THE ASPEN INSTITUTE

HONOR THE HARVEST FORUM

U.S. Farmers & Ranchers Alliance

PLANTING THE FUTURE

June 4th – 6th, 2019

Newburg, Maryland

PARTICIPANT BRIEFING PAPER

TABLE OF CONTENTS

WELCOME FROM THE CONVENERS

Thank you for participating in the inaugural Honor the Harvest Forum. We are honored you are joining us as part of an extraordinary group of leaders who have demonstrated a readiness to step up and create change. We are bringing you together in pursuit of a common purpose: to shape the positive future of the U.S. food and agriculture systems so that we can all thrive — as individuals, as organizations, as industries, and as a society — even in the midst of a world and an environment undergoing rapid change. We have a strong bias for action and we urge you to please read this briefing paper and come to the Forum prepared to plant the seeds of our future.

"We have an incredible opportunity to Honor the Harvest for the next generation. Feeding our fellow human beings is both a unique privilege and a deep responsibility. Recognizing the impressive legacy of American farming, the food and agriculture system today is ready to take on the challenge of our generation. The stakes are higher than ever, and the interdependencies between our food systems are equally great. Our greatest assets in farm and food are the people who are dedicated to both the land and their love of nourishing communities. Through inspiring and igniting a collective purpose, we envision proactive collaboration between the best minds in food, agriculture, science, finance, government and technology, working together to achieve lasting environmental, social and economic sustainability. We can co-create the sustainable food systems of our future. We are counting on you."

Erin Fitzgerald
CEO
U.S. Farmers & Ranchers Alliance

"I am very excited to be a part of this deep dive at how we can innovate and disrupt the food system. Climate change is the greatest threat we have ever faced as a species and agriculture is both impacting and being impacted by it. The conversations and collaboration that will take place over the next few days is the beginning of new opportunities for positive change through lasting partnerships across the food and ag system. The result of this will help create a more resilient future for generations to come. The Aspen Institute Energy and Environment Program's mission is to explore significant challenges with diverse thinkers and doers to co-create a more prosperous, equitable, and sustainable society for all. I could not think of a better opportunity to achieve our mission than through the Honor the Harvest Forum."

Greg Gershuny
Interim Director
Energy & Environment Program
The Aspen Institute

We are also grateful to Chip and Lynn Bowling for hosting us at beautiful Bunker Hill Farm in Newburg, Maryland, in the heart of the Chesapeake Bay watershed. The Bowling family raise corn, wheat, soybean, barley, and grain sorghum on their farm and have been kind enough to invite us in during one of their busiest times—planting. What better backdrop could we have for our collaborative ideation on creating a bold, better future for U.S. food and agriculture.

INTRODUCTION

Abraham Lincoln once observed that "no other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought, as agriculture."[1] American farmers and ranchers provide food and other materials for millions of people in the United States and around the world, and they are constantly seeking out ways of doing so that produce better results and are better for the world. Food and agriculture are at the forefront of efforts to unlock and enable the UN's Sustainable Development Goals addressing poverty, hunger, health, and more. There has never been a greater time for American agricultural leadership — nor a time that more called for transformation of food and agricultural systems. Decisions made over the next few years will define the next decade and beyond of American food and agriculture.

Imagine a world in which agriculture sequesters 50% more carbon than it emits - a 150% reduction from today's baseline. A world in which farmers' stewardship of natural resources and support for ecosystem services are appropriately recognized and valued. Where the U.S. agriculture and food systems are key parts of the solution to climate change, while also being resilient to climate impacts. A world where young people want to take up farming — and can make a good living at it. Where robustly supported agricultural research and innovation efforts produce huge societal, environmental, and economic benefits. Where food and agriculture systems further improve health, economic, and environmental outcomes.

This world is possible. Various stakeholders in the food and agriculture systems are already pursuing innovative and inspirational initiatives to make progress toward this world, but bringing it to full fruition will require significant collaboration and innovation among food and agriculture leaders.

To spur such action, the U.S. Farmers & Ranchers Alliance and the Aspen Institute Energy and Environment Program are convening the inaugural Honor the Harvest Forum. This Forum is bringing together an extraordinary group of diverse leaders representing major stakeholders in food and agriculture systems for a rare opportunity to spend a day and a half focusing on collaborative, transformative action, with this central task driving the work:

How might we harness the power of agriculture to propel year-on-year drawdown of greenhouse gases and adapt to an already changing climate, while growing shared value across the supply chain?

At the Forum — and in this paper — the focus is on identifying opportunities to connect stakeholders' strengths, build on successes, and commit to action around solutions to some of the greatest challenges of the 21st century. This paper reviews the situation today in a range of opportunity areas, highlights innovations already underway, and asks how to accelerate progress further.

CONTEXT AND BACKGROUND

THE EVENT

On June 4-6, the U.S. Farmers and Ranchers Alliance, in partnership with the Aspen Institute, will host the inaugural Honor the Harvest Forum. Today's world is increasingly requiring that our food systems adapt to meet the demands of a growing population, changing consumer demands, and the challenges of climate change and environmental conservation. The stakes are higher than ever — and demand collaborative, consensus-building inquiry that results in lasting environmental, social, and economic solutions.

The Forum will bring together select leaders representing major stakeholders in food and agriculture systems, including farmers, ranchers, input suppliers, packagers, retailers, brands, funders, innovators, government officials, NGOs, and other experts in environmental, social, and economic sustainability. The group will reflect in miniature a 'system in the room', allowing co-creation of vision, strategy, and specific action across system boundaries to produce game-changing solutions for a shared future.

THE CONVENERS

★ U.S. Farmers & Ranchers Alliance ★

U.S. Farmers & Ranchers Alliance (USFRA) convenes food and agriculture stakeholders and consumers in an inclusive dialogue on the sustainable food systems of the 21st century. We aim to elevate food and agriculture as the solution for sustainability, positioning farmers and ranchers as the key change agents. Collectively, we believe that farmers and ranchers uniquely enable the sustainable food systems of the future by nourishing our communities, natural resources, and planet.

THE ASPEN INSTITUTE

The Aspen Institute Energy and Environment Program explores significant challenges with diverse thinkers and doers to make a more prosperous, equitable, and sustainable society for all. The Program's forums and dialogues are designed to cultivate leadership and develop collective solutions based on the ideal that both humankind and the natural world have intrinsic value. Like the Aspen Institute as a whole, the Energy and Environment Program seeks to inspire and explore new ideas that provoke action in the world.

APPRECIATIVE INQUIRY

The Forum will feature a day-and-a-half of working sessions designed and facilitated using the Appreciative Inquiry approach of large-scale system innovation. Appreciative Inquiry was pioneered by David Cooperrider, Professor of Appreciative Inquiry at the Weatherhead School of Management at Case Western Reserve University. This structured, highly interactive process enables participants to connect with the strengths of the food and agriculture systems, explore opportunity areas, prototype solutions, and create a practical action plan — all in the course of the Forum.

This model has been used in a wide variety of contexts to create large-scale positive change by engaging a broad range of stakeholders. Varied groups have used this approach, including the United Nations Global Compact, the United Religions Initiative, the U.S. Navy, Walmart, the U.S. Dairy Industry, the Academy of Nutrition and Dietetics, and the City of Cleveland.

What is Appreciative Inquiry? To appreciate means to value — to understand those things worth high esteem. To inquire means to study, to ask questions, to explore. Appreciative Inquiry is, therefore, a collaborative exploration aimed at identifying and understanding a particular group's strengths, their greatest opportunities, and their aspirations for the future — and building a shared action plan that will help construct that future.

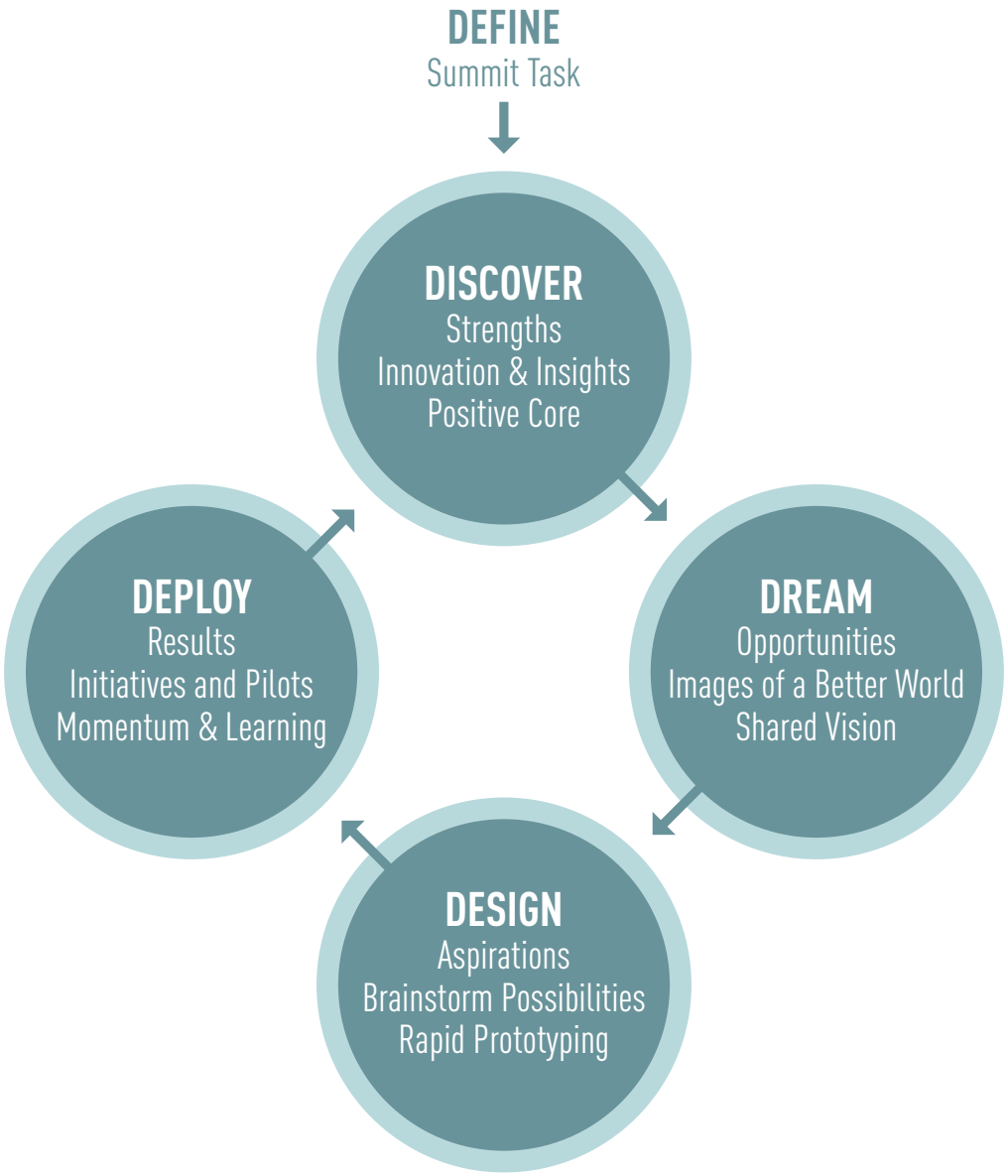
For more information about Appreciative Inquiry, please see: http://appreciativeinquiry.champlain.edu.

