

# Driving Feed, Food, and Fuel Sustainability

through Compositional Productivity

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How Benson Hill Made from Better™  
Soybeans help agribusiness partners meet  
large-scale, long-term sustainability goals

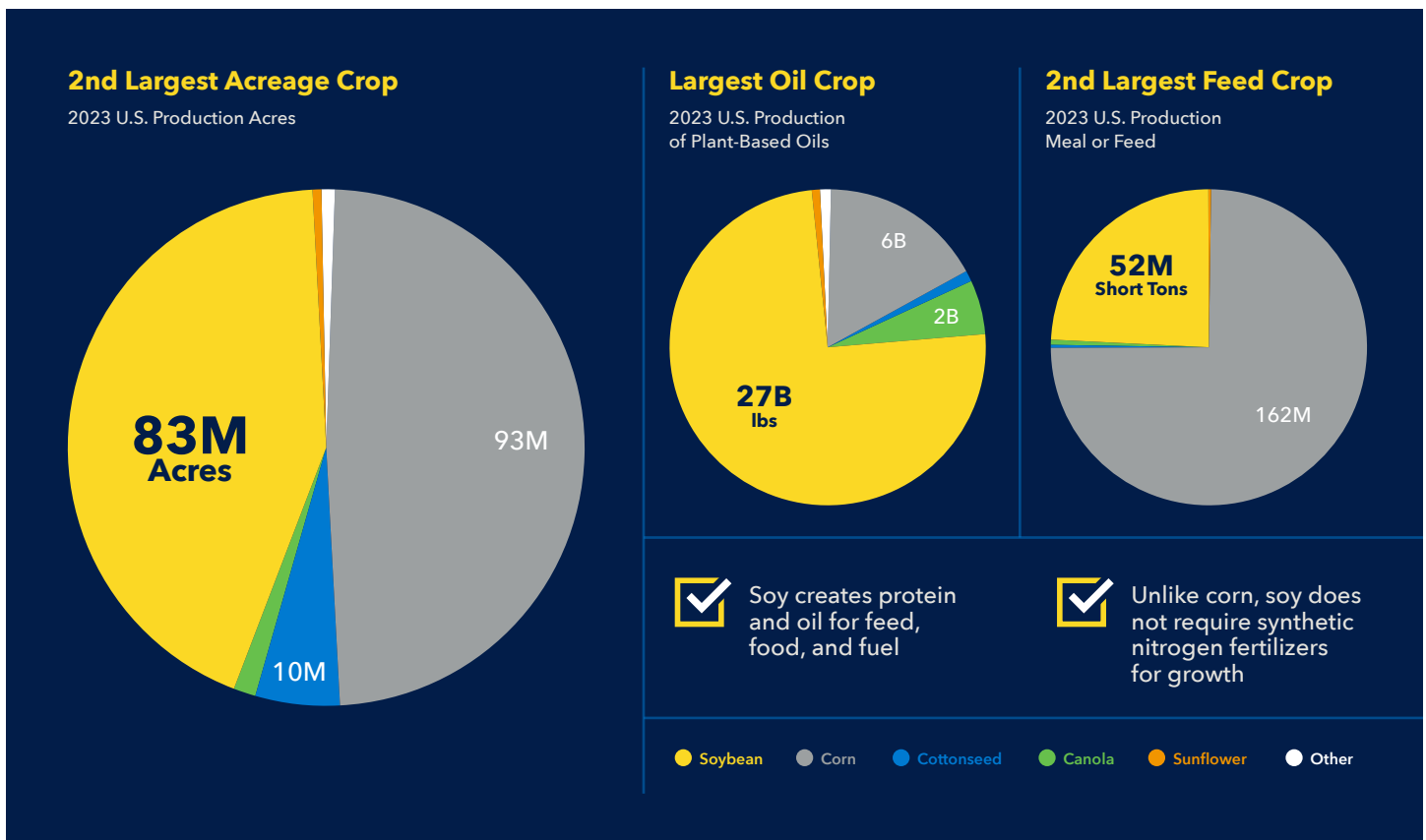
**BENSON**  **HILL**®

October 2024

As demand for feed, food, and fuel continues to grow with a rising global [population and income](#) levels, industries face the pressing challenge of reducing their carbon footprint and achieving ambitious sustainability goals. Agriculture and food systems are increasingly critical to meet climate targets, and soybeans, given their extensive applications and geographic footprint, play a vital role in decarbonizing the agrifood system.

