

WHAT IS REGENERATIVE AGRICULTURE?

By Katy Martin Rainey, PhD

What you need to know:

- **Regenerative agriculture is a mindset of continuous improvement that focuses on soil health, resource efficiency, and profitability—supported by both traditional practices (like cover cropping and crop rotation) and modern technologies.**
- **Modern tools, including precision equipment, genetic innovation, and carefully regulated pesticides, play a vital role in making regenerative practices scalable and sustainable for today's farms while maintaining productivity and environmental stewardship.**
- **Case studies, like "The Past, Present, and Future of Rangeland Grasshopper Management", provide a real-world example that underscores how today's technology, when thoughtfully applied, allows farmers to reduce inputs, enhance efficiency, and support long-term sustainability goals.**

In 2023, U.S. agricultural industries contributed roughly \$1.537 trillion (5.5%) to GDP.¹ Today, one U.S. farmer feeds 169 Americans,² compared to just 15.5 in 1950³—a testament to decades of agricultural innovation. Increased productivity over the past 75 years has brought both benefits and challenges for consumers and the environment. Overall, the trajectory of innovations in agriculture has trended towards greater safety and sustainability. Most recently the attention has turned to **regenerative agriculture**. For many farmers, regenerative agriculture is not a fixed set of practices but a mindset of continuous improvement—an ongoing commitment to finding new ways to use resources more efficiently, enhance soil health, and maintain a profitable, resilient operation.

The Core of Regenerative Agriculture

Regenerative agriculture primarily aims to preserve, improve, and restore soil health by regenerating soils that have been degraded by past agricultural practices, resulting in soils that are healthier than their current state.^{4,5} Healthier soils also contribute to **climate mitigation, improved water quality, increased soil organic matter, enhanced carbon sequestration, and increased biodiversity.**^{4,5} Common regenerative practices include:

- Cover cropping
- Crop rotation
- Promoting persistent living roots
- Reduced or no-till farming
- Agroforestry
- Managed grazing

Advances in technology, equipment, and seed varieties are enabling farmers to adopt more sustainable practices that support both long-term land stewardship and their bottom line. While many regenerative methods have roots in pre-industrial farming traditions, it's clear that scaling these practices for today's farms will increasingly rely on modern innovations—helping farmers care for their land across generations while maintaining productive operations.

The Role of Modern Technology

Modern farming leverages a range of technologies—including genetic modification, precision equipment, and microbial inputs—to optimize outcomes for both productivity and sustainability. Among these tools, pesticides are often misunderstood due to a historical legacy that no longer reflects current practices.

The article “[The Past, Present, and Future of Rangeland Grasshopper Management](#)” by Kerri M. Skinner traces the evolution of grasshopper control in the U.S. rangelands from the 19th century to today.⁶ It provides a real-world example that underscores how today's technology, when thoughtfully applied, allows farmers to reduce inputs, enhance efficiency, and support long-term sustainability goals. Initially driven by the devastation caused by the Rocky Mountain locust plague, also known as the Grasshopper Plague of 1874, early grasshopper population control methods included mechanical traps, crop rotation, and later chemical insecticides. Over time, the focus shifted from croplands to rangelands, where cost-effectiveness of treatment became a major concern. Growing environmental awareness led to research into biological controls like *Nosema locustae*, a microsporidium fungus bait, though with limited success. Today, management emphasizes ecological understanding, predictive modeling, and integrated strategies to sustainably control grasshopper populations while minimizing environmental impact.

Pesticides: A Vital and Carefully Regulated Tool in Modern Farming

Pesticides—including herbicides, insecticides, and fungicides—are essential tools that help farmers protect crops from weeds, insects, and diseases, ensuring a stable, safe, and abundant food supply. In regenerative farming systems, where soil health is prioritized, herbicides are often used to manage weeds and terminate cover crops in a way that avoids soil disruption. While practices like cover cropping offer benefits, they can also introduce challenges—such as creating habitats for pests that may later affect main crops. For example, researchers at North Carolina State University have documented how pests can move from dying cover crops to emerging soybean plants, increasing pressure on early-stage crops.⁷

Modern pesticides are designed with precision, targeting specific pests while minimizing unintended effects on humans and the environment. Extensive safety testing is required before any pesticide is approved for use, including evaluations for potential carcinogenicity, reproductive harm, and environmental impact. Synthetic pesticide residues found in food are present at extremely low levels—far below the thresholds considered safe by regulatory agencies. These limits are set through rigorous scientific assessments by agencies like the U.S. Environmental Protection Agency (EPA), which reviews toxicological data and sets conservative safety margins to protect even the most vulnerable populations.