WHAT TO EXPECT AT THE FORUM

Unlike a purely educational event or conference, the Forum is task-focused. It's designed to be engaging, energizing, and fun — but it is serious fun, with the goal of system-level change. An Appreciative Inquiry Forum is a whole-system working meeting that engages a cross-section of as many stakeholder groups as possible — leaders and organizations that care about and have a stake in the issue at hand. Each person and stakeholder group will have an opportunity to be heard and to be exposed to other perspectives on the challenges and opportunities facing the system.

As part of the planning and design of the Forum, the conveners have defined the task for the Forum as follows: ***How might we harness the power of agriculture to propel year-on-year drawdown of greenhouse gases and adapt to an already changing climate, while growing shared value across the supply chain?***

Based on this defined task, the Forum design will utilize the 4-D cycle that is part of the Appreciative Inquiry process. The first D involves discovering what works by conducting interviews focused on high-point stories, positive strengths, and ideas for change, and in advance of this Forum, numerous interviews were conducted with a range of stakeholders to view this landscape through a lens of new possibilities. The second D involves dreaming of possible futures based on the achievements and successes identified in the interviews. The third D involves designing ideas for transformative action. The final D involves identifying how to deploy those ideas to create a new destiny -- moving from ideas to actions.



The Forum is therefore solution- and action-oriented. We will use our time together to create a common vision of a positive future and then identify and begin to work on collaborative solutions to some of the biggest opportunities in food and agriculture systems today. By the close of the Forum, we expect to have a common vision and five to ten collaborative ideas or initiatives conceptualized to drive action. The Forum is intended to be the start of a longer journey to produce tangible outcomes.

OVERVIEW OF THE U.S. FOOD AND AGRICULTURE SYSTEMS TODAY

The U.S. food and agriculture systems are increasingly diverse and among the largest in the world. According to the 2019 U.S. Food and Agriculture Industries Economic Impact Study, which reviewed the industry "from farm to fork" (encompassing any businesses involved in food agriculture, manufacturing, wholesaling, and retailing), the industry:

- Employs more than **22 million people directly** (about 15% of total U.S. employment);
- Creates more than **45 million jobs** when also including indirect effects (i.e., suppliers) and induced effects (i.e., the multiplier caused by employees' activities);
- Generates more than **$700 billion in wages** — and more than **$2 trillion** when factoring in indirect and induced effects;
- Contributes more than **$2.8 trillion of economic impact** — and more than **$7 trillion** when factoring in indirect and induced effects (which means more than one-fifth of the nation's economy is linked, either directly or indirectly, to the food and agriculture sectors); and
- Pays more than **$913 billion in local, state, and federal taxes**.[2]

The range of stakeholders within the food and agriculture systems is actually even broader than farm-to-fork, including influencers such as academics, scientists, funders, NGOs, government agencies, regulators, experts in the media, and more. The Forum will bring together participants reflective of the diversity of stakeholders in U.S. food and agriculture.

Value Chain Players

Communities • Urban / Rural Development Organizations / Agencies • Community Organizations

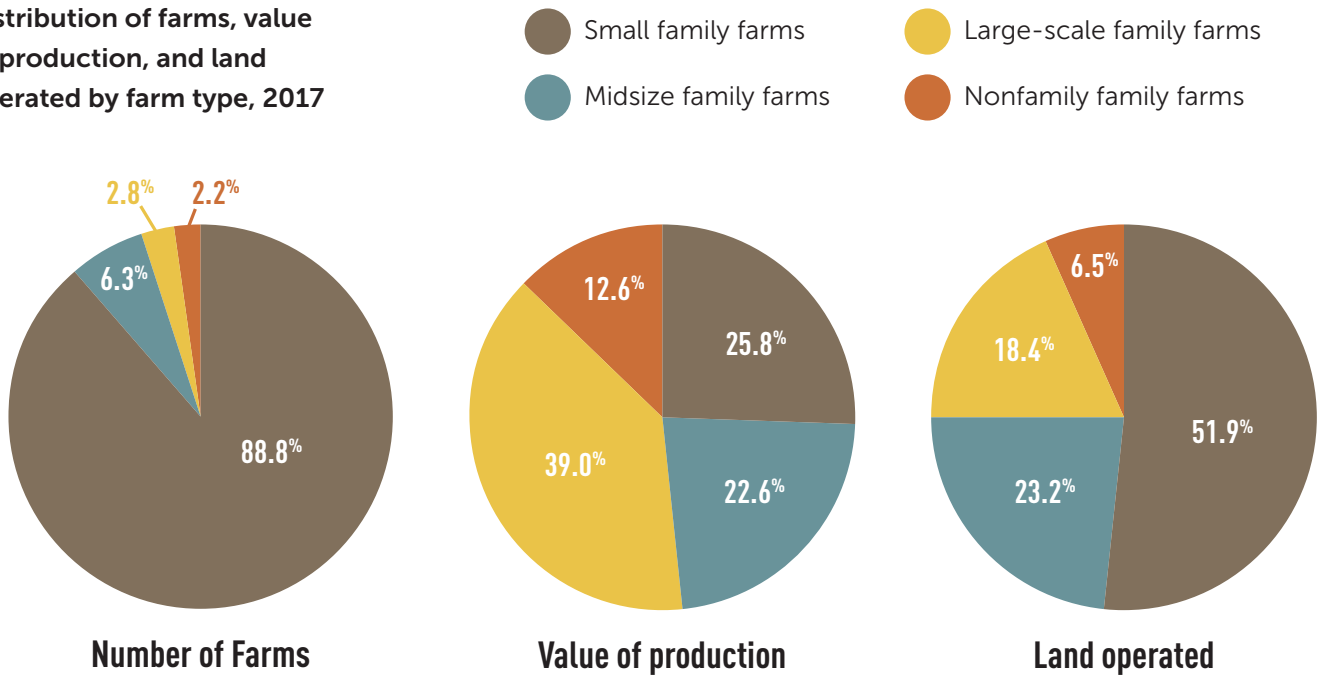
Inputs	Producers	Transport / Distribution	Processing	Packaging	Retail	Consumer	Food Waste
Ag Tech Providers	Animal Protein Producers	Logistic Service Providers	CPG Companies and Brands	B2B Packaging	Grocery Stores	Consumers	Food Waste Solutions and Innovators
Seed, Fertilizer, Pesticide Companies	Food and Fiber Crop Producers	Trucking Companies	Processors	B2C Packaging	Resaurants & Chefs	Consumer Insights Experts	
Equipment Manufacturers	Organic & Non-organic	Freight Rail	Co-op Models	Recycling Experts and Advocates	Online	Consumer Advocates	
	Urban Ag Innovators				Foodservice		
	Industry Organizations						

Influencers

Academia / Science	Finance / Funders	NGOs	Government Agencies / Lawmakers / Regulators	Media / Comms	Other
Experts On:	Foundations	Youth-Focused	Secretaries of Agriculture (Federal and State)	Expert Journalists / Columnists	Tech Companies
Carbon Cycle & Climate Science	Institutional and Private Investors	Nutrition Advocates	Ag House & Senate Comittee Members	Authors	Biofuels / Energy
Ag Studies / Soil Health / Agronomy	Venture Capital	Environmental Advocates	Governers	Magazines	Youth
Human Health & Nutrition	Lenders	Ag / Farming Focused	Federal Agencies (NRCS, FDA, Urban / Rural Development)		Influencers
	Insurance	Urban / Rural Development			
		Metrics and Standards Organizations			

While the range of stakeholders is wide, the core of the food and agriculture systems — and the image that comes to mind for many people — is the farm. The number of farms in the United States peaked at 6.8 million in 1935, fell sharply until the early 1970s, and then leveled off. As of 2017, there were about **2.05 million farms in operation**. The total amount of land in farms has been declining gradually since the 1950s, though farms are bigger now — about **444 acres on average** in 2017 compared to 155 acres in 1935.[3]