With 83 million acres of U.S. farmland dedicated to soybean production, soy is not only the second-largest crop by acreage, but it is also the top oilseed crop, contributing 75% of the plant-based oils produced in the U.S. annually. This immense agricultural footprint presents both a challenge and an opportunity for sustainable practices to take root.

### The soybean crop has a large agricultural footprint



Benson Hill is well positioned and competitively advantaged to lead a sustainability transformation in soy, specifically by enabling farmers to grow soybeans more efficiently, with higher value per acre and fewer resources. Leveraging our innovative seed development process and data-driven insights through the CropOS® platform, we strive to advance sustainability across end markets for feed, food, and fuel. By enhancing soy quality traits that can ultimately improve Scope 3 carbon emissions for downstream partners, Benson Hill is poised to play a key role in the future of sustainable agriculture—supporting food security, environmental goals, and energy independence.

At the heart of Benson Hill's work is our Made from Better™ approach, driving an emphasis on Compositional Productivity that increases the nutrition and oil content within the soybean and reduces low-value carbohydrate co-products. Whereas traditional productivity prioritizes getting more beans per acre, Compositional Productivity prioritizes getting more value per acre. With Compositional Productivity as a North Star, we strive to develop better seeds that drive positive environmental impact while delivering greater value to every link in the supply chain, from farmers to consumers. Genetic innovation must become a tool we master to achieve the environmental sustainability goals of downstream partners, without sacrificing quality in the pursuit of quantity.

Our proprietary soybeans are designed to help address the unique demands of today's climate-conscious (and climate-committed) industries and satisfy the demand for soy-based protein and oil while simultaneously improving land efficiency, a key topic in global sustainability circles.

## **BENSON HILL RECOGNIZES THE URGENCY TO REDUCE CARBON EMISSIONS**

In 2015, global leaders convened in Paris to discuss and confront the challenge of climate change. That year, the National Oceanic and Atmospheric Association (NOAA) reported the warmest year on record, significantly surpassing the previous record and marking an alarming trend. [Scientific guidance](#) shows that each 0.1° Celsius of temperature increase brings greater risks in the form of longer heatwaves, more intense storms and wildfires, thus threatening the safety and security of life on the planet. In response, governments established the [Paris Agreement](#) - a global commitment to reduce carbon emissions from human activity and pursue efforts to limit average global temperature rise to 1.5° Celsius.

On the heels of the Paris Agreement, several large corporations announced ambitious carbon emissions reduction targets. These targets encompass the [three Scopes of carbon emissions](#) for any organization:

- **Scope 1** – direct emissions controlled by a company,
- **Scope 2** – indirect emissions from purchased energy, and
- **Scope 3** – indirect emissions resulting from the value chain, typically 70% or more of a company’s total carbon emissions.

Many of these stated targets are coming due in the next decade. However, [a recent McKinsey study](#) found that the majority of consumer goods companies are not on track. While many corporations have made strides in reducing direct and energy-related emissions, Scope 3 reductions—those linked to the broader value chain—have proven more elusive.

The complexities of the agribusiness value chain drive much of the missing Scope 3 progress. While companies downstream such as feed, food, and fuel companies own reduction goals, they rely on partners upstream in the [value chain](#) to execute necessary changes and take on the additional cost and risk to actually deliver emissions reductions. In more recent years, downstream companies have incentivized and even required farm practices such as cover crops, reduced tillage, or investments in farm digitization to curb carbon emissions. While these efforts attempt to share the risk and cost burden of carbon emissions reductions, the onus primarily falls [on the farmer](#) to improve carbon intensity for the entire value chain. This poses a significant challenge for adoption and achieving meaningful impact at scale.

