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Science Breakthroughs to Advance Food and Agricultural Research by 2030

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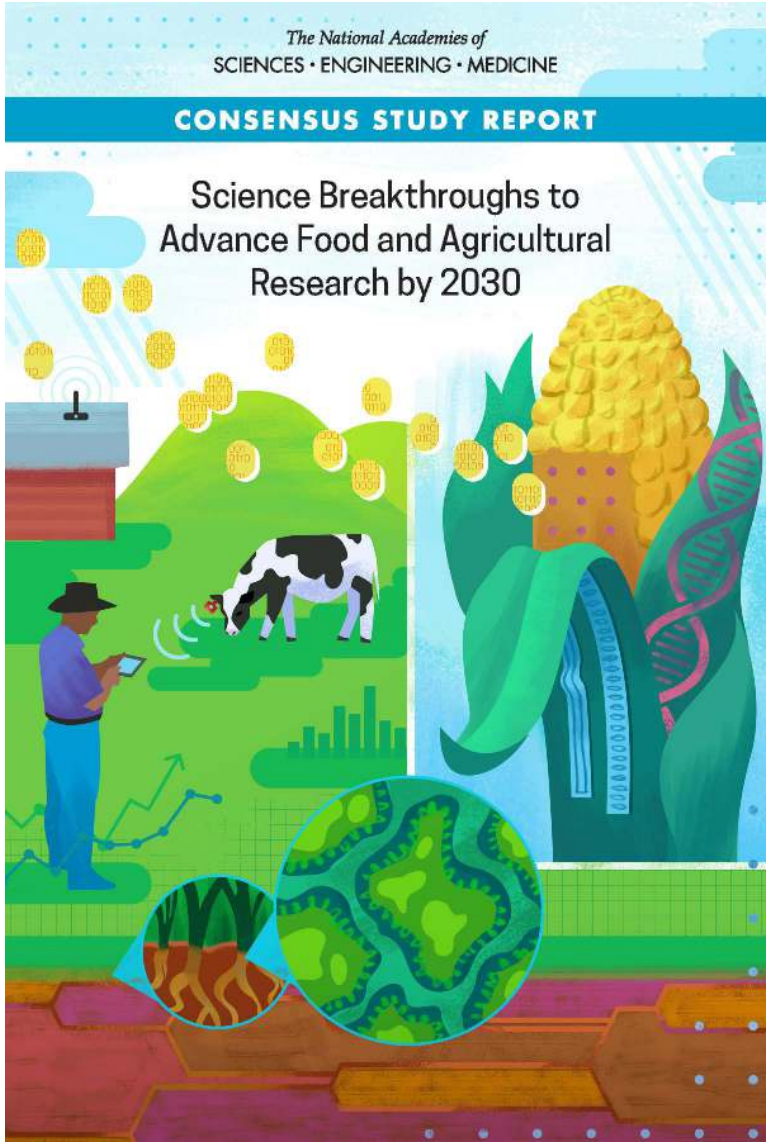


Committee Membership

John D. Floros, *Co-Chair*, New Mexico State University
Susan R. Wessler, *Co-Chair*, University of California, Riverside
David B. Allison, Indiana University
Corrie C. Brown, University of Georgia
Lisa Goddard, Columbia University
Mary Lou Guerinot, Dartmouth College
Janet Jansson, Pacific Northwest National Laboratory
Lee-Ann Jaykus, North Carolina State University
Helen H. Jensen, Iowa State University
Rajiv Khosla, Colorado State University
Robin Lougee, IBM Research
Gregory V. Lowry, Carnegie Mellon University
Alison L. Van Eenennaam, University of California, Davis

Why did we conduct this study?

Challenges to the U.S. Food & Agriculture System

- **The U.S. food & agriculture system is <u>not</u> efficient, resilient, and sustainable in the face of growing demand and yield plateaus**
  - Losing global competiveness from a lack of investment in research and translational activities
  - Future U.S. food security is at risk
  - U.S. producers lack access to cutting edge research and modern agriculture management tools
  - Insufficient understanding of system interactions, especially socioeconomic factors hinders optimal management
  - Climate related abiotic and biotic stresses (drought, heat, flood, disease) caused over $5B in losses
  - About 1/3 of the food produced in the U.S. is wasted, which is enough to feed 260 million people

What was the committee asked to do?

To lead the development of an innovative strategy for the future of food and agricultural research, answering the following questions:

1. What are the greatest challenges?
2. What are the greatest scientific opportunities?
3. What are the most important knowledge gaps?
4. What general areas of research can fill these knowledge gaps?