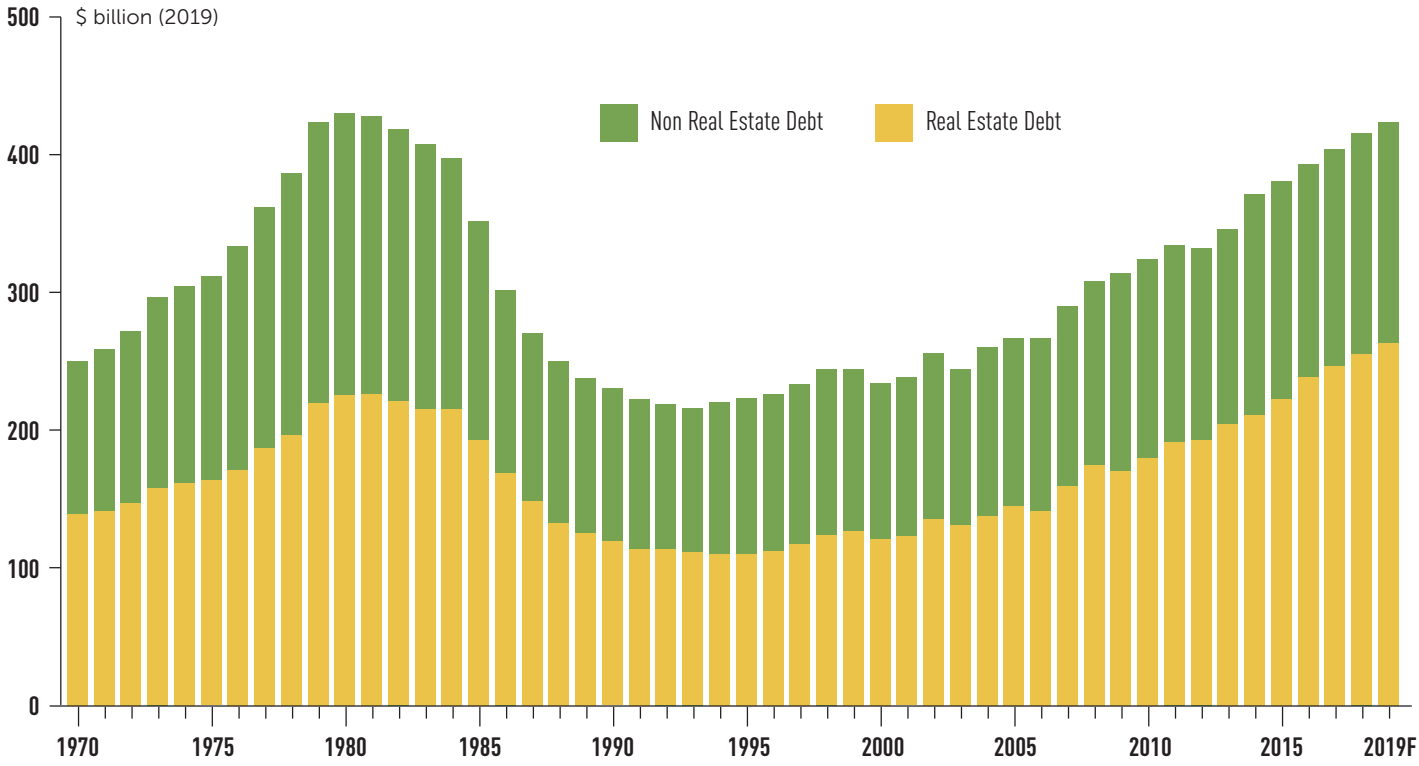
Distribution of farms, value of production, and land operated by farm type, 2017



The vast majority of these farms are small family farms (less than $350,000 in gross cash farm income), which account for the majority of the land operated by farms but only about a quarter of the value of production. In contrast, large family farms ($1 million or more in gross cash farm income) account for under 3% of farms but more than 18% of land operated and 39% of production. The share of value of production, though, varies by commodity, with small family farms producing most of the value in poultry (excluding eggs) and hay, while large family farms dominate in dairy, cotton, and fruits and vegetables.[4]

U.S. farmers are facing **challenging economic trends**. Production costs have been increasing, while commodity prices have been dropping – and the U.S.-China trade war is depressing demand and prices further. The prices paid to farmers dropped about 30% from 2008 to 2017 for corn, 17% for soybeans, about 45% for wheat – more than the prices that consumers pay for food have fallen.[5] In 2008, more than 16 cents of every dollar spent on food commodities went to farmers, with the rest going to other actors in the post-farm food supply chain, but that had dropped to about 12 cents by 2016.[6] Average net farm income is basically back to 2011 levels and is down more than 30% from 2013.[7] Farmers are getting squeezed, and as a result, producers cannot cover annual expenses with operating loans and are transforming them into debt. American farmer debt has jumped to $409 billion, up from $385 billion a year ago, and is now at levels last seen during the 1980s farming crisis, after climbing steadily for many years.[8] U.S. farmers are filing for bankruptcy at levels not seen for years.[9] Many are taking on second jobs to make the finances work.[10]

Farm sector debt, inflation adjusted, 1970-2019F



Note: F = forecast; data for 2018 and 2019 are forecasts. Values are adjusted for inflation using the chain-type GDP deflator. 2019=100.
Source: USDA, Economic Research Service, Farm Income and Wealth Statistics. Data as of March 6, 2019.

Compounding the situation, U.S. agriculture and food systems are becoming increasingly **aggregated and reliant on a few large corporations**, which can lead to reduced competition in the market and lower and more unpredictable returns for independent farmers.[11] In addition, **climate change is already affecting agriculture**, creating more unpredictability and more extreme weather events that can make risk mitigation and management more expensive – and put farmers out of business.

Furthermore, **alternative agriculture formats** – such as urban, rooftop, and indoor agriculture – are growing, creating more competition with traditional farms. While these formats have a range of benefits, they sometimes struggle financially as well, and they aren't addressing the full range of food needs and aren't replacing the losses occurring in conventional agriculture.[12] Growth in alternative proteins (e.g., non-dairy milks, plant-based meat and eggs) is also creating additional competitive pressure on some animal agriculture farmers.[13]

The demographics of U.S. farm operators are also changing. As of 2012, the **average age of principal operators was 58**, and **more than 31% were 65 or older**. Both the average age and percentage over 65 have been growing for decades; for instance, in 1978, the average age was 50.3 and the percentage over 65 was under 20%.[14] The **percentage of women as principal operators** of farms has been increasing, from less than 5% in 1978 to **about 12%** in 2012. When looking at all farm operators, not just the principal operators, they account for more than a quarter. These female principal operators are generally older than male operators, operate smaller farms, and produce everything from beef to aquaculture to high-value crops.[15] In addition, while **more than 95% of principal operators are white**, racial diversity is also increasing among farmers, with more black, Asian, Hispanic, American Indian or Alaska Native, Pacific Islander, and multiple-race farmers in 2012 than there were in 2007.[16]

At the same time, more than a third of rural counties are **losing population**, particularly in the Great Plains.[17] While mechanization has reduced the need for farm labor,[18] there are still labor and workforce shortages on farms and in rural communities.[19]

Another structural shift underway in American agriculture is the **decline of owner-operated farms** and the corresponding increase in farmers working land rented from non-operating landowners. In 2018, non-operating landowners controlled 41% of U.S. farmland and 62% of Midwest farmland. Approximately 70% of rented farmland acres in the Midwest is on a cash-rent basis, often for annual leases.[20] Farmers renting land face particular challenges in aligning management practices with stewardship and conservation.

AGRICULTURE'S POTENTIAL FOR CARBON DRAWDOWN

Excepted from "Net-Negative: The power of resiliency in agriculture's ecosystem services" from USFRA's Ecosystem Services Science Advisory Council

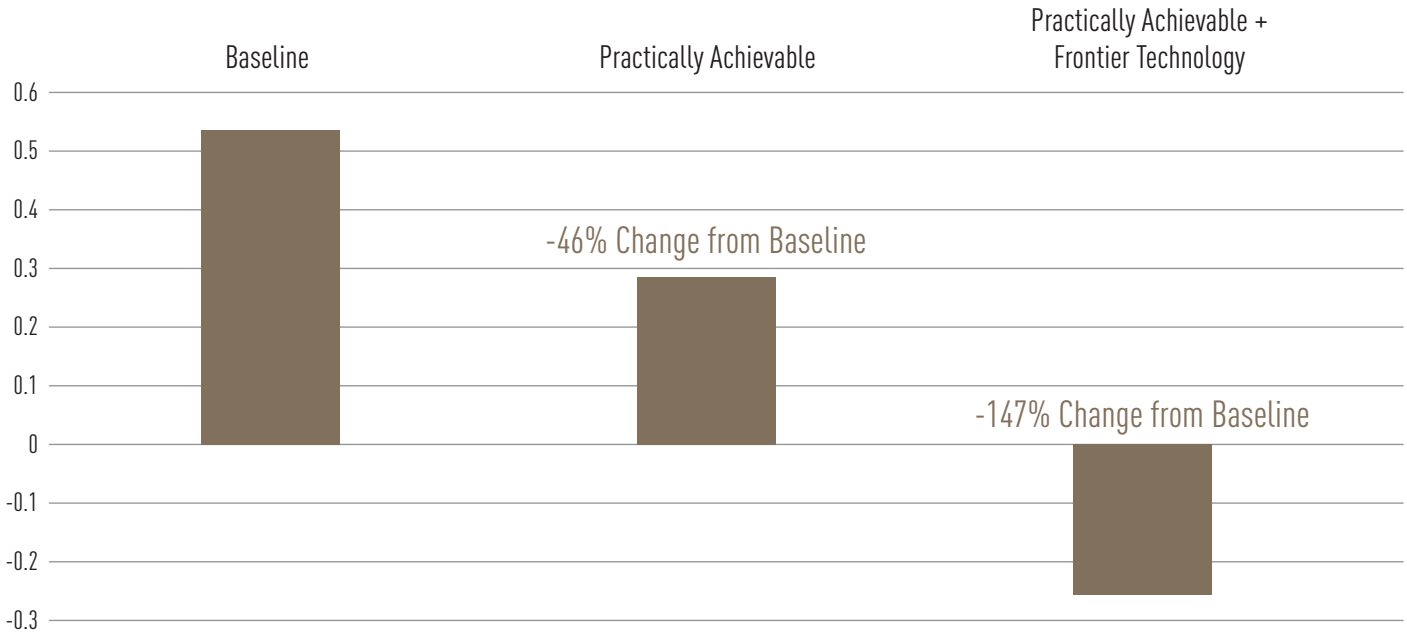
Agriculture is recognized today as contributing 8.4% of total U.S. greenhouse gas emissions (GHG). The primary greenhouse gases across agricultural systems are methane, N_2O and CO_2. (EPA 2019) Practices in both animal and crop agriculture release GHGs – primarily methane (CH_4), nitrous oxide (N^2O), and carbon dioxide (CO_2) – with more GHGs coming from livestock production than from crop production. These emissions come primarily from:

- Enteric fermentation (i.e., during digestion) in domestic livestock and livestock manure management
- Agricultural soil management
- Soil liming, nitrogen (urea) fertilizer (EPA Greenhouse Gas Emissions, USDA Greenhouse Gas Emissions)

But while agriculture today is a net emitter, it has the potential to play the opposite role – that of a carbon 'bank.' Agricultural carbon banking comes from inputs such as crop plant photosynthesis (productivity), crop residues, animal manure incorporation, no-till farming and cover crops.

Because of soil's carbon cycling properties, **growing scientific literature shows that agriculture has the potential to offset its own GHG emissions and become a net carbon sink** especially in comparison to other sectors. In fact, soils represent the largest carbon sink in land-based systems.