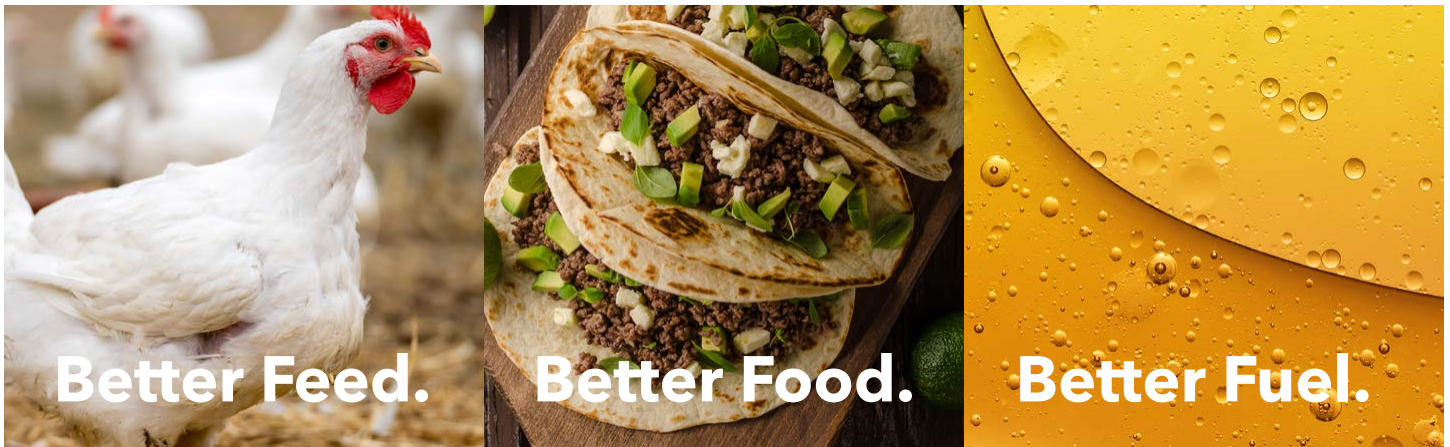
Conventionally, major seed companies and on-farm practices have emphasized traditional productivity (yield) to increase soybean productivity per acre. This progress has been important to support more efficient use of our limited land and water. However, an exclusive focus on yield (soybean quantity) has come at the cost of composition (soybean quality), with negative impacts on both nutrition and oil volume that limit the sustainability potential of the larger agribusiness system.

With modern technologies and a more strategic knowledge of sustainable design, we can do better. And as Maya Angelou said “Do the best you can until you know better. Then when you know better, do better.” By concentrating on Compositional Productivity, we can prove that gains can be made in yield without sacrificing the nutrition and oil content of the soybean.

## SEED INNOVATIONS TAKE PRESSURE OFF THE SUPPLY CHAIN AND DELIVER A BETTER BEAN

How we deliver a better soybean is connected to what we have already learned about them. By directing our soybean seed breeding efforts to Compositional Productivity, Benson Hill offers Made from Better™ soybean seed innovations that are:

- **Better for feed and food production:** Livestock feed represents a significant portion of global agricultural emissions and is a major cost in animal production. By improving the protein content, concentrations of amino acids, and anti-nutrient levels in our flagship soybean varieties, Benson Hill can help farmers produce more environmentally sustainable, nutritious feed for poultry and other species and reduce the need for excessive land use and additional supplements for animal production. This higher protein content brings efficiency and lower carbon intensity to alternative meat markets as well, supporting nutrition security for a growing population.
- **Better for energy production:** Benson Hill's Ultra-High Oil (UHO) soybeans, scheduled for release at the end of the decade, are optimized for use in renewable diesel, to help reduce emissions in the transportation sector. By offering a low-carbon-intensity feedstock for biofuel production, our soybean innovations can help decarbonize plant-based fuels while supporting a cleaner energy future. We can grow these high-oil soybeans domestically as a certified deforestation-free crop, further minimizing their environmental impact.



