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What Do Bitter Greens Mean to the Public?

A growing bioeconomy must prioritize new forms of public engagement and transparency.

When I heard that a North Carolina biotech company had used gene editing technology to create a new mustard green with less bitterness earlier this year, I laughed. The company cofounder boldly claimed it was “a new category of salad.” But bitter greens are a cultural tradition that I hold dear—they are not just some green leaf that would be more desirable if it tasted like a Jolly Rancher. When I told my mother about the new mustard green, she paused, looked at me, and promptly responded, “It sounds like all they did was remove the culture.” I say this not to oppose the innovation, but to point out that the conversation around it clearly did not include my community. This extends to more complicated topics in the application of biotechnology, which feature the loud voices of companies, activists, and scientists, but not the wider, quieter opinions of, say, my relatives or the many Americans who value food in different cultural, economic, religious, spiritual, historical, and profoundly personal ways. If biotechnology is to be widely regulated and accepted, many more people need to be invited into the conversation about what we value, what our aspirations are, and how this technology should be applied.

The movement to build the US bioeconomy has gained significant momentum over the last decade, leading scientists and policymakers to forecast industrial revolutions in medicine, food, fuel, and materials. In its *Bold Goals for Biotechnology and Biomanufacturing*

report, the Biden administration’s Office of Science and Technology Policy (OSTP) sketched out a vision of “what could be possible with the power of biology,” including the sequencing of the genomes of one million microbial species in the next five years, and the replacement of more than 90% of plastics with biobased feedstocks in the next 20 years. As others have written, realizing this future will take concerted, cross-sectoral efforts to build a multidisciplinary workforce, create a coordinated regulatory framework, and equitably distribute the benefits of the transformation to communities across the country.

Overlooked in these projections, however, is the reality that even if these other elements fall into place, advancing the bioeconomy requires public trust. When it comes to a consumer’s purchase of a biotechnology, the pivotal factor is often not price but trust. A 2009 report from the Organisation for Economic Co-operation and Development warned that consumer acceptance and demand for bioeconomy-related products would require active support from governments and engagement from the public at large. Although studies continue to show the importance of citizen engagement in building public trust in science and innovation, the current mechanisms for public engagement in the regulatory process fall short of delivering public acceptance of biotechnology.

At this stage, the administration has a unique opportunity to address this issue directly by creating new

mechanisms for public engagement. If correctly structured, these processes could serve as a resource for decisionmakers and support the formation of a data repository for evaluating how public perceptions evolve over time.

As a soil biogeochemist and ecologist focused on sustainable agriculture for climate change mitigation, I am energized by the transformative potential of a new bioeconomy era. But I believe the surest path forward will prioritize building trust through new forms of public engagement and transparency.

Influences on public trust

Pathways for building public trust in biotechnology products and techniques must work with the ecosystem of federal regulators, product developers, researchers, and consumers. Federal regulation of the bioeconomy is carried out by three key agencies: the US Environmental Protection Agency (EPA), Food and Drug Administration (FDA), and Department of Agriculture (USDA). Through the regulatory process, the federal government acts as a broker of public trust in biotechnology by providing guidelines that govern

public engagement that promotes “bi-directional exchange of information and perspectives” between researchers and the public can increase trust. A more recent workshop of the Genetic Engineering and Society Center of North Carolina State University on gene drives in agriculture also highlighted the importance of considering public perception and acceptance in risk-based decisionmaking, in the context of developing further research priorities in the field.

Much of today’s framework for biotechnology regulation involves expert deliberations, but the opinions of the public at large are essential to move products into the marketplace. Historically, spaces that allow for dialogue on values, sentiments, and opinions on biotechnology have been dominated by technical experts who keep the discussion confined to issues of their own concern, using relatively narrow terms to label areas of contention. For example, the “product versus process” debate is one of the most contested in the regulatory system for biotechnology. But such narrow approaches to dialogue rarely advance consensus. Since the biotechnology discourse has been inaccessible to general

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the interactions between developers and consumers of biotechnology. Over the past three decades, product developers have depended on strategic alliances with industrial partners from pharmaceutical, agricultural, and food processing corporations to ensure the success of biotechnology within the marketplace. Given that the regulatory approval process for pharmaceuticals can easily exceed 10 years, government partnerships—through technical services or research and development contracts—offer biopharmaceutical companies a financial lifeline during the premarket phase. These strategies demonstrate a regulatory flexibility that could just as easily be directed toward mechanisms that build public trust.