Terrestrial Carbon Removal Estimates



This translates to significant potential to act as a carbon sink. Using only technologies and practices in use today, the greenhouse gas footprint of U.S. agriculture could be reduced by 46%. If the technologies and practices were expanded to include 'frontier technologies' – or those still in the process of coming to market – the carbon removal estimates extend to a 147% reduction off of baseline. **This means that agriculture could offset half again as much as its own baseline emissions.**

Gt CO2 / year	Total Ag GHG Emissions - 6.5 Gt CO2 Eq.	Hypothetical Emissions within Sector (Gt CO2 Eq.)	% Change from baseline	% of Total US GHG Emissions
Baseline		.542		8.4% of US
Practical	-.25	.292	-46%	3.8% of US
Frontier	-.8	-.258	-147%	-4.0% of US

What's more, agricultural practices that enhance soil carbon are aligned with economic value as well. According to an analysis by The Nature Conservancy, for each 1% of cropland in the U.S. that adopts an adaptive soil health system, annual economic benefits translate into $226 million of societal value.

In the midst of this expansive, changing landscape, and emerging insights into the nature of agricultural carbon cycling, some key opportunities are emerging to improve the food and agriculture systems, touching on everything from climate change to economics to data to marketing. The following sections review these diverse opportunities for collaboration and innovation. The Forum will be an opportunity for each participant to focus designing solutions in one of these areas. As you read through this paper, please be thinking about which opportunity areas you would be most excited to work on.

OPPORTUNITIES FOR COLLABORATION AND INNOVATION: SUMMARY

HOW MIGHT WE HARNESS THE POWER OF AGRICULTURE TO PROPEL YEAR-ON-YEAR DRAWDOWN OF GREENHOUSE GASES AND ADAPT TO AN ALREADY CHANGING CLIMATE, WHILE GROWING SHARED VALUE ACROSS THE SUPPLY CHAIN?

THE CLIMATE OPPORTUNITY

1. **MAXIMIZE CARBON DRAWDOWN:** Fulfill the potential of farming and ranching as climate solutions.
2. **ADAPT TO A CHANGING CLIMATE:** Invest in resilient food production.

THE ROLE OF METRICS, STANDARDS, AND COMMUNICATION

3. **AGREE ON WHAT GOOD LOOKS LIKE:** Align on a pre-competitive way to define climate-resilient food production that everyone can feel good about.
4. **OPTIMIZE METRICS:** Coordinate to measure what matters.
5. **CREATE FEEDBACK LOOPS TO ACCELERATE ADAPTATION:** Improve the flow of information up and down the food value chain.

THE ROLE OF RESEARCH, INNOVATION, INVESTMENT, AND MARKETS

6. **VALUE STEWARDSHIP:** Compensate farmers for investing in nature.
7. **PRIORITIZE RESEARCH, INNOVATION, AND TECH TRANSFER:** Invest in the future of food production as though our lives depended on it.
8. **RECOGNIZE CLIMATE SOLUTION INNOVATION ACROSS FOOD AND AG SYSTEMS:** Publicly share and celebrate the exciting stories of how food and ag systems are mobilizing to maximize carbon drawdown.

THE CLIMATE OPPORTUNITY

01

MAXIMIZE CARBON DRAWDOWN: FULFILL THE POTENTIAL OF FARMING AND RANCHING AS CLIMATE SOLUTIONS

There is a pervasive view that agriculture is one of the biggest contributors to global greenhouse gas (GHG) emissions. A growing body of scientific literature, however, shows that agriculture has the potential to not only offset its own GHG emissions, but also to become a net carbon sink, offsetting the emissions of other industries. Agricultural carbon is part of a biogenic cycle, which means that much of the carbon emitted by agriculture is carbon that was taken up during the growing process just months before. Further, through conservation practices and regenerative agriculture, farmers and ranchers can enhance the uptake of carbon during the growing process and retain it after harvest. There are also opportunities through renewable biofuels, co-product utilization, treatment and usage of manure, and reclamation of food waste, among others, to reduce GHG emissions through farming and ranching.

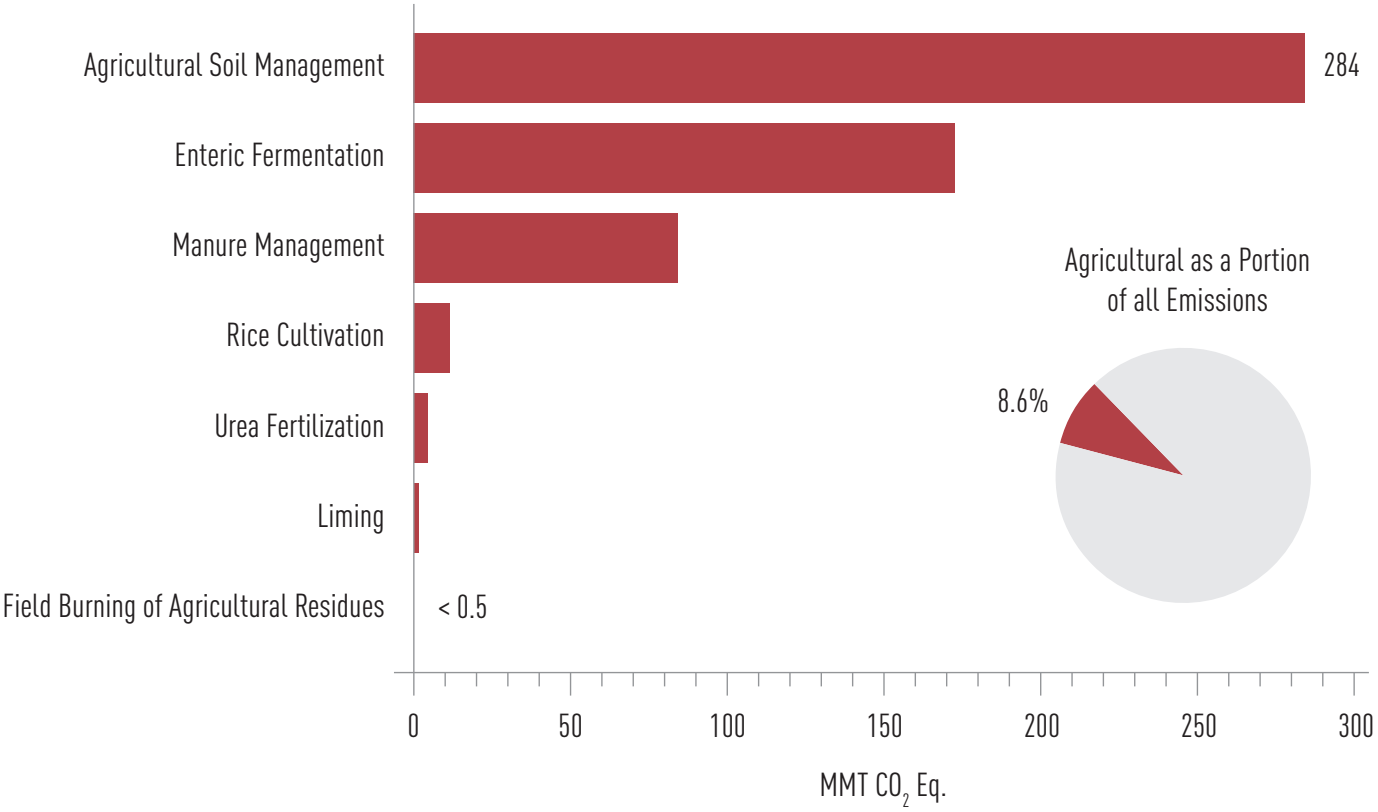
THE SITUATION TODAY

Agriculture accounted for about **8.6% of total U.S. greenhouse gas emissions** in 2016, emitting about 563 million metric tons of carbon dioxide equivalent (MMT CO_2 eq.). Practices in both animal and crop agriculture release GHGs – primarily methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2) – with more GHGs coming from livestock production than from crop production. These emissions come primarily from:

- enteric fermentation in domestic livestock (CH_4);
- livestock manure management (CH_4 and N_2O);
- rice cultivation (CH_4);
- agricultural soil management (N_2O);
- soil liming (CO_2);
- urea fertilization (CO_2); and
- field burning of agricultural residues (CH_4 and N_2O).

In addition, there are emissions from on-farm use of fossil-fuel-based electricity and fuels (CO_2), which account for about 13% of agricultural emissions. There are also CO_2, CH_4, and N_2O fluxes from agricultural land-use practices and land-use conversion (e.g., loss of soil carbon, grassland fires, conversion of forest land to cropland).[21]

2016 agricultural GHG sources in the United States (Source: EPA 2018)



CO_2 emissions from U.S. agricultural activities **increased** by more than 26% and CH_4 emissions by almost 16% between 1990 and 2016, while N_2O emissions fluctuated from year to year but increased by more than 14% overall.[22]

Like oceans and forests, **soils store large amounts of carbon**. In fact, soils in North America contain more than 90% of the continent's total carbon stocks, and global soils contain more carbon dioxide than the atmosphere. The more carbon that remains in the soil, the better for the soil, crop yields, and the planet.[23]

INNOVATIONS & INSPIRATIONS

- Carbon itself is not inherently a problem. Indeed, there is a natural carbon cycle on which life is based. The problem instead comes from what could be thought of as 'fugitive carbon', which is carbon where it is unwanted and dangerous. **Changing the framing or language of carbon** can open new solution pathways, such as boosting 'living carbon' to get carbon out of where there should not be as much of it (i.e., the atmosphere) and into where there should be more (e.g., the soil).[24]

- Agricultural practices are a key determinant of soil health and soil carbon. **Practices to improve soil carbon** include: conservation tillage practices (e.g., strip-till and no-till management); crop residue management (i.e., returning crop residues to the soil); use of cover crops; crop rotation selection (e.g., perennial crops, crops with greater root mass); addition of manure and compost; and rotational grazing on grasslands.[25] Increasing the carbon stored in topsoils worldwide by just 0.4% per year would, some assert, both improve soil fertility and completely offset anthropogenic emissions (i.e., achieve net-zero emissions).[26] Currently, adoption of some of these practices (e.g., use of cover crops) remains very low on U.S. annual cropland,[27] while conservation tillage was used on about 70% of soybean, 65% of corn, 67% of wheat, and 40% of cotton acres in the United States.[28]

- **Shellfish production both has the potentional to sequester large amounts of carbon** and is also vulnerable to some of the first manifestations of climate change. The Shellfish Growers Climate Coalition was launched in 2018 in partnership with The Nature Conservancy and grew from seven founding members to over 100 grower members just in its first year. Research is underway to better understand the circumstances under which cultivation of bivalves, other shellfish and sea grasses may hold potential as a carbon sink as well as the most effective techniques for adapting to a changing climate.