**Better Feed.**

**Better Food.**

**Better Fuel.**



More Energy and Protein  
Per Acre



More Protein Per Acre



More Oil Per Acre



Lower Carbon Intensity



Lower Carbon Intensity



Lower Carbon Intensity



- **Better for the value chain:** Our seeds and asset-light business model are designed to generate shared value across the supply chain. Soybean farmers benefit from increased yields and lower input costs (particularly with herbicide-tolerant varieties). Processors gain access to high-quality soybeans designed for various applications. And downstream companies retain reliable sources of more responsible ingredients and feedstock for feed, food, or biofuel production.

Discussions with value chain participants about [our innovation pipeline](#) center on the mass balance within the soybean that will deliver the greatest value to the customer. Independent analysis and Benson Hill's practical experience with [business partners](#) demonstrate that improving Compositional Productivity creates significant ripple effects across the entire value chain, from farming to food production. By enabling low-carbon agriculture commodities, our proprietary soybeans offer downstream companies a seamless solution to help achieve Scope 3 emissions reduction goals.

## **THE MATH BEHIND COMPOSITIONAL PRODUCTIVITY: HOW TO PRODUCE MORE VALUE WITH LESS CARBON INTENSITY**

Increased kilocalorie, protein or oil content in the soybean produces more value (in the form of meal, protein or oil) from a single acre without additional fertilizers, pesticides, or water. If we create more value per acre while holding carbon emissions steady per acre, this results in lower carbon intensity "per unit of product," therefore fulfilling the [CDP](#) (Formerly Carbon Disclosure Project) definition of a low-carbon product – comparatively lower carbon emissions across the lifecycle of the soybean seed compared to commodity soybeans. This low-carbon soybean seed becomes the source material for low-carbon soybean meal and soybean oil for downstream companies.

In 2023, Blonk Consultants conducted an independent Life Cycle Assessment (LCA) on Benson Hill's soybean meal and oil. This analysis forecasted significant carbon emissions reductions from our seed innovation pipeline. For example, Benson Hill Ultra-High Oil varieties are expected to match commodity yield in 2028 while producing more oil per bushel, resulting in lower carbon intensity per bushel<sup>1</sup>.

<sup>1</sup> Internal analysis based on LCA conducted by Blonk Consultants (2023)