When used responsibly as part of an integrated farm management plan, pesticides support crop health and contribute to more sustainable practices. With strong regulatory oversight and ongoing innovation, farmers can use these tools safely and effectively to meet growing food demands.

The Future: Innovation Driving Regeneration

The path to sustainable agriculture will depend on:

- Continued **investment in research and technology**.
- Embracing **diverse tools**—from advanced crop genetics and precision technologies to responsible pesticide use.
- Supporting **soil health and climate resilience** through regenerative principles.

Recent trends in U.S. soybean production illustrate this dynamic. National yields have risen from about 43 to over 50 bushels per acre since 2002, even as soybean acreage has expanded into marginal lands and new regions (Figure 1). The expansion into less traditional growing areas demonstrates that, with the right combination of technology and stewardship, yield improvements are possible even under more challenging conditions.

Regenerative agriculture isn't a return to the past—it's a **forward-looking fusion** of tradition and innovation. With the right combination of ecological insight, cutting-edge science, and strategic inputs, U.S. farmers can continue to grow more while doing better—for the land, the economy, and future generations.

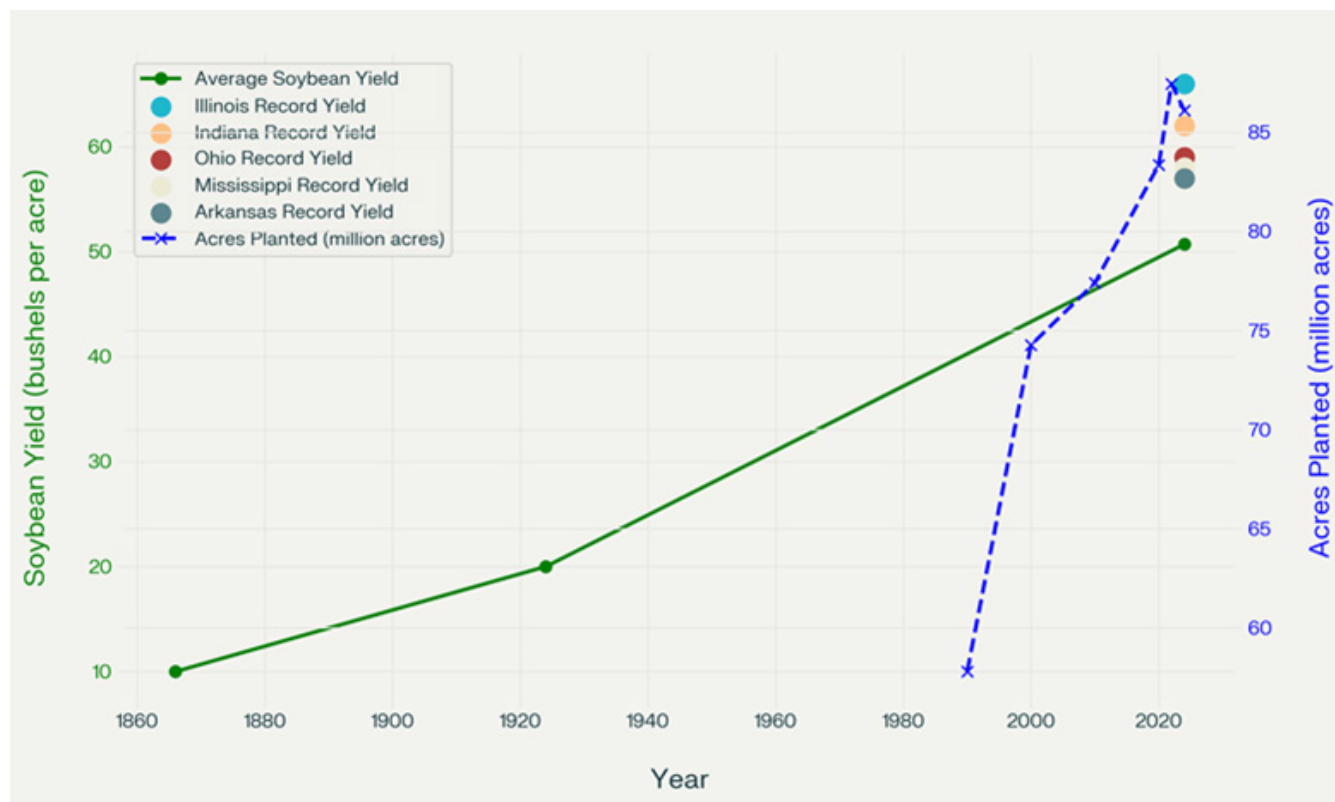


Figure 1: Historic average U.S. soybean yields, soybean area planted since 1988, and 2024 record soybean yields.⁸⁻¹⁰

ABOUT THE AUTHOR

Katy Martin Rainey, PhD, is a soybean breeder and researcher in the Agronomy Department at Purdue University, where she also serves as the Director of the Purdue Soybean Center. With a career dedicated to advancing soybean genetics and improving crop performance, Dr. Rainey focuses on developing high-yielding, resilient soybean varieties tailored for diverse growing conditions. Her research integrates traditional breeding methods with cutting-edge technologies like genomic selection and data-driven phenotyping.