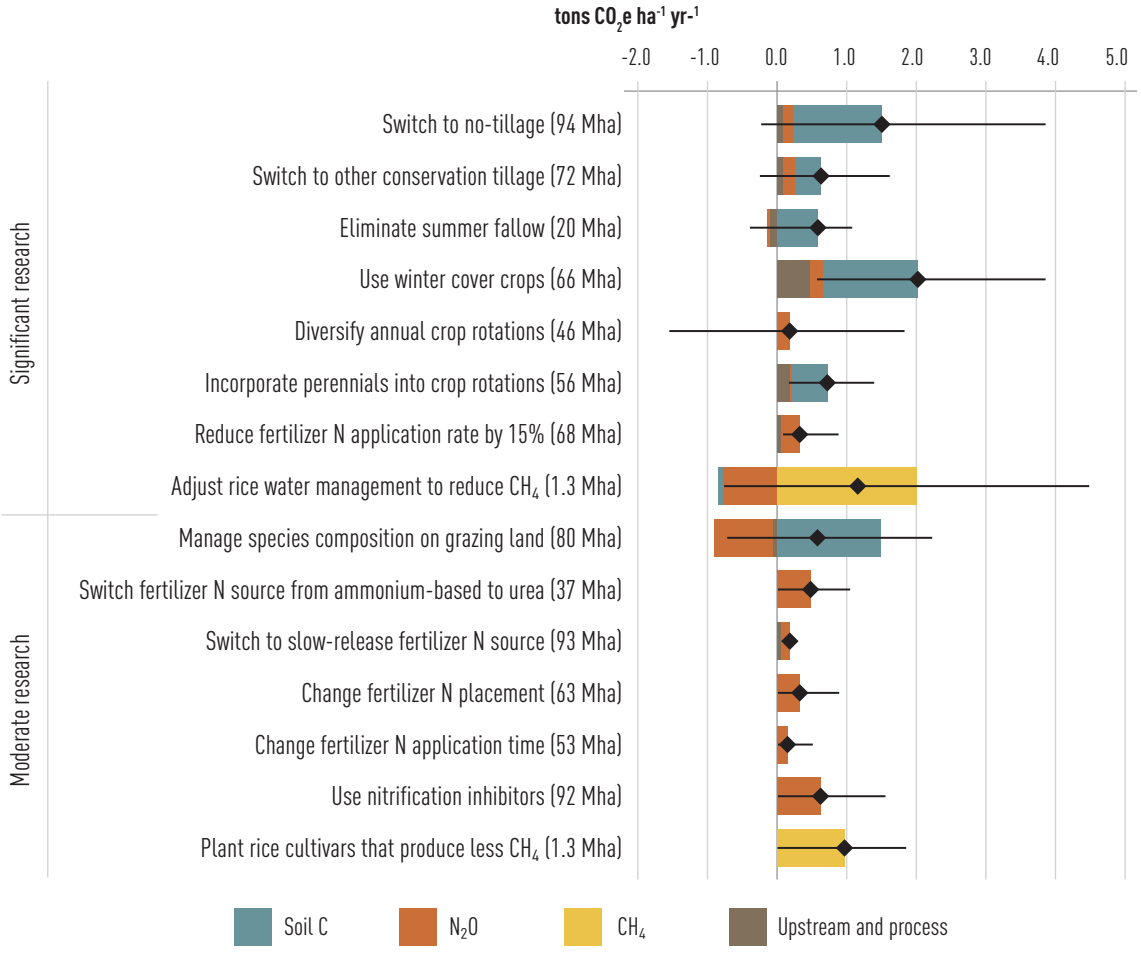
- There are many **avenues for driving greater carbon sequestration in agriculture**, including training, spreading awareness and knowledge, supporting adoption of new practices, and incentives from other stakeholders in the system. For instance, the Soil Health Partnership, a farmer-led initiative of the National Corn Growers Association, engages with and offers technical assistance to farmers at a local level, providing trained field managers and agronomists to help them test practices that can improve soil health.[29] Similarly, the Soil Carbon Coalition has a Soil Carbon Challenge competition to encourage land managers to boost soil carbon by providing monitoring, experimentation, and recognition of success.[30]

- Agriculture already **offsets some of its own emissions**, but more is possible. The practically achievable CO_2 removal rate from U.S. agriculture through expansion of use of existing practices is around 250 MMT (0.25 Gt) per year. About the same amount is possible from forests. If advanced technologies (e.g., still in the basic research phase) are also included, the potential CO_2 removal rates from U.S. agriculture could be around 800 MMT (0.8 Gt) per year (plus another 350 MMT from forests), which is enough to offset agriculture's emissions, as well as some of the emissions from other sectors.[31]

- Beyond increasing soil carbon stores and reducing soil carbon losses, **additional opportunities to reduce GHGs in U.S. agriculture** include fertilizing crops with the appropriate amount of nitrogen, draining water from wetland rice soils, adjusting livestock feed, using anaerobic digesters to capture emissions from manure (e.g., through EPA's AgSTAR program), and improving energy efficiency and use of renewable energy on farms.[32] With regard to altering livestock feed composition, many approaches are being studied at university research centers – from adding various chemical compounds (e.g., at Penn State) to adding seaweed (e.g., at University of California Davis).[33] Off the farm, there are significant opportunities to close the food cycle loop and reduce emissions by minimizing food waste and using composting and digesters to keep organic waste out of landfills.[34]

- U.S. agriculture can also produce tools to help reduce GHGs, such as **biofuels**,[35] as well as provide land for renewable electricity generation from **wind and solar**.[36]

Mitigation potential in terms of net greenhouse gases per hectare per year for certain practices
(Source: T-AGG 2011)



- Simulation tools can allow for scenario planning to anticipate where the biggest bang for the buck can be achieved in terms of emissions reductions. USDA's NRCS and Colorado State University have developed the COMET-Farm tool to create a **whole farm and ranch GHG accounting system** that can compare emissions under current management practices to emissions under alternative future management scenarios.[37] There is also a Denitrification-Decomposition (DNDC) model that can simulate **carbon and nitrogen cycling** in agricultural ecosystems, which can be helpful in assessing the impact of changes in management practices on ecosystems, which can be helpful in assessing the impact of changes in management practices.[38]

THOUGHT-STARTER QUESTION

How might we propel year-on-year drawdown of greenhouse gases through agriculture?

02

ADAPT TO A CHANGING CLIMATE: INVEST IN RESILIENT FOOD PRODUCTION

Even as farmers and ranchers work to reduce GHG emissions, the U.S. food and agriculture systems – perhaps more than any other sector – are being impacted by the effects of climate change. Gradual climatic changes (e.g., rising average temperatures, shifts in pest ranges) and extreme weather events (e.g., storms, floods, droughts, heat waves, wildfires) are creating unpredictability, disruption, destruction, and loss. Many climate mitigation strategies may also serve as adaptation strategies, but it is important to recognize that the food and agriculture sectors need to be resilient and adaptive through the coming decade and beyond in order to preserve food security and economic viability.

THE SITUATION TODAY

- Climate change has **clear impacts on agriculture**, including crops, animals, and people. Increases in average temperature, for example, could affect U.S. crop production, soil evaporation rates, and the health of field workers. Increases in extreme heat conditions are projected to cause more heat stress for livestock and greater risks of heat exhaustion, heatstroke, and heart attack for humans. Increased occurrences of heavy rainfall could lead to excessive runoff, flooding, and soil erosion, as well as loss of soil carbon and degraded water quality in nearby bodies of water. Changes in temperature, humidity, and precipitation could expand the incidence and range of pests and diseases affecting crops and livestock. Increased droughts and other changes in precipitation could lead to reduced availability of water for rain-fed and irrigated agriculture. Changes in the frequency and severity of extreme weather events (e.g., floods, heat waves, storms) and wildfires (e.g., on rangelands) could cause devastation to agricultural lands. While some regions (e.g., the Northern Great Plains) may see improved conditions for agricultural productivity over the next few decades, overall yields from major U.S. crops are expected to decline.[39]

- These are **not just future projections**. Climate change is already affecting agriculture. Rising seas are leading to saltwater intrusion and loss of farm fields on the Eastern Shore of Maryland; measurements at one farm indicate that its farmland has been converting to salt marsh at a rate of about 100 acres per year since 2009.[40] The wetter weather and rapid spring warm-ups that are now more likely because of climate change contributed to the spring 2019 flooding in the Midwest that devastated farmland, killed cattle, and wiped out crop stockpiles, as well as roads, bridges, and other infrastructure that the agricultural sector relies on to move products.[41] The 2017 Northern Great Plains drought – which sparked wildfires, harmed livestock, and reduced agricultural production – was made more likely by human-caused climate change.[42] Climate change is also one of several stressors that are reducing bee populations, threatening the pollination services that bees provide (e.g., to orchard growers).[43]

- Impacts of climate change **require farmers to adapt** in various ways, but this is still a relatively new area that requires significant development and engagement with farmers. Keeping farming viable in the face of a changing climate could involve modifying what is produced, the inputs used, the technologies deployed, and management strategies. For instance, modern breeding techniques and genes from wild crop relatives are being utilized to produce higher-yield crops that have greater tolerance for droughts, floods, salinity, extreme temperatures, and other stresses.[44] Similarly, breeding more heat-tolerant livestock, improving the designs of animal housing, and expanding human health services in rural areas will likely all be needed to respond to the growing risks from heat.[45] Other adaptation measures could include changing crop mixes, irrigation methods, fertilization practices, tillage practices, pesticides (and pesticide uses), and management of land.[46]

- All of these measures, however, while helpful, have **limits as climate impacts grow more severe**. At some point, the impacts of climate change will be more than technological and operational fixes will be able to address.[47]

INNOVATIONS & INSPIRATIONS

- Cities and farmers can work together to **reduce the potential for flooding**. The city of Cedar Rapids, Iowa, has partnered with farmers upstream to form the Middle Cedar Partnership Project in the Middle Cedar watershed to use cover crops, nutrient management, wetlands, and saturated buffers to improve water quality, water quantity, and soil health in order to reduce nitrate concentrations and extreme flood events.[48]

