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A report summary from the Economic Research Service

Biotechnology in U.S. Crop Production: A Primer on Adoption, Costs, and Regulatory Structure

Daniel Bonin, Jonathan McFadden, Laura Dodson, and Sam Bailey

Key Points

- Genetically engineered (GE) crops have become a cornerstone of U.S. agriculture, with USDA data showing adoption rates exceeding 90 percent of planted acres for corn, cotton, and soybeans since 2013, as well as industry estimates showing similarly high adoption for sugarbeets and canola since 2018.
  - Herbicide tolerance (HT), insect resistance (IR), and, more recently, drought tolerance (DT), have simplified pest management, reduced crop losses, and supported conservation practices.
  - Farmers pay higher prices for GE seeds compared to conventional varieties, but these premiums reflect benefits such as improved pest control, yield stability, and labor savings. Per-acre cost differences are smaller than per-bag differences because GE traits can enable more efficient planting and management.
- Newer genetic engineering methods have the potential for faster and less costly development of GE traits compared to earlier methods, while also changing the kinds of traits being developed.
  - The economic literature suggests gene editing could reduce development costs by at least 40 percent and shorten commercialization timelines by 25 percent or more.
  - These advantages are particularly relevant for specialty crops, which face high pest and disease pressures but have smaller markets that could make traditional GE development less economically viable.
  - Additional traits aimed at product quality have been developed, including some consumer-oriented traits for apples, tomatoes, and potatoes.
- Regulatory changes like the Sustainable, Ecological, Consistent, Uniform, Responsible, and Efficient (SECURE) rule have allowed USDA, Animal and Plant Health Inspection Service to increase the speed of trait commercialization, decreasing approval times by two-thirds and doubling the number of approvals.

Why Does This Matter?

Biotechnology has reshaped U.S. crop production over the past three decades, bringing substantial benefits to trait developers and farmers, especially to those producing three major GE field crops (corn, cotton, and soybeans), as well as sugarbeets and canola. These benefits come at significant cost to trait developers, who invest millions of dollars over multiple years to commercialize a new GE trait. The GE regulatory structure helps shape these outcomes, as do newer GE technologies like gene editing, which offer a pathway to lower costs, faster development timelines, and could help expand innovation to other crops and traits. A better understanding of these dynamics is crucial for policymakers, farmers, industry stakeholders, and researchers seeking to foster a system that supports efficient technological advancement. As global food systems face mounting pressures from many sources, the ability to develop and deploy beneficial GE traits will be important for sustaining U.S. agricultural productivity and

competitiveness. In particular, weed resistance to widely used herbicides (e.g., glyphosate) and insect resistance to insecticidal proteins (e.g., *Bacillus thuringiensis* (Bt)) continue to erode the effectiveness of existing GE traits, spurring demand for new solutions. Other stressors (e.g., drought, viruses, fungi) underscore the need for traits that improve resilience without sacrificing yield potential. Farmers' options for planting crops with new GE traits may be limited by development costs, consumer acceptance, and the timing of multi-market regulatory approvals for internationally traded GE crops.

A Few More Details

This report relies on data from three USDA agencies, the Economic Research Service (ERS), the National Agricultural Statistics Service (NASS), and the Animal and Plant Health Inspection Service (APHIS), and summarizes and consolidates information from economic literature and agency regulations. Information about average GE seed prices and herbicide-resistant weed management practices is drawn from the field-level version of the Agricultural Resource Management Survey (ARMS), which is produced jointly by USDA, ERS and USDA, NASS. Specifically, we use ARMS data for corn production in 2016 and 2021, cotton in 2019, and soybeans in 2023. Adoption rates of GE seeds for years 2000–25 come from the USDA, ERS Adoption of Biotechnology data product, which draws on the USDA, NASS June Agricultural Survey. We analyze public USDA, APHIS GE product review records to examine differences in confirmation and approval patterns under primarily two different regulatory structures (SECURE versus pre- and post-SECURE). The USDA, APHIS data are also used to create a visualization of how the two regulatory structures differ, including the timing and duration of various stages throughout the regulatory processes.