HOW FARMING AFFECTS OUT FOOD SUPPLY

By Dustin Moore, PhD, RD

What you need to know:

- Modern farming innovations like pesticides, genetic modification (GMOs), and gene editing are essential tools that help U.S. farmers (who make up a very small percentage of the population) feed a large population by increasing crop yield, resilience, and efficiency.
- Common misconceptions surround organic farming, such as the belief that it is entirely pesticide-free or inherently more nutritious. While organic marketing often emphasizes lower residues, it's important to note that residues in both types of produce are well within safety limits set by regulatory agencies.
- Agricultural advancements are crucial for food security and sustainability, especially as farmers face growing environmental challenges and the need to feed an expanding global population.

Across the United States, grocery stores are filled with an array of food—from fresh produce to canned goods and ready-made meals. This abundance is thanks to the efforts of farmers, who only account for 1.2% of the population, but by their expertise, technology, and passion, manage to feed more than 340 million Americans.¹ This massive undertaking often goes unrecognized; leading to misconceptions about modern farming practices, particularly regarding crop protectants, genetically modified organisms (GMOs), and crop quality. To better understand what goes on your plate, here's a closer look at some of the agricultural innovations that make our meals possible.

The Role of Pesticides and Crop Protectants

Crop protectants, including pesticides, are among the most misunderstood tools in agriculture. Pesticides, which encompass herbicides, insecticides, fungicides, and other related chemicals, are used to manage a wide range of agricultural pests. They play a vital role in supporting sustainable farming practices both today and for future food security. Inherent to their name, crop protectants help preserve crops, prevent losses, and improve land use efficiency, thereby reducing food costs. Pesticides in particular control pests like locusts and beetles, which though small in size, can destroy vast crop areas if left unchecked.

Crops with reduced pesticide use may not produce as much food.² Studies comparing organic and conventional crops show that organic yields are generally smaller, although the growing methods and conditions are otherwise similar.³ A stark example of the necessity of crop protectants occurred in Sri Lanka in 2021, when the government banned the use of pesticides. By the end of 2021, the country saw an estimated 30% year-over-year drop in harvests of its staple tea crop, and a further halving of total production by March 2022, highlighting the importance of these tools in global food security.⁴

Organic Farming Misconceptions

Much of the confusion about pesticides stems from misunderstandings around the standards of the National Organic Program (NOP) and how select crops are grown. While many believe organic means pesticide-free, the NOP allows specific non-synthetic and synthetic pesticides, including copper sulfate and peracetic acid.⁵

The most notable differences between organic and conventional crops are production efforts, cost, and 30% lower pesticide residues.⁶ While organic marketing often emphasizes lower residues, it's important to note that residues in both types of produce are well within safety limits set by regulatory agencies. More concerning is the presence of dirt and debris, but these can be removed by washing them in water. Of course, if it's a concern, there are helpful pesticide residue resources, including a [calculator](#) to see how many servings a man, woman, teen or child could consume and still not have any adverse effects from pesticide residues.⁷

GMOs and Gene Editing

Another key innovation in modern agriculture is bioengineering. The USDA uses the “bioengineered” label for foods with detectable modified DNA that could not have otherwise been obtained from conventional breeding or found in nature (Figure 1). These crops are modified to introduce genes from outside the breeder's gene pool that give them beneficial traits like herbicide or insect protection.

Genome editing is another breeding tool. Distinct from GMOs, genome edited crops contain modifications in their DNA that could have been obtained through conventional breeding or in nature but in a more efficient and targeted manner. These modifications lead to desired beneficial characteristics such as improved crop germplasm to boost the crop's resilience in various geographical areas, or distinct characteristics such as an improved nutrition profile or plant architecture. An example of a genome edited crop is high GABA tomato, commercially available in Japan. The tomato contains increased levels of gamma-aminobutyric acid (GABA) and its consumption is intended to help lower blood pressure.^{8,9}



Figure 1: USDA bioengineered label.

Genetically modified, genome edited, and conventionally bred crops are developed to improve crop resilience, yield, and nutritional quality, helping farmers grow more food with fewer resources.