- As the climate grows more unpredictable and challenging, **controlled environment agriculture** (CEA) could become more important, as CEA grows crops hydroponically within, as the name suggests, a controlled environment. AeroFarms, for instance, produces pesticide-free leafy greens in indoor vertical farming facilities that are designed to optimize conditions for healthy plant production.[49]

- **It is likely that the crops grown and the seed varieties used will need to be adapted to new climate realities**. "The major crop (by volume) grown in the United States, corn does not reproduce at temperatures higher than 95 degrees. During the 20th century, Iowa experienced three straight days of 95-degree heat only once a decade. But by 2040, if greenhouse gas emissions remain on their current high trajectory, Iowa will experience three straight days of 95-degree heat in three summers out of four."[50]

- Agribusiness companies have already produced **seeds that can tolerate a dry year** (for example, Pioneer's AQUAMax corn),[51] new hybrids are being developed to be more tolerant to flooding,[52] and there have been scientific studies that conclude that modified seeds may be required to meet the demands of food production in a changing climate.[53]

- But climate-resilient seeds alone will not be enough. **Diversifying the range of foods that humans eat** could not only improve the climate resilience of the food supply (e.g., by utilizing more crops that can tolerate challenging weather and environmental conditions), but also benefit ecosystems and human health. Knorr, a German food and beverage brand owned by Unilever, and WWF launched the Future 50 Foods campaign and report in 2019 to push for such diversification.[54]

- Several scientists are exploring how to **boost the resilience of livestock** to climate impacts. For instance, scientists at the University of Florida are studying the DNA of Angus and Brahman cows to figure out how to breed cattle that can better regulate body temperature and thus better adapt to hotter conditions.[55]

THOUGHT-STARTER QUESTION

How might we adapt our food and ag systems in the US to produce safe, abundant and affordable food in a changing climate?

THE ROLE OF METRICS, STANDARDS, AND COMMUNICATION

03

AGREE ON WHAT GOOD LOOKS LIKE: ALIGN ON A PRE-COMPETITIVE WAY TO DEFINE CLIMATE-RESILIENT FOOD PRODUCTION THAT EVERYONE CAN FEEL GOOD ABOUT

Farmers and ranchers carry a heavy burden in trying to provide food, fiber, and more to the world. They generally try to do 'the right thing' for their land, their animals, and the environment, but new information and new societal demands can lead to a shifting landscape in terms of what 'the right thing' is. If farmers and ranchers are going to provide for the world's needs without seriously damaging the planet, collaboration across the agriculture and food value chains to agree on basic, common standards for sustainable production and end-use will be essential. All parts of the value chains have to do a better job of being transparent with the public about practices and impacts, acknowledging where there is work to be done, and celebrating successes.

THE SITUATION TODAY

- **There are dozens, if not hundreds, of different food and ag standards and certifications today**. These standards and certifications optimize for a range of different ideals, from fair trade to biodynamic. These various programs set out criteria for how they determine whether or not a particular producer or product meets the standard.

- **Media reporting** on farming, food, and nutrition influences what people eat and drink, but it often is incomplete, inaccurate, or sensationalized, spreads misinformation, and creates confusion among consumers about the benefits or harms of various products.[56] The public is also uncomfortable with some modern agricultural practices and have a perception of widespread malfeasance (e.g., regarding animal treatment) because of media reporting, even if examples portrayed in the media are not always representative of wider practices.[57]

- There are sometimes **disconnects between science and consumer opinions**, such as with respect to the safety of genetically modified foods. About 90% of scientists believe genetically modified foods are safe, but only about a third of consumers do[58] – a disconnect that has important repercussions for the future of some crops, such as U.S. citrus, which may need genetically modified trees to combat citrus greening disease.[59] Food miles are another example of this disconnect, with some in the public trying to reduce their carbon footprints by buying local even though analyses of foods' carbon footprints suggest that this may not be particularly effective.[60]

- At the same time, farming and ranching clearly have impacts. Companies are currently competing on who is best addressing those impacts, and there are numerous sustainability certifications that highlight good actors. This situation is good in terms of emphasizing the importance of sustainable agriculture and food production, but a **baseline of sustainability** beyond regulations could raise the entire industry's performance. If producers cannot agree on what 'good' looks like, then customers will continue defining it for them.

INNOVATIONS & INSPIRATIONS

- Some other industries have come together to **define what 'good' looks** like in order to improve the practices and perceptions of the industry and to allow for competition to be based on other business aspects. For instance, the Sustainable Apparel Coalition developed a standardized value chain suite of tools for all apparel, footwear, and textile industry participants to measure environmental, social, and labor impacts, which in turn allows the industry to address inefficiencies, change harmful practices, and provide transparency for consumers.[61] The chemical manufacturing industry likewise has its Responsible Care initiative on environmental, health, safety, and security performance.[62]

- Some industries and companies that have had poor consumer trust have restored it (at least somewhat) by improving performance and offering a **compelling vision of a better future**. For instance, Volkswagen, which lost tremendous trust with the diesel emissions cheating scandal discovered in 2015, has mostly bounced back, partly due to fixing the vehicles and partly due to making unprecedented commitments to and investments in an electric-vehicle future.[63]

- Greater **transparency can change customer perceptions** and enhance consumer trust and loyalty. Research by Label Insight into food brands, for instance, has found that consumers want brands to be totally transparent about what ingredients are in products, where those ingredients were sourced, and more. Most consumers will verify for themselves information that is on food labels, and many do not trust brands to accurately provide complete product information, but brands still have an opportunity to create and promote a complete and transparent source of information that can build greater trust.[64]

- Some big food manufacturers, such as Danone North America, have pursued certification as a **B-Corp** as a way to build consumer trust regarding their impact on the environment, employees, and more.[65]

- There are efforts to **improve the media's and the public's understanding of science**. For instance, Virginia Commonwealth University launched a Science Journalism class in fall 2016 to teach students how to communicate complex scientific discoveries to the general public.[66] Sense About Science is a non-profit organization that aims to help journalists, policy-makers, and the public understand evidence and science. The U.S. Sense About Science group offers a free statistical assistance service for journalists and has produced a media guide for scientists,[67] while the UK group allows people to ask for evidence on a range of topics and developed an activity pack and a lesson plan for kids and classrooms.[68]

THOUGHT-STARTER QUESTION

How might we establish a shared perspective and set of target outcomes for climate-resilient agriculture in the US?

04
OPTIMIZE METRICS: COORDINATE TO MEASURE WHAT MATTERS

Better data can lead to improved decision-making on the farm and across the value chain, allow producers to demonstrate more sustainable outcomes, and enable compliance with regulatory requirements. There has been an explosion of efforts to define, collect, analyze, and report agriculture and food systems' data and metrics. This proliferation of requests, tools, initiatives, and regulations, however, has created a complex and often time-consuming landscape for stakeholders to navigate. Adding to the complexity, it is not always clear who owns or has the right to profit from the data, raising questions of how best to balance privacy, transparency, and innovation.

THE SITUATION TODAY

- Data collection and analysis are happening across the supply chain. Some farmers are using **dozens of dashboards** from a variety of precision ag technologies and inputs in response to a range of **customer data requests**. Processors are **aggregating data** across hundreds or thousands of farmers and ranchers – and reporting to potentially hundreds of customers. Consumer packaged goods (CPG) providers, restaurants, and retailers are aggregating data throughout their supply chains for their own reporting, and some send thousands of data request surveys to their suppliers, including farmers and ranchers. Investors and local, state, and federal governments are likewise requesting or requiring food and agriculture systems' data.
- There are **numerous data reporting guides and frameworks**, including a range of initiatives that convene sectoral stakeholders to define shared metrics for agriculture specifically, as well as broader frameworks that can be applied to food and agriculture operations, as laid out in the table below. A number of tools have been set up to facilitate data collection consistent with these frameworks.

Specific to Food & Ag		Broader, Including Food & Ag
• U.S. Roundtable for Sustainable Beef • U.S. Poultry and Egg Association Environmental Program • Stewardship Index for Specialty Crops (SISC) • Sustainable Agriculture Initiative (SAI) • Field to Market: The Alliance for Sustainable Agriculture • Innovation Center for U.S. Dairy	• Honey Bee Health Coalition • Monarch Collaborative • Soil Health Partnership • Midwest Row Crop Collaborative • Better Cotton Initiative • Round Table on Responsible Soy (RTRS) • Roundtable on Sustainable Palm Oil (RSPO)	• The Sustainability Consortium • Global Reporting Initiative • CDP • Sustainability Accounting Standards Board • Dow Jones Sustainability Index

- These different requests and frameworks, which can take significant time and effort to respond to, can sometimes be **of questionable value**. Data requests are often narrowly framed and may weight certain practices in ways that are inappropriate for some geographies. For example, using cover crops, generally recognized as beneficial in terms of GHG emissions and soil health, can negatively influence other metrics (e.g., on grazing or labor). Metrics can fail to capture the unique soil, weather, and other conditions on individual farms, making the data less usable or meaningful. Many current established metrics also are not actually capturing some key aspects of how farmers and ranchers manage their operations, such as ongoing research (e.g., testing out new seeds or conservation practices) and risk management practices (e.g., using several different types of hybrids to minimize risk). Furthermore, data is often measured using different tools and metrics, may be calculated inconsistently, and may not always be accurate (e.g., due to unclear guidance and protocols about what and how to report).

- Some businesses and other entities recognize the value of ag data and are working to create (and in some cases monetize) higher quality data, including a range of precision ag technology providers. **The business model** in this space, however, is still very nascent, and digital ag has yet to become a standalone profit center for companies.

- A large number of the data-generating and data-analyzing tools and technologies do not currently "speak" to each other (i.e., **lack interoperability**), making it even harder to simplify, streamline, and standardize these processes.

- Collection and analysis of data by tool providers, technology companies, and others raise complicated questions about **transparency, privacy, data ownership, and beneficiaries of data analysis**. For instance, there are concerns that proprietary digital ag platforms owned by big corporations mean that farmers are ceding ownership of and access to that data if they choose to leave those platforms.[69]

INNOVATIONS & INSPIRATIONS

- The basic architecture of digital ag needs to be developed and streamlined to improve on-farm data capture and analysis, better leverage technologies, and minimize the time and effort needed to respond to data requests. For instance, the Open Ag Data Alliance is pursuing an **open-source approach to develop data-sharing standards and software libraries** that will help farmers access, control, and share their data from a range of hardware and software systems that are not currently interoperable.[70] The Agricultural Data Coalition, a collaborative non-profit organization, has also created a place for farmers to **store, manage, and share data** with service providers, research institutions, and others.[71]

- Some entities are making efforts to **streamline ag data reporting**, including the Climate Corporation (owned by Bayer), which has partnered with crop insurance companies on data usage,[72] and the USDA Farm Service Agency (FSA), which has established an Acreage Crop Reporting Streamlining Initiative that lets farmers and ranchers report their common crop acreage information just once, either to their FSA local county office or to their participating crop insurance agent.[73]

- **IBM's Food Trust** uses blockchain technology to enable the creation of a permissioned, permanent and shared record of food system data.[74] IBM claims that the benefits of this system include improved food safety, food waste reductions, fresher food, and greater sustainability. The tool also facilitates the process of confirming and logging relevant certifications.