Articulate Science Breakthroughs & Recommendations

What was the committee's approach?

- **Information Gathering & Input in 2017**
  - Meetings (57 speakers/invited participants)
    - 1st: June 14-15
    - 2nd (public Town Hall): August 8-9
    - 3rd (Workshop): October 2-6
    - 4th Meeting: November 14-15 (closed for deliberations)
  - Online Discussion Platform (79 submitters)
  - Webinars on: food science, phosphorus, water, sensors, and urban agriculture

Study Boundaries and Scope

- Considered a time horizon of 2030
  - Determine the most challenging issues in food and agriculture that can be addressed by science
  - Identify science breakthroughs necessary to meet the challenges

Study Boundaries and Scope

- The food and agricultural system is extensive (from farm to fork)
  - Committee focus was on the scientific breakthroughs most likely to meet the challenges
- Within and Outside of Scope
  - Within: U.S. centric issues, recognizing global impact
  - Outside: human nutrition, biofuels, food distribution and access, and policy

Committee's Findings and Conclusions

Major goals for food & agricultural systems for 2030

(1) improving efficiency,

(2) increasing resiliency to adapt to rapid changes and extreme conditions, and

(3) increasing sustainability.

Most Challenging Issues

- increasing nutrient use efficiency;
- reducing soil loss and degradation;
- mobilizing genetic diversity for crop improvement;
- optimizing water use in agriculture;
- improving food animal genetics;
- developing precision livestock production systems;
- early and rapid detection and prevention of plant and animal diseases;
- early and rapid detection of foodborne pathogens; and
- reducing food loss and waste throughout the supply chain.

Organization of Chapters by Areas

- Crops (Chapter 2)
- Animal Agriculture (Chapter 3)
- Food Science and Technology (Chapter 4)
- Soils (Chapter 5)
- Water-Use Efficiency and Productivity (Chapter 6)
- Data Science (Chapter 7)
- A Systems Approach (Chapter 8)

Science Breakthroughs & Recommendations

Science Breakthroughs & Recommendations

1. *Transdisciplinary Research & Systems Approach*
2. *Sensing Technologies*
3. *Data Science and Agri-Food Informatics*
4. *Genomics and Precision Breeding*
5. *Microbiome*

Transdisciplinary Research & Systems Approach

- Breakthrough 1: A systems approach to understand the nature of interactions among the different elements of the food and agricultural system that can be leveraged to increase overall system efficiency, resilience, and sustainability.

- Recommendation 1: Transdisciplinary science and systems approaches should be prioritized to solve agriculture's most vexing problems.

Convergence

- Integration of knowledge, tools, and ways of thinking to identify novel transdisciplinary solutions to complex problems facing food and agriculture
  - New ways to formulate the questions to provide holistic solutions

Sensing Technologies

- Breakthrough 2: The development and validation of precise, accurate, field-deployable sensors and biosensors will enable rapid detection and monitoring capabilities across various food and agricultural disciplines.

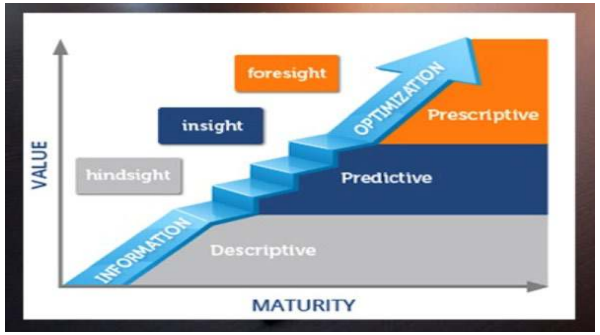
- Recommendation 2: Create initiatives to more effectively employ existing sensing technologies and to develop new sensing technologies across all areas of food and agriculture.

NAS, 2018

Data Science and Agri-Food Informatics

- Breakthrough 3: The application and integration of data sciences, software tools, and systems models will enable advanced analytics for managing the food and agricultural system.

- Recommendation 3: Establish initiatives to nurture the emerging area of agri-food informatics and to facilitate the adoption and development of information technology, data science, and artificial intelligence in food and agricultural research.



Genomics and Precision Breeding

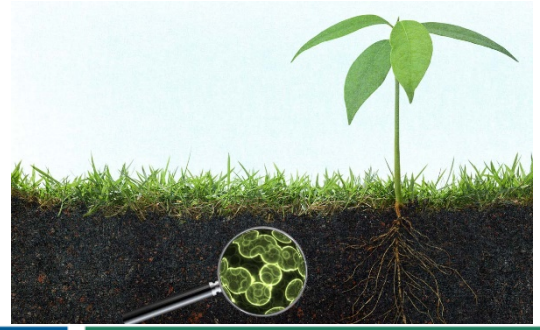
- Breakthrough 4: The ability to carry out routine gene editing of agriculturally important organisms will allow for precise and rapid improvement of traits important for productivity and quality.

