

Ensuring Sustainable Novel Plant Biotechnologies Requires Formalized Research and Assessment Programs

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It is becoming abundantly clear that new technologies and innovative solutions are needed to ensure a safe, abundant, and sustainable food system. New and novel plant biotechnologies, including recent advancements in genetic engineering and gene editing, have allowed for the development of new food and agricultural products on the market (e.g., gene-edited mustard greens and genetically engineered purple tomatoes), with many more on the horizon. Many of these plant biotechnologies have the potential to provide a range of sustainability benefits, such as reduced environmental impacts, increased resilience to climate change (e.g., heat, drought, and salinity resistance), as well as health benefits (e.g., nutrition). This is commendable, given the urgent need to develop more sustainable agricultural solutions, while aligning with federal calls to advance a sustainable bioeconomy in the United States.¹

While there is a general consensus about the need to ensure novel plant biotechnologies contribute to sustainable food and agriculture systems, there is not yet a consistent, harmonized, or formalized set of assessment tools or parameters for measuring sustainability. Current assessment and oversight processes for plant biotechnologies have traditionally focused on a narrow set of parameters that predominantly evaluate environmental and human health risks and safety and have not incorporated broader considerations such as transparency and stakeholder inclusion.² Meanwhile, numerous studies have documented that stakeholders identify a broader range of criteria when evaluating novel biotechnologies in food and agriculture.^{3,4} As our society faces an ever increasing need to ensure food security to feed a growing population within a changing climate, while also dealing with increased levels of complexity, interdependence, and polarization, it is imperative that novel agricultural biotechnologies be adequately assessed for their sustainability using consistent, formalized assessment tools. In summary, we find that there is an unsuitable gap between the current assessment and oversight processes for plant biotechnologies and the current tools and programs

needed to evaluate their sustainability while also aligning with stakeholder preferences and needs.

To close this gap, we call for the establishment of formalized research programs that develop a suite of tools and approaches needed to evaluate the sustainability of novel plant biotechnologies befitting the 21st century. To do this, one option is to assemble a central coordinating office at the federal level (e.g., through the Office of Science and Technology Policy) that oversees and manages research focused on sustainability assessments for biotechnologies, including applications in plants. The National Nanotechnology Coordination Office could serve as an example of how a centralized office can provide technical and administrative support to coordinate research areas within a technological umbrella, share data and information among stakeholders, and engage the public. For novel biotechnologies, a centralized office could be tasked with compiling and coordinating research on sustainable plant biotechnologies conducted at the federal level [e.g., U.S. Department of Agriculture (USDA), Environmental Protection Agency, and Food and Drug Administration] and from federally funded research grant programs (e.g., USDA's Biotechnology Risk Assessment Grant program, Social Implications of Food and Agriculture Technologies program area). The central office could also collaborate with international organizations and initiatives, such as the Organisation for Economic Co-operation and Development and Food and Agriculture Organization to improve harmonization on a global scale. Through this compilation and coordination effort, a database of federally funded projects focused on sustainability assessments of novel plant bio-

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technologies could be developed and made publicly available, potentially linking to and drawing from already-established databases such as USDA's Current Research Information System. After compiling information on existing research projects focused on the sustainability assessment of novel plant biotechnologies, the central office could then coordinate with federal institutions to develop specific funding mechanisms (e.g., Request for Proposals and Request for Applications) to advance the development of formalized sustainability assessment tools and approaches. These funding mechanisms would complement existing programs within the fields of risk assessment, biosafety, biosecurity, and regulatory sciences of biotechnologies.

In addition, the centralized office could be tasked with establishing a common set of parameters that would be used to evaluate sustainability across dimensions of health, ecological, and ethical, legal, and societal implications, spanning both potential benefits and risks. This list of common parameters could start with those already proposed by various scholars (e.g., ref 5), elicit public comment from diverse stakeholder groups, and finalize the list of sustainability assessment parameters for novel plant biotechnologies. Ideally, such a common set of parameters could also be used by decision makers (including those in review and approval processes) to determine the degree to which a novel plant biotechnology is "sustainable" across various dimensions. Developing and utilizing a list of sustainability parameters could also help developers and innovators of novel plant biotechnologies look beyond risk and safety assessments and drive them toward considering a broader list of parameters to determine sustainability in their own work. Other options include developing sustainability certification programs for novel plant biotechnologies, similar to what has been implemented in forestry and for some agricultural commodities.²

Developing formalized research and assessment programs in sustainability assessments will undoubtedly require investments in resources as well as political will to be realized. However, without adequate investments in research programs to formalize and develop fit-for-purpose assessment tools and approaches, the process of developing these tools/processes based only on "bottom-up" efforts by individual researchers will not be able to keep pace with the degree of innovation. As biotechnology researchers and developers tout the ability of new gene editing and other emerging technologies to improve ecological sustainability and food security, we believe that the research to back up these claims is important for public trust and legitimacy, especially given the contentious history of the first generation of genetically modified organisms in agriculture. As the research on sustainability assessment for biotechnology in agriculture grows and matures and societal consensus about the parameters for assessment is reached, incorporating these assessments into more formal decision making for emerging biotechnologies in agriculture will be important for steering the field in directions that can live up to the promises made by biotech developers.

In conclusion, to ensure sustainable food systems that rely on novel plant biotechnologies, sustainability must be assessed through a formalized research program with fit-for-purpose tools and approaches. This Viewpoint puts forward one approach for establishing such formalized research programs to develop a suite of tools and approaches needed to evaluate the sustainability of novel plant biotechnologies befitting the 21st century (Figure 1).

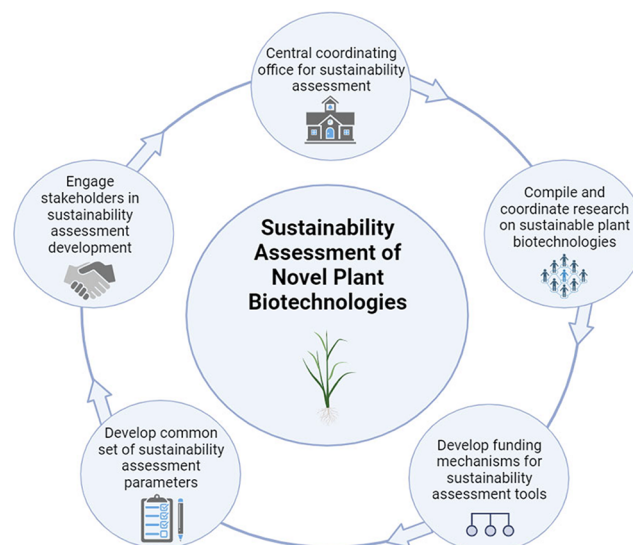


Figure 1. To ensure sustainable food systems that rely on novel plant biotechnologies, sustainability must be assessed through formalized research programs with fit-for-purpose tools and approaches. This Viewpoint puts forward one approach for establishing such research programs for evaluating the sustainability of novel plant biotechnologies befitting the 21st century.

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Notes

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