- Several metrics initiatives are exploring **ways to compensate farmers and ranchers** for their time and effort spent on collecting data for reporting, based on interviews conducted for the Forum. There are also some companies looking to help farmers sell their data instead of farmers giving it away.[75]

- Many **other sectors** that are also pursuing solutions to data standardization, ownership, sharing, and other issues could provide models for the ag sector, such as the Consolidated-Clinical Document Architecture (C-CDA) and Fast Healthcare Interoperability Resources (FHIR) standards in the healthcare sector or the Green Button initiative in the energy sector (to give utility customers easy access to their electricity usage data for sharing with service providers).[76]

THOUGHT-STARTER QUESTION

How might we improve agricultural and food metrics while easing the reporting burden?

05

CREATE FEEDBACK LOOPS TO ACCELERATE ADAPTATION: IMPROVE THE FLOW OF INFORMATION UP AND DOWN THE FOOD VALUE CHAIN

With the multitude of players in today's industry structure and the onerous, slow, and largely one-directional nature of data collection and sharing, there are gaps and delays in the communication of information critical to decision-making by other stakeholders. This creates mismatches between supply and demand, challenges in the bioavailability of nutrients in some foods, issues related to food safety, and other inefficiencies that result in economic and environmental loss and waste across the value chain. Feedback loops are essential to enabling strong responses, adaptation, and innovation from farms and industry. As the industry prepares to make significant shifts in response to climate change, the importance and urgency of being able to recognize and share key insights and data across the system will only increase.

THE SITUATION TODAY

- **Feedback loops** are processes in which the outputs of a system are circled back and used as inputs. In the agriculture and food systems, it is difficult to connect concerns about food quality and local environmental risks to consumer choices or agricultural production methods, due to globalization of the food market, the many layers and players involved in the value chain, and the growing separation between consumers and producers. Long distances and the lack of consumer understanding of how or where food is produced impede the flow of information to farmers making production management decisions and consumers making purchasing decisions. There is a need to tighten feedback loops that connect ecosystems, producers, processors, marketers, and consumers.[77]

- Most consumers are now **two or three generations removed from the farm**, limiting their understanding of how farming practices have modernized and changed. Increasing demands regarding issues such as environmental protection and animal welfare are not always grounded in an understanding of current agricultural practice and are not always matched with a willingness to pay more for those demands to be met.[78] The lack of understanding of and connection to agriculture has led to a situation where consumers do not know or trust the producers of their food, leading them to turn to elected officials for laws and regulations to address their concerns.[79]

- Retailers and brands spend millions if not billions of dollars on consumer research each year, either in-house or with external agency support, to get data and insights that can inform product development and marketing decisions. There is an entire industry of **consumer insights** and market research firms that cater to this need through surveys, shop-alongs, focus groups, taste tests, and more. Yet these insights do not typically make it far enough upstream to influence food production decisions at farm level in a timely manner.

- Shifting **consumer preferences** can lead to mismatches between supply and demand, which in turn lead to both lost revenues for food producers and wasted food that was produced but not consumed. For instance, the consumer shift from low-fat to high healthy-fat diets has led to shortages and high prices for foods such as avocados, butter, and salmon, as producers struggle to increase output to meet surging demand.[80] At the same time, there currently appears to be more supply than demand of goods like cage-free eggs and antibiotic-free chicken.[81]

- Where excess food does exist in the system, feedback loops can help **ensure that food goes to good use**, and also provide that information back to producers to better optimize for the future. Feeding America reports that American families would need $21 billion to be able to purchase sufficient nutritious food, and three-quarters of the counties with the highest rates of food insecurity are in rural areas, ironically the places growing most of the country's food.[82] While many retailers and brands donate food, and food banks often have local networks that allow them to connect with sources of excess food, agricultural surpluses could be better anticipated and donated to food banks or purchased by them at low costs.

- Plants provide a range of nutrients (e.g., iron, zinc, copper) vital to human health. Nutrient deficiencies can vary by region. Scientists are working to ensure that foods offer nutrients that the human body can actually absorb, as foods sometimes have inhibitors that bind nutrients and limit their **bioavailability**.[83] Closer linkages and feedback loops are needed between the agriculture, nutrition, and human health sectors.[84]

- Tens of millions of Americans get sick from **food-borne illnesses** every year, and hundreds of food products get recalled, but slow information flows in the U.S. food and agriculture systems mean it can take days for companies to trace the source of the problem, and many recalled food products have already been eaten by the time consumers hear of the recall.[85] Climate change may expose consumers to both more and more unpredictable food safety risks. For example, a recent disease outbreak in Yuma, CA is believed to have been caused by a series of unusual weather events that contaminated lettuce in a way that could not be washed away.[86]

INNOVATIONS & INSPIRATIONS

- An expert committee convened by the Institute of Medicine and the National Research Council developed an **analytical framework** for U.S. food systems as a tool for decision-makers, researchers, and other stakeholders to identify the potential impacts of particular interventions, promote transparency, and improve communications among stakeholders.[87]

- To enhance food safety and traceability, Walmart piloted use of **blockchain** technology in 2016 to track the origins of the sliced mangoes it sells, reducing tracking time from seven days using conventional approaches to 2.2 seconds.[88]
- Several food companies that have adopted mandatory metrics for suppliers reported in interviews that they provided these suppliers with data that **assesses their performance relative to an average of their peers** on key metrics to help them identify opportunities for improvement.[89]
- Barilla, together with the Barilla Center for Food and Nutrition, **has worked directly with farmers to choose crops, implement conservation practices on farms, and maximize the nutrition available** in the foods they produce, while staying in line with consumer preferences. Barilla's legume-based pastas, which are made from red lentils and chickpeas, are a source of plant-based protein, high in fiber, and gluten-free.[90]
- Johns Hopkins University created a free, downloadable **curriculum** to teach high school students about food systems and to empower them to become informed consumers.[91]

THOUGHT-STARTER QUESTION

How might we enable faster, better adaptation and innovation through improved sharing of essential information among all stakeholders in the food and agriculture systems?

THE ROLE OF RESEARCH, INNOVATION, INVESTMENT, AND MARKETS

06

VALUE STEWARDSHIP: COMPENSATE FARMERS FOR INVESTING IN NATURE

With 48% of land in the United States being used to grow crops or animals, farmers and ranchers are on the front lines of conserving, protecting, and managing natural resources such as water, biodiversity, and soil carbon. Most farmers would say that stewardship is just part of good farming, but it does not always align with lower costs or increased value for farmers. Farmers and ranchers who want to convert to more sustainable practices or more diverse cropping systems face significant financial risk in doing so and may have difficulty accessing needed capital.

THE SITUATION TODAY

- **Stewardship** suggests a responsibility and a commitment by farmers and others in the agriculture and food systems to provide for the current population while also preserving and enhancing the land for the next generation. **Ecosystem services** are the goods and services derived from natural ecosystems, such as water purification, carbon sequestration, and pollination. **Valuing** stewardship and support for ecosystem services could involve both financial compensation and non-financial elements (e.g., reputational benefits, regulatory assistance). What gets valued gets measured, managed, and protected, though there is some concern among farmers about overly tying financial performance to stewardship, as some aspects are not fully in their control.

- Some conservation practices allow for savings over time, especially things like improving the efficiency of inputs (e.g., water- and energy-efficient irrigation, nutrient management), which can directly reduce costs, though the payback period can be years. **Stewardship does not always align with cost savings** or higher value, however. Even though farmers' planning horizons can be decades (and not just the next harvest season), there are some practices (e.g., installing a saturated buffer) that provide conservation benefit but no significant financial return.[92] Many farmers will go against their strict financial interests to "do the right thing" – but they have their limits.

- Conservation practices that are truly externalities – that benefit the public but are not in farmers' economic interests – require **public funds and incentives** in order to get farmers to implement them. The USDA's Natural Resources Conservation Service (NRCS) has grant and cost-sharing programs to support implementation of conservation practices on working lands, but funds are limited.[93]

- Sustainable ag **certification programs** can also provide a mechanism for supporting implementation of stewardship practices, with the reward for farmers being expanded or premium market access.[94] For example, access for meat producers to Whole Foods Markets involves certification through the Global Animal Partnership's 5-step animal welfare rating standards.[95] USDA organic certification provides farmers with the ability to sell products that often receive significant price premiums compared to conventionally grown products.[96]

- Ecosystem services **markets and payment systems** likewise provide financial incentives for farmers and ranchers to be stewards of natural resources and to support ecosystem services. These markets involve landowner "sellers" who can enhance services such as clean water and wildlife habitat, "buyers" that invest in conservation for regulatory or public relations purposes, and some kind of program or platform to connect them. In Oregon, for example, an operator of wastewater treatment facilities in the Tualatin River basin is paying upstream farmers to plant shade trees and perform other riparian restoration activities to offset the thermal loads from the treatment facilities.[97] In the Chesapeake Bay region, Maryland is developing a water quality nutrient trading program to allow a range of sectors to pay for pollution reduction activities in the agricultural sector.[98] Ecosystem services markets have grown from just a few in the mid-1980s to more than 2,400 in 2015, with most emerging east of the Mississippi and on the West Coast. These markets can deliver substantial funding for conservation activity; transactions in watershed markets, for instance, have generated tens or hundreds of millions of dollars in several states since their inception.[99] Voluntary carbon markets are another variant of an ecosystem services market and can provide value to farmers for activities such as agro-forestry, land management, no-till agriculture, and measures to boost soil carbon.[100] It can be difficult and expensive, however, to measure and verify results in these markets, and there is a need for stronger market pull from customers for many types of offset credits.