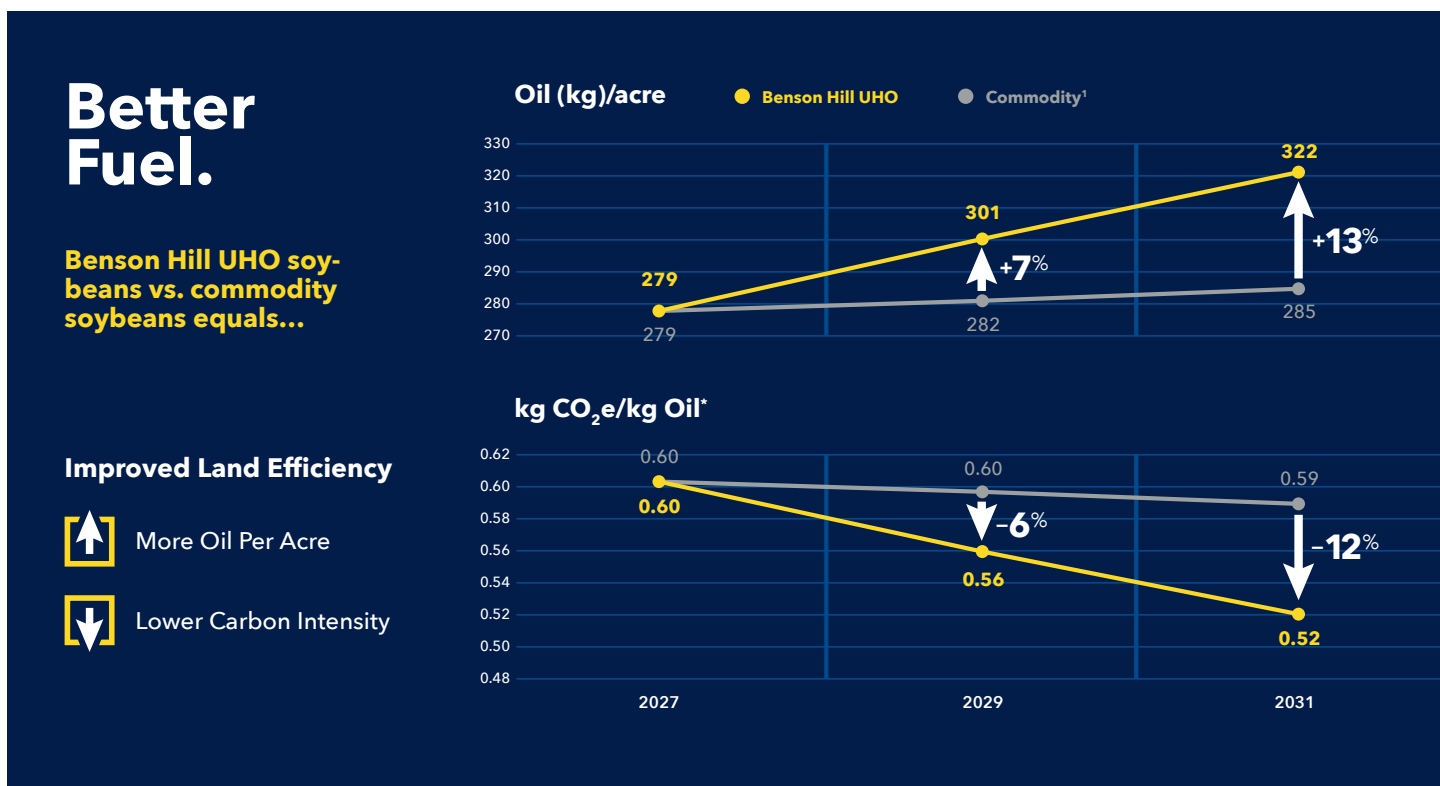
Today, commodity soybeans have an average increase in yield of 0.6% per year with 21% seed oil content. Meanwhile, Benson Hill soybeans match commodity yield and augment seed oil content, forecasting a 23% seed oil content in 2028 that will surpass 25% by 2031. As a result, by 2031, Benson Hill soybeans are expected to have 13% more kg of oil per acre compared to commodity soy, and yield will be on par with other elite soybean varieties.

At the same time, on-farm cultivation practices should remain the same for these proprietary seeds. Farmers will not need to make any changes to the way they grow Benson Hill soybeans to achieve this increased oil volume. Since on-farm practices such as fertilizer and pesticide applications generate carbon emissions, keeping agronomic practices the same will result in overall carbon emissions per acre remaining constant.

With carbon emissions per soybean acre remaining constant and Compositional Productivity per acre rising, the carbon emissions intensity per unit of output decreases.

**2027:**  $\text{kg carbon emissions} / \text{kg Oil} = 167 \text{ kg CO}_2\text{e/acre} \div 279 \text{ kg oil/ac} = 0.60 \text{ kg CO}_2\text{e/kg oil}^{2,3}$

**2031:**  $\text{kg carbon emissions} / \text{kg Oil} = 167 \text{ kg CO}_2\text{e/acre} \div 322 \text{ kg oil/ac} = 0.52 \text{ kg CO}_2\text{e/kg oil}^{2,3}$



<sup>1</sup> Assumes 0.6% yield improvement per annum

<sup>2</sup> 167 kg CO<sub>2</sub>e/acre based on Blonk Consultant LCA (2023)

<sup>3</sup> kg oil/acre based on Benson Hill innovation pipeline forecast

\* Estimated carbon emissions reductions based on LCA conducted by Blonk Consultants (2023) reflecting 0.64 kg CO<sub>2</sub>e/kg soybean oil baseline and targeted oil content reflected in the innovation pipeline.