- Recommendation 4: Establish an initiative to exploit the use of genomics and precision breeding to genetically improve traits of agriculturally important organisms.

Microbiome

- Breakthrough 5: Understanding the relevance of the microbiome to agriculture and harnessing this knowledge to improve crop production, transform feed efficiency, and increase resilience to stress and disease.

- Recommendation 5: Establish an initiative to increase the understanding of the animal, soil, and plant microbiomes and their broader applications across the food system.



Additional Conclusions & Research Directions

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1. *Research Infrastructure*
2. *Funding*
3. *Education and Scientific Workforce*
4. *Socioeconomic and Other Considerations*

Conclusions

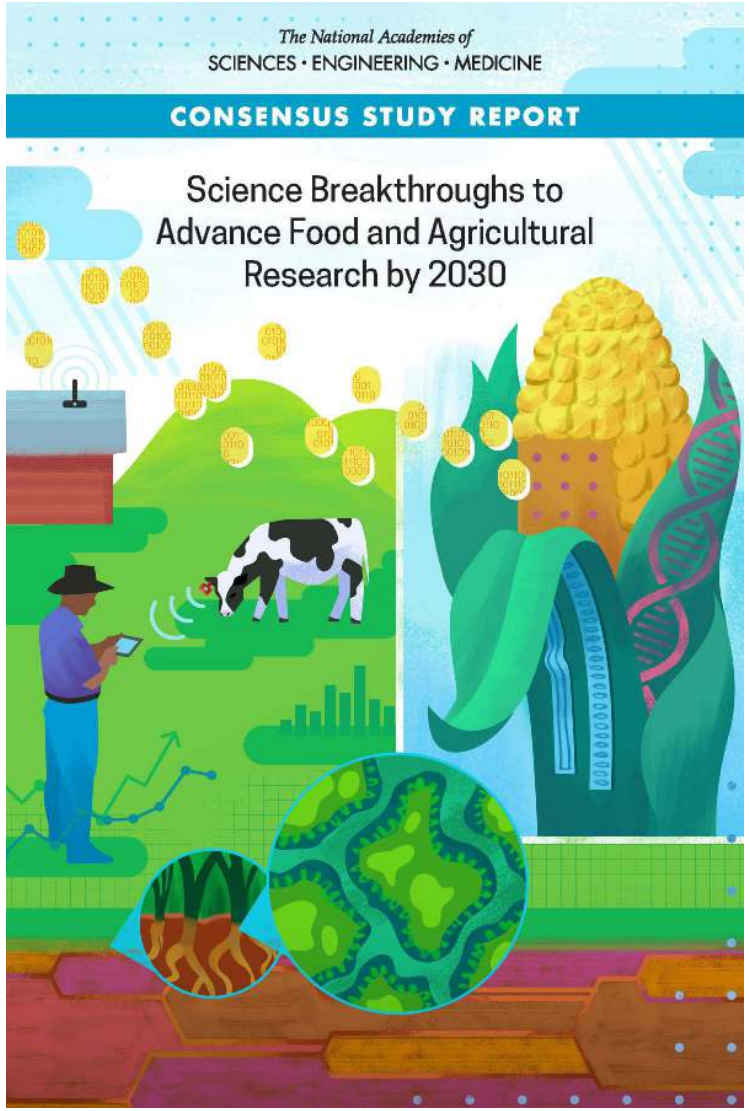
- Research Infrastructure
  - Investments are needed for tools, equipment, facilities, and human capital to conduct cutting-edge research in food and agriculture.
  - The Agricultural Experiment Station Network and the Cooperative Extension System deserve continued support because they are vital for basic and applied research and are needed to effectively translate research to achieve impactful results in the food and agricultural sectors.
- Funding
  - Current public and private funding for food and agricultural research is inadequate to address critical breakthrough areas over the next decade.

Conclusions (cont'd)

- Education and Scientific Workforce
  - Efforts to renew interest in food and agriculture will need to be taken to engage non-agricultural professionals and to excite the next generation of students.
- Socioeconomic and Other Considerations
  - A better understanding of linkages between biophysical sciences and socioeconomic sciences is needed to support more effective policy design, producer adoption, and consumer acceptance of innovation in the food and agricultural sectors.

Questions?

Thank You



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