	**Nitrogen-fixing microbes** As of 2024, Pivot Bio's nitrogen-fixing microbial products, which can replace up to 25% of traditional fertilizer usage, were used on over 5 million acres of US farmland. With just 2% of the emissions of synthetic fertilizer and manufactured with 1,000 times less water, the potential operational value is substantial.[12]	 **CAR-T therapies** Personalized CAR-T therapies, such as those provided by Novartis,[13] provide targeted cancer treatments with improved efficacy and increased specificity compared to traditional approaches.[14] The global CAR-T cell therapy market for drugs with Kymriah's indications was valued at $4.38 billion in 2023 and is projected to grow to $16.35 billion by 2032.[15]

Source: World Economic Forum analysis, Bioeconomy Community input

Beyond the customer: Production system value is fundamental to unlocking value-chain transformation

Bio-innovation can create differential product value that is transformative both for consumers and in how businesses create value through production systems. Bio-enabled approaches must also be deployed in existing production systems and value chains in a way that is commercially more attractive and/or offers increased resilience (e.g. by competing on cost or improving supply chain resilience) (see Figure 4).

FIGURE 4 **Production systems enhancement plays different roles in overall commerciality**



Source: World Economic Forum analysis, Bioeconomy Community input

For existing products, bio-enabled approaches such as precision fermentation, can be used to create competitive bio-derived substitutes where production system value is the primary driver for adoption. Attributes including improved supply chain efficiency, cleaner or safer production processes and sustainability benefits provide important advantages to businesses. Furthermore, while the customer may perceive little additional value in the end-product from such attributes, corporations may achieve broader profitability and gain a business advantage through production transformation and technological innovation.[16]

Bio-innovation isn't just for start-ups and therapeutics, it is poised to become the backbone of industrial production.

These advantages are more applicable to established, complex value chain ecosystems that are incorporating sustainable inputs or processes; bio-innovation isn't just for start-ups and therapeutics, it is poised to become the backbone of industrial production.

For bio-improved, bio-superior or bio-disruptive products in particular, achieving commercial viability can be more difficult due to higher upfront costs and scaling challenges. Bio-innovation can no longer rely on green premiums, and must be competitively priced, implying that production system approaches must be cost effective. Given the unique nature of these solutions, value chains and ecosystems must be positioned for adaptation, transformation or even complete creation through innovative production system approaches (such as decentralized production) to address demand with viable commercial models.

In both cases, production system value is key to balancing the commercial viability equation. Commercial bio-innovation provides opportunities for businesses to become more resilient, flexible and versatile in how they source and operate; and to focus on reducing supply chain risk and lowering costs across the value chain. The time is now to reimagine how products and services are grown, sourced, processed, produced and delivered.

Moving forward: Designing for greater commercial viability

Bio-innovation has shown glimmers of promise across industries to drive markets and in the future-proofing of value chains. Given the significant challenges that persist, many bio-innovations have failed to establish commercial viability by leading with a "technology-first" lens with too little focus on "make-or-break" commercial factors. To move beyond the technology-push approach of hype cycles of the past, bio-innovation must be designed earlier for value creation, seamlessly integrating backwards to drive existing and new business models and production set-ups.

History has repeatedly demonstrated that green premiums don't work; a meaningful transformation won't be possible on price parity alone. Wider value must be created, captured and conveyed. Such a transformation requires sharper focus on market drivers and a concrete understanding of where product value will be higher (e.g. higher-paying segments or new value areas).

Beyond responding to and capturing existing value, bio-innovation must generate future demand through strategic commercialization that is supported by enabling policy, funding and accessible technology, and appeals to and educates customers. To unlock commercial viability, bio-innovations must align with regulation and deliver value for both production systems and end-consumers. Technology remains central to shaping this value, but it represents only one step in the journey to realizing a truly commercial, scaled bioeconomy.

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Endnotes

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