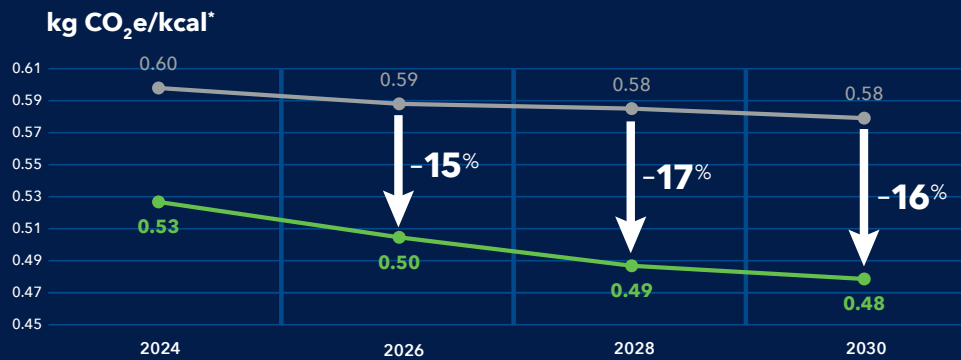
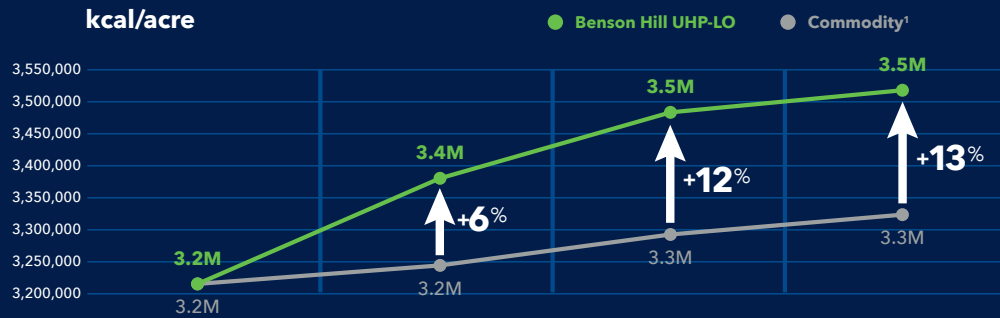
**SIMILAR CALCULATIONS APPLY TO FEED AND FOOD APPLICATIONS**