The academic research community is often caught in the center of debates squaring the frontiers of research and innovation with questions of ethics, risk assessment, and public perception. In 2016, the National Academy of Sciences, Engineering, and Medicine (NASEM) released recommendations on aligning public values with gene drive research. Though gene drive research has tremendous potential to offer solutions to complex agricultural and public health questions, the possibility of the uncontrolled spread of genetic changes raises numerous ethical, regulatory, socio-ecological, and political concerns. The NASEM report revealed that

audiences, the opinions of experts continue to drown out calls of concern.

Public engagement programs that gather a wide range of opinions across issues central to the advancement of the bioeconomy could help researchers and policymakers put public concern into context, which will add value to the entire regulatory ecosystem. Regulation informed by science and responsive to the values of citizens will more effectively strengthen the sustainability of the US bioeconomy.

Seizing an opportunity

For the first time in the nearly 40-year history of biotechnology governance, the 2022 CHIPS and Science Act directs OSTP to establish a coordination office for the National Engineering Biology Research and Development Initiative charged with, among other activities, conducting public outreach and serving as coordinator of “ethical, legal, environmental, safety, security, and other appropriate societal input.” This policy window presents a novel opportunity to reify a regulatory system for the bioeconomy that also encompasses the voices of the public at large.

The Biden administration should start this work by establishing a bioeconomy initiative coordination office

(BICO) within OSTP to foster interagency coordination and provide strategic direction. The office should then create a set of public engagement programs, guided by an advisory board in coordination with EPA, FDA, and USDA, to meet three main priorities.

The first priority should be to involve an inclusive network of external partners to design forums for collecting qualitative and quantitative public acceptance data. The advisory board should include consumers (parents, young adults, patients, etc.) and multidisciplinary specialists (for example, biologists, philosophers, hair stylists, sanitation workers, social workers, dietitians, etc.). Using participatory technology assessments (pTA) methods, the BICO should support public engagement activities, including focus groups, workshops, and forums to gather input from members of the public whose opinions are systemically overlooked. The BICO office should use pre-submission data, past technologies, near-term biotechnologies and, where helpful, imaginative scenarios such as science fiction to produce case studies to engage with these nontraditional

complements Findable, Accessible, Interoperable, Reusable (FAIR) Principles, so that data management is clearly in the interest of the public. In the end, public acceptance data will provide new insights to new audiences and underpin a public-facing framework that can advance the bioeconomy.

The third priority should be to translate this social data into biotechnology regulation. BICO public engagement programs could be used to develop an understanding of noneconomic values in reaching bioeconomy policy goals. These could include, for example, deeply held beliefs about the relationship between humans and the environment, or personal or cultural perspectives related to specific biotechnologies. The program could collect data from nontraditional audiences through pTA methods and multiple criteria decision analysis. Workshops hosted through the program could be used for long-term and short-term horizon scanning. In the short term, information about public perception on products can be used to better understand obstacles to public acceptance, and to support the development of outreach programs,

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audiences. Public engagement should be hosted by external grantees that maintain a wide-ranging network of interdisciplinary specialists and interested citizens to facilitate activities.

The second priority should be for the BICO and its advisory board to translate the raw data collected through these activities into recommendations for regulatory agencies. All public acceptance data (qualitative, quantitative, and recommendations) should be gathered into a repository that can complement the already developing “biological data ecosystem” called for in President Biden’s executive order on advancing biotechnology and biomanufacturing innovation. The biological data ecosystem will include a mix of public, private, and confidential data types and sources. Incorporating data on public acceptance could provide regulators with insights on novel biotechnologies, and even help BICO match product developers with communities to seed cross-sector partnerships. Management and use of this data should employ governance standards that are people- and purpose-oriented, including Collective Benefit, Authority to Control, Responsibility, Ethics (CARE) Principles for Indigenous Data Governance, which

tools, and strategies to incorporate public feedback. In the long term, the BICO will be able to inform regulatory policy development with richer data on socioeconomic and cultural preferences.

Historically, biotechnology regulations have struggled to strike a balance between transparency and protection. Recent federal action to improve coordination around the development of the bioeconomy has provided policymakers with another chance. Cultivating public acceptance and demand for biotechnology products—as speculative and futuristic as some may sound—will take a concerted effort to recognize and engage the public at large. Investment in building public engagement resources and practices now will put the bioeconomy on a more sustainable path in the future.

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