Appreciating Agricultural Innovation

Farming is the backbone of our food supply, continually evolving through innovation and necessity. With a growing global population and increasing environmental challenges, agricultural advancements play a critical role in ensuring food security, sustainability, and efficiency. By understanding these innovations, we can better appreciate the dedication and expertise of the farmers who work tirelessly to feed communities around the world.

ABOUT THE AUTHOR

Dustin Moore, PhD, RD, is a nutrition scientist, dietitian, and writer with expertise in dietetics, public health, and scientific communication. With over a decade of experience in academia and research, he mentors future dietitians, promotes discussions regarding evidence-based practice, and contributes to public discourse on nutrition and public health.

A LOOK AT MODERN SOYBEAN FARMING ON SCHEIER FARMS

By Dawn Scheier, U.S. soybean farmer

What you need to know:

- **Blending generational knowledge with modern tools**, like genetically modified seeds, precision agriculture, and artificial intelligence, helps farmers enhance efficiency and minimize environmental impact.
- **Soybeans are a key contributor to the U.S. economy and soil health**, used globally for food, feed, fuel, and industrial purposes, while also supporting sustainable farming through crop rotation and land conservation.
- **Future-focused farming is crucial**, requiring adaptive strategies such as advanced crop protection planning and ongoing innovation to address rising costs and ensure the sustainability of farming for future generations.

Soy farming has been central to American agriculture for generations, and Dawn Scheier of Scheier Farms in South Dakota has witnessed its evolution firsthand. What began with traditional plowing has transformed into a high-tech operation using artificial intelligence, precision tools, and sustainable practices. Discover how today's farmers blend tradition with innovation to shape the future.

Q: How has farming changed over time in the U.S.?

A: "My family has farmed soybeans, corn, and small grains in South Dakota for four generations. The biggest change in my lifetime came in 1996 with the introduction of genetically modified seeds. At Scheier Farms, we've used genetically modified organisms (GMOs) to reduce pesticide use and minimize tillage, helping protect the soil. Many consumers don't realize how tightly regulated GMOs are in the U.S., requiring up to 20 years for approval from the FDA, EPA, and USDA. It's a major commitment, but it's been a game-changer for our farming."

Q: What are crop protectants and how do you develop your crop protection plans?

A: "We use crop protectants, or pesticides, to safeguard our crops from pests, diseases, and weeds. At Scheier Farms, we create a crop protection plan every winter by attending seminars, staying updated on research, and consulting with our agronomist. Farming can be unpredictable, so we remain flexible and adjust the plan as needed to protect both the crops and the land."

Q: Why is soy farming important for both the economy and the environment?

A: "Soybeans are incredibly versatile, used globally for food, feed, fuel, and industrial products. Most of our soybeans go to animal feed, but some are used in human food. As a high-quality plant protein, soy provides all of the essential amino acids.¹ And from a farmer's standpoint, soybeans help with soil health, especially when we rotate them with other crops.

On top of that, soybeans contribute \$124 billion to the U.S. economy annually,² creating jobs, and supporting rural communities—making it a crop we’re proud to grow.”

Q: What sustainable practices do you implement on your farm, and why are they important to you?

A: “Sustainability means growing efficiently while preserving the land for future generations. On our farm, we rotate crops, minimize tilling, and use precision technology to apply inputs where needed. We also manage runoff with grass waterways, protect fields with tree shelter belts, and put less productive land into the Conservation Reserve Program. It’s all about caring for the land so it can continue to support us and future generations.”

Q: What changes do you envision taking place in the near future for soy farming?

A: “Most farmers will use artificial intelligence and remote sensing to precisely determine when crops need protection, eliminating guesswork and improving decisions from planting to harvest. We’ll also see more pest- and disease-resistant soybean varieties, and more farmers growing identity-preserved soybeans for specific health benefits. We’re just scratching the surface of what soybeans can do, and the science is only getting better.”

Q: What are some on-farm challenges you face today? What are on-farm challenges you are preparing for in the future?

A: “Our biggest challenge right now is rising costs while soybean prices drop, as we navigate uncertainty. Agricultural technology is advancing quickly, and keeping up requires both time and money. Looking ahead, our priority is to ensure farming remains viable for the next generation through smart, sustainable decisions.”

ABOUT THE AUTHOR

Dawn Scheier, a fourth-generation farmer in Salem, SD, farms with her husband at Scheier Farms, where they raise corn and soybeans. She studied animal science at Illinois State University and Illinois Central College and is a graduate of the South Dakota Ag and Rural Leadership Program. Scheier serves as a farmer-director on the United Soybean Board and is an active volunteer with CommonGround, a consumer outreach group. She strongly supports value-added agriculture, soybean processing, and corn ethanol plants.



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