# Better Feed.

**Benson Hill UHP-LO soybeans vs. commodity soybeans equals...**

## Improved Land Efficiency



-  More Energy and Protein Per Acre
-  Lower Carbon Intensity

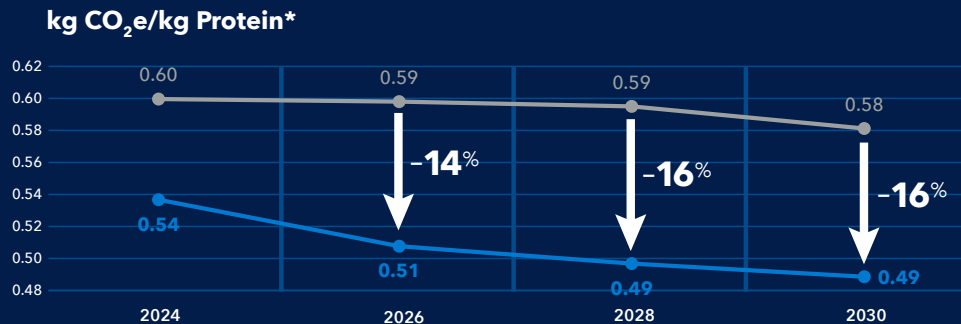
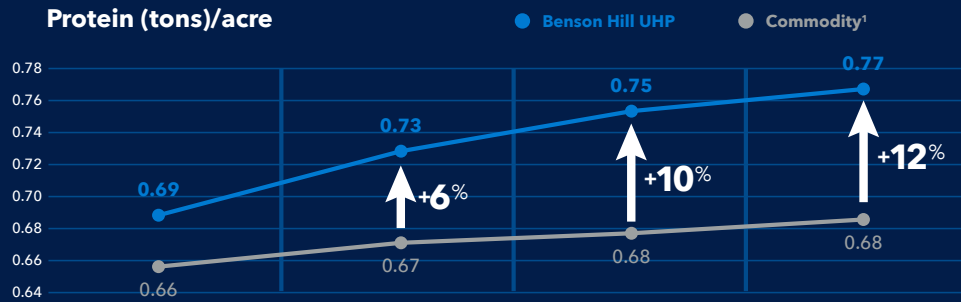


# Better Food.

**Benson Hill UHP soybeans vs. commodity soybeans equals...**

## Improved Land Efficiency

-  More Protein Per Acre
-  Lower Carbon Intensity



<sup>1</sup> Assumes 0.6% yield improvement per annum  
 \* Estimated carbon emissions reductions based on life cycle assessment conducted by Blonk Consultants (2023) reflecting 0.277 kg CO<sub>2</sub>e/kg soybean meal baseline and targeted kcal and protein content reflected in the innovation pipeline.



While increases in traditional productivity (yield) also drive down carbon emissions intensity, improving Compositional Productivity, through the combination of yield and quality increases, has a multiplier effect on carbon emissions reductions.

Benson Hill's approach to seed innovation is unique. We have amassed industry-leading proprietary data sets on soybean yield, protein, and oil expression. These data sets are leveraged by our [CropOS technology platform](#) to generate breeding predictions via artificial intelligence and machine learning.

Our [Crop Accelerator](#) rapid prototyping facility manifests these breeding roadmaps into living plants. With the predictive power of CropOS and the best-in-class Crop Accelerator, Benson Hill can eliminate the need for land use in developing and proving the value of our next-generation seeds with a predictive accuracy of up to 80 percent.

