BREAKTHROUGH SCIENCE GOALS FOR THRIVING FARMS AND A HEALTHIER NATION

The U.S. has been one of the world's leading agricultural producers for decades, but our food and agricultural systems are being tested by numerous challenges, such as animal and plant diseases, increased weather variability, rising production costs, and changing consumer demands. **The competitive advantage of U.S. agriculture relies on science to address these challenges.**

In July 2018, The National Academies released its ***Science Breakthroughs to Advance Food and Agricultural Research by 2030*** report, which identifies the **greatest scientific opportunities** to make the U.S. food and agricultural system more *efficient*, *resilient*, and *sustainable*. The report recommends prioritization of five research areas:

- genetics and precision breeding
- plant, animal, and soil microbiomes
- sensors and sensing technology
- data science and analytics
- transdisciplinary research

In January 2019, representatives from commodity organizations, universities, scientific societies, private research institutions, and other organizations met to identify research goals that can only be achieved through advancing the *Breakthroughs 2030* priorities. **Together, these goals can help ensure two crucial outcomes: THRIVING FARMS and a HEALTHIER NATION**.

What can Breakthrough Science Achieve for Producers and Consumers?

THRIVING FARMS are efficient, resilient, sustainable, and profitable. A **HEALTHIER NATION** is one with broad access to safe, affordable, and nutritious foods. Implementing the *Breakthroughs 2030* research priorities will enable our nation to achieve both these outcomes. **The goals below illustrate the enormous progress that investments in these research priorities will deliver for our nation.**

GOAL: Reduce water use in agriculture by 20% by the year 2030

Agriculture currently uses 80% of water consumed in the U.S. Reduced availability and competing demands from other sectors will put increasing pressure on this limited resource both in terms of volume and quality. Research investments, such as the following, are essential for realizing this goal:

- Develop more water-efficient crops and livestock using **advanced biotechnology tools**.
- Enhance crop resistance to drought by harnessing naturally-occurring microbial populations (**microbiomes**) to improve the health of soil and its ability to retain water.
- Develop and deploy a new generation of low-cost **sensors** for precise, **data-driven** water management (irrigation), leading to reductions in plant stress and disease susceptibility.
- Develop technologies that enable the use of brackish and other non-potable water sources for crop irrigation through **transdisciplinary research**.

GOAL: Reduce fertilizer use by 15% by the year 2030

Better performing and affordable alternatives to existing fertilizers and fertilizer application methods would reduce production costs for farmers and prevent the environmental impacts of nutrient losses from the field. Research investments, such as the following, are essential for realizing this goal:

- Develop new crops capable of producing their own fertilizer (e.g., nitrogen-fixing) as well as those with improved nitrogen and phosphorus efficiency using **advanced biotechnology tools**.
- Capitalize on the **genetic diversity** of wild varieties to produce crops that require less fertilizer.
- Increase sustainable yields by harnessing naturally occurring soil and plant microbial populations (**microbiomes**) to serve as biological sources of key fertilizer nutrients, such as nitrogen.
- Utilize **sensors** and **data-driven** applications for early detection of nutrient deficiencies and field variations to reduce fertilizer use.
- Harness **transdisciplinary research** in materials science, chemistry, soil physics, and root **genomics** to develop targeted and controlled nutrient delivery to plants.

GOAL: Significantly reduce the need for fungicides and pesticides in plant production by 2030

Fungicides and pesticides add costs for producers and can negatively impact water quality and public health. Research investments, such as the following, are essential for realizing this goal:

- Develop disease-resistant crops with **advanced biotechnology tools**.
- Through advances in **microbiome** research, develop probiotics – compounds that help generate beneficial microbes – for crop plants that increase disease and pest resistance.
- Create and deploy a new generation of **sensors** to monitor crops for swift detection of pests and diseases and **data**-driven management of outbreaks.

GOAL: Radically reduce the incidence of infectious disease epidemics for livestock by 2030

*Cattle, swine, and poultry systems are vulnerable to significant outbreaks of diseases. For example, the 2015 Avian Flu epidemic led to the loss of over 50 million chickens and a 60% increase in egg prices, requiring **$879 million from the federal spending** for depopulation, cleaning, and indemnities. Research investments, such as the following, are essential for realizing this goal*:

- Reduce antibiotic use by introducing additional disease resistance traits into major U.S. commercial breeds through **advanced biotechnology**.
- Produce new vaccines for U.S. poultry and livestock diseases using **advanced biotechnology**.
- Develop probiotics for increase livestock immune function using advances in the animal **microbiome**.
- Reduce the response time for major livestock disease outbreaks by 50% by 2030 through deploying advanced **sensors**, new **data** platforms, and **analytical tools**.
- Use a **transdisciplinary** approach to model the potential spread of pests and diseases in fields, flocks, and herds to identify the economic thresholds for different interventions.

GOAL: Reduce incidence of foodborne illnesses by 50% by 2030

The U.S. Centers for Disease Control (CDC) and Prevention estimates that roughly one in six Americans (or 48 million people) get foodborne illnesses each year, resulting in 128,000 hospitalizations and 3,000 deaths. Research investments, such as the following, are essential for realizing this goal:

- Use **advanced biotechnology** approaches to develop new plant varieties with reduced levels of arsenic, cadmium, and other toxic heavy metals.
- Modify the animal gut **microbiome** to stimulate natural immunity to pathogens.
- Develop and deploy **sensors** to instantly detect the presence of common foodborne pathogens such as *E. coli*, *Salmonella*, and *Listeria.*
- Use field **sensors** to mitigate transfer of foodborne diseases from wildlife to fresh produce.
- Implement new **data technologies**, such as blockchain, to decrease the time it takes to identify the sources of outbreaks.
- Apply algorithms typically used in defense applications to sense and predict foodborne illness risks along all points of the food chain through **transdisciplinary** teams that combine machine learning, plant biology, and post-harvest experts.

GOAL: Increase the availability of new plant varieties and animal products to deliver food with enhanced nutrient content by 2030

About half of all Americans – 117 million individuals – have one or more preventable diet-related chronic diseases (e.g., cardiovascular disease, high blood pressure, diabetes). Scientific advances can position farmers to meet consumer demand for affordable new foods that are higher in key nutrients. Research investments, such as the following, are essential for realizing this goal:

- Use **advanced biotechnology** approaches to develop a wider range of locally-adapted livestock and crops – including those for urban farming – that meet consumer health and producer needs.
- Enhance nutrient content and quality of existing crops by harnessing the diversity of older varieties and develop flavorful, nutritious foods using **advanced biotechnology tools** and traditional breeding.
- Use advanced **sensor technology** and **data analytics** for rapid field detection of desirable traits in breeding new variations to accelerate crop improvement.
- Support **transdisciplinary research** that draws expertise from plant and animal microbiologists, human physiologists, and plant breeders to better understand the health benefits of the human gut **microbiome** and develop food crops enhancing those benefits.

Conclusion

In addition to tackling the challenges facing producers and consumers, significant investment in the *Breakthroughs 2030* research priority areas will help attract and train a **new generation** in the agricultural sciences. This will translate into additional scientific advancements that support new industries, create jobs, and maintain the competitive edge our producers need in a rapidly growing global market.

About this Document

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