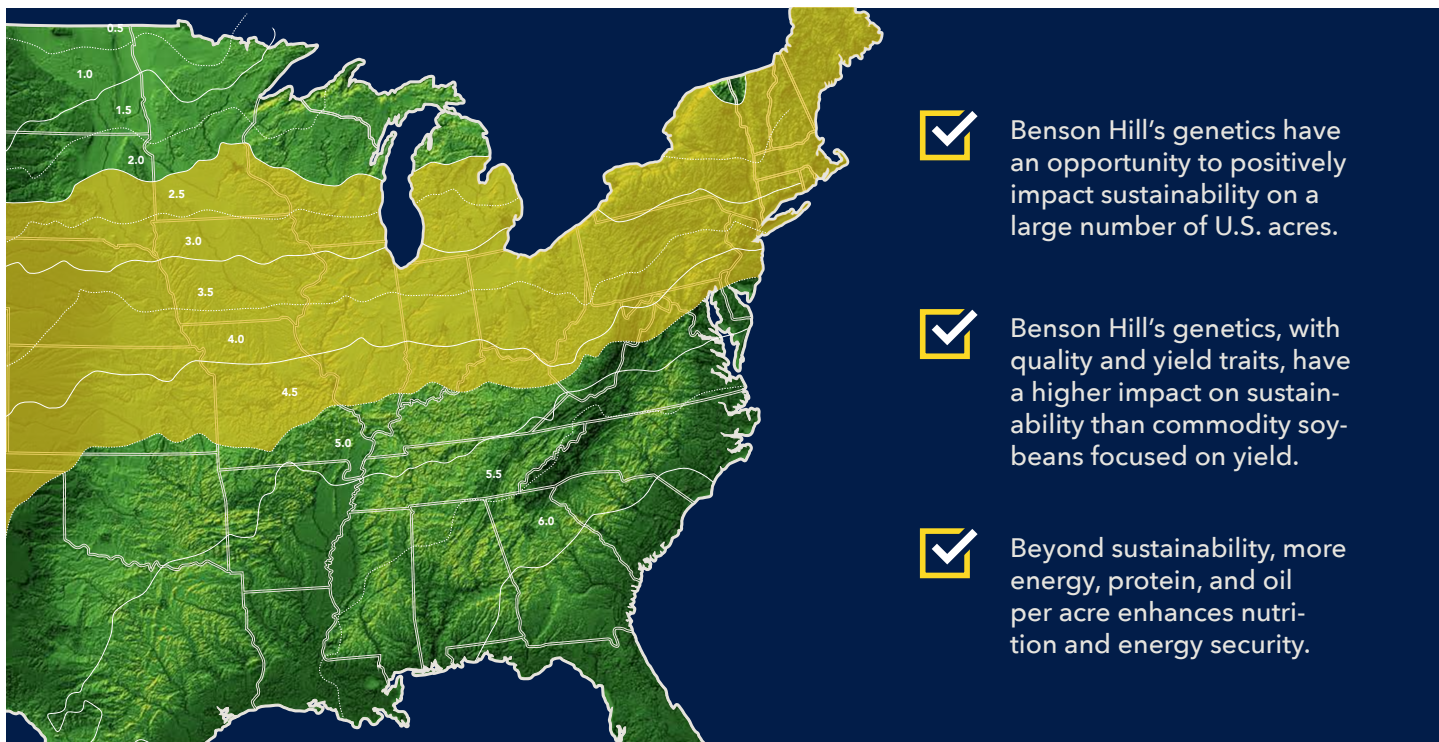
When these technology advantages are applied to our downstream customers' needs, we are able to improve the Compositional Productivity per acre of feed and food ingredients and oil feedstock and enable data-backed, low-carbon end products. Industry partners such as Perdue and BioMar have experienced how Benson Hill's seed innovations can unlock sustainability benefits for them in their respective supply chains, improving the overall environmental footprint of U.S. soy.

## **COMPOSITIONAL PRODUCTIVITY SHAPES A SUSTAINABLE FUTURE IN SOY**

The global demand for feed, food, and fuel will continue to grow, and the risk of expanding agricultural land use poses a potential threat to ecosystems like forests, prairies and wetlands. At Benson Hill, we recognize that simply increasing traditional productivity is not enough.

Instead, our Made from Better™ approach with a focus on Compositional Productivity addresses the demand of the end user, improving the resource efficiency of the acres already in use, and generates shared value across the agribusiness supply chain.

## BY 2025, BENSON HILL GENETICS WILL BE ABLE TO ADDRESS ~70% OF U.S. SOY ACRES



Our vision is to create a future where farmers can seamlessly and efficiently grow soybeans with more value per acre, using fewer resources overall. By 2025 we expect Benson Hill genetics will be able to address up to 70% of U.S. soybean acres and advance sustainability on a massive scale. Through data-driven insights and continuous innovation, we are confident that Benson Hill's seed technology can help meet the growing demand for sustainable feed, food, and fuel solutions without expanding land use or disrupting the U.S. soybean system - thus supporting food security, environmental goals, and energy independence.





**BENSON HILL**

**About Benson Hill**

Benson Hill is a seed innovation company that unlocks nature's genetic diversity in soy quality traits through a combination of proprietary genetics, its AI-driven CropOS® technology platform, and its Crop Accelerator. Benson Hill collaborates with strategic partners to create value throughout the agribusiness supply chain to meet the demand for better feed, food and fuel. More information can be found at [bensonhill.com](https://www.bensonhill.com) or on X, formerly known as Twitter at [@bensonhillinc](https://twitter.com/bensonhillinc).

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