INNOVATIONS & INSPIRATIONS

- Initiatives such as Farmers for Monarchs are connecting farmers to **federal and state conservation programs** that allow farmers to earn good returns on marginal crop lands and get technical help and cost-sharing incentives for establishing monarch butterfly habitat and implementing other conservation practices on their lands.[101]

- There are many ideas being pursued to **bring more private capital into supporting natural resource stewardship** and ecosystem services. For instance, a 2017 report explored the potential for NRCS to leverage private capital to drive conservation practices that can earn a financial return.[102]

- A related, emerging idea for supporting ecosystem services with private capital is **"insetting"** – which is similar to offsetting but occurs within the supply chain. Hotel companies, beverage companies, and others are investing in projects related to sustainable agriculture, tree planting, and more on their suppliers' farms and in the surrounding ecosystems.[103]

- Noble Research Institute is in the process of developing a national **voluntary ecosystem services market**, to be launched by 2022, that incentivizes farmers and ranchers to improve soil health and carbon sequestration. The draft protocol has been completed, identifying carbon and water ecosystem services that farmers and ranchers could sell for use either as insets or offsets. The pilot phase will run from 2019 to 2020.[104] Similarly, Nori is creating a new, open-source, blockchain-based marketplace to make it easier to pay people for activities that remove carbon dioxide from the atmosphere, with agricultural soil carbon projects being the first type of Carbon Removal Certificates on its platform.[105]

- Indigo Ag's digital marketplace and certification of crops can **connect farmers directly with buyers** seeking rice, soybeans, corn, or cotton with specific qualities, characteristics, or farm management practices, enabling companies to pay farmers premiums for sustainable practices that, for example, reduce the crops' carbon footprint or the amount of nitrogen used. The direct connection and individualized data allow for greater differentiation and de-commoditization of agriculture, which can support farmer profitability and greater sustainability.[106]

- A model for **creating more market pull** in ag-related ecosystem services markets might be found in the REDD+ Acceleration Fund, which is designed to combine public and private capital to create a source of long-term demand for carbon credits created by reducing emissions from deforestation and forest degradation (REDD+) in developing countries, thereby reducing the risk of investing in such credits.[107]

- **Crop insurance** has sometimes penalized carbon-sequestering conservation practices, but it could be a tool to empower farmers to pursue them. The AGree Conservation and Crop Insurance Task Force, for instance, aims to lay the groundwork for greater conservation practices in the United States while maintaining a viable federal crop insurance program.[108]

THOUGHT-STARTER QUESTION

How might we create, improve, and scale mechanisms – and demand for them – that value the public benefits that farmers and ranchers create through stewardship of natural resources and support for ecosystem services?

07

PRIORITIZE RESEARCH, INNOVATION, AND TECH TRANSFER: INVEST IN THE FUTURE OF FOOD PRODUCTION AS THOUGH OUR LIVES DEPENDED ON IT

Agricultural research can involve basic science, applied science, tech transfer, lab work, field work, and public-private partnerships. Past investments in ag science have led to critical advances that produced wide-ranging societal benefits, but funding for research and infrastructure still falls short. Although nourishing a growing population with finite resources and in a changing climate is widely acknowledged as a pivotal challenge, agriculture only receives 2% of the U.S. federal research and development (R&D) budget. An improved convergence of science, technology, and finance is needed.

THE SITUATION TODAY

- USDA R&D funding generally accounts for somewhere **around 2% of total federal R&D**, a percentage that has stayed relatively consistent for decades.[109] Federal funds may support USDA staff scientists doing research or may be granted to university researchers who are doing research aligned with USDA focus areas.

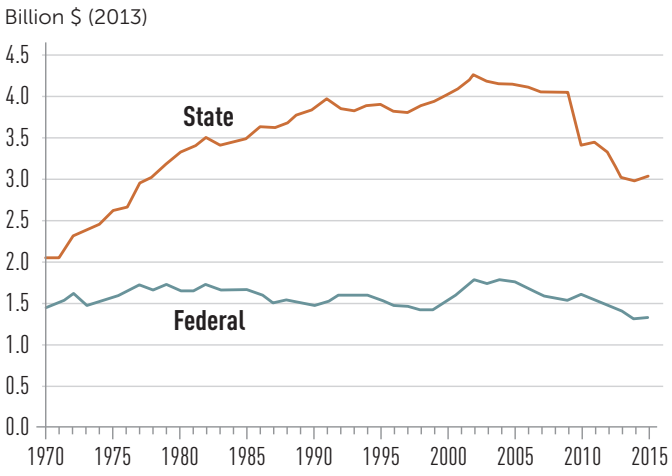
- USDA is not the only funder of agricultural research, as additional funding comes through the **Foundation for Food and Agriculture Research** (FFAR, created in the 2014 Farm Bill), Advanced Research Projects Agency - Energy (ARPA-E, for work on biofuels), and others.[110] FFAR, for instance, matches public dollars with private dollars to support research programs designed to spur agricultural and food innovation. As of the drafting of this paper, FFAR had challenge areas focused on soil health, sustainable water management, next generation crops, advanced animal systems, urban food systems, and the health-agriculture nexus, as well as open funding opportunities focused on developing an automated monitoring tool that quantitatively assesses key animal welfare indicators in broiler chickens and on developing a technology that can accurately and rapidly determine the sex of layer chicks before they hatch.[111]

- Research typically progresses through stages. For crop research, for instance, USDA uses **Technology Readiness Levels** (TRLs) adapted from NASA, which progresses through nine levels, from preliminary identification of the challenge through experimental testing to commercialization and sustained production.[112]

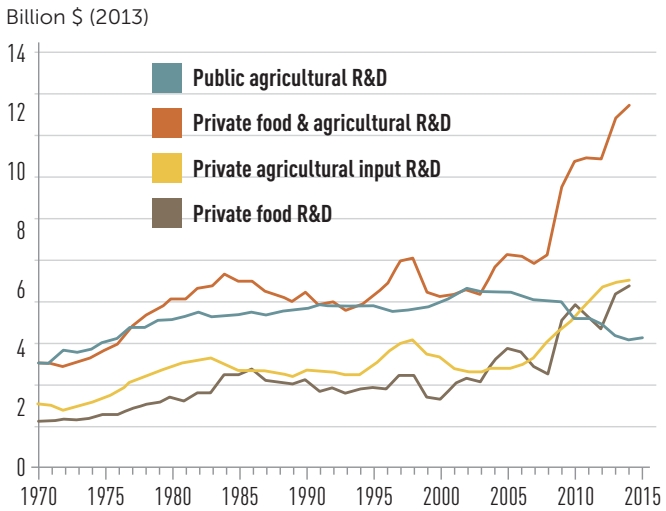
- Public expenditures on agricultural R&D declined 28% between 2002 and 2015 (in real terms), with states spending significantly more than the federal government. **Private-sector food and agricultural R&D spending**, in turn, far surpasses public spending, with the former focusing more on marketable products and the latter focusing on more fundamental R&D. Private-sector spending really began to diverge from public spending in the early 2000s, and by 2010, private-sector spending on agricultural input R&D and on food R&D were each higher than total public spending on ag R&D.[113]

Inflation-adjusted R&D spending (Source: USDA ERS 2019)

Expenditures of Federal and State public agricultural R&D



Public and private agricultural R&D expenditures in the United States



- **Land grant universities**, which are centers of ag science (as well as other research), have faced shrinking levels of public funding, forcing them to try to diversify their sources of funding, including seeking out private dollars.[114]

- Funding to agrifood tech startups (both upstream and downstream) grew eight-fold from $2.1 billion in 2013 to $16.9 billion in 2018, **growing 43% year-over-year** from 2016 to 2018.[115] Upstream receives less funding, getting about 40%, or $6.9 billion, of the funding that downstream receives. In comparison, in 2018 biotech startups globally raised $29 billion in seed through late rounds from all investors.[116] Perhaps not surprisingly, the biggest upstream category for investment was ag biotechnology.

- McKinsey has characterized **agriculture as the least digitized major sector of the economy**.[117] There is investment in agriculture, in particular technologies that fall under the precision ag umbrella, but much of is not aligned with full market needs. There are potential disruptions, yet most food producers have very little free cashflow to invest in new technologies. There is money invested into university R&D but not an innovation and investment pipeline to translate that research to the market. "In a field that has historically been dominated by academic research, NGO, and government investment or grant initiatives, this recent shift towards digital infrastructure is paving the way for the Food and Ag sector to support scalable, private sector business models which incorporate positive externalities into their ongoing growth plan."[118]

INNOVATIONS & INSPIRATIONS

- A recent report showed that "meeting the challenges of the food and agriculture sectors sustainably could **unlock 14 major business opportunities worth US$2.3 trillion** annually by 2030." The top areas of opportunity included reducing food waste in the value chain and at the consumer, forest ecosystem services, low-income food markets and technology on large farms.[119]

- The 2018 Farm Bill created a **new Agriculture Advanced Research and Development Authority (AGARDA)**, modeled after ARPA-E and the Defense Advanced Research Projects Agency (DARPA), to support cutting-edge agricultural R&D that the private sector is unlikely to undertake. Congress authorized $50 million annually for 5 years.[120]

- Major private companies, including Google, General Mills, Campbell's Soup, Kellogg, Land O'Lakes, Bayer, Syngenta, Dupont, Microsoft, and Monsanto, are investing substantial capital in **ag tech**, including early-stage ag tech companies.[121] Better Food Ventures, meanwhile, is raising a new $50 million fund to help address the current gap in funding for late seed and early venture (Series A/B stage) financing.[122]

- AgThentic, AgFunder, and Sapling created an **AgriFood Tech Startup Resources Tool** to help innovators search for potential sources of early-stage agrifood business funding and support, ranging from accelerators to incubators to venture development organizations.[123]

- With greater support, land grant universities could provide unbiased perspectives on how to better identify and pursue carbon-sequestering and GHG-reducing sustainable agriculture practices. This could be an enhanced aspect of the **work of university initiatives** such as the Center for Environmental Farming Systems (a partnership of North Carolina State University, North Carolina Agricultural and Technical State University, and the North Carolina Department of Agriculture and Consumer Services) and the Minnesota Institute for Sustainable Agriculture (at the University of Minnesota).[124]

THOUGHT-STARTER QUESTION

How might we expand and deepen the knowledge base of agricultural science and innovation to bring it more readily into practice?

08

RECOGNIZE CLIMATE SOLUTION INNOVATION ACROSS FOOD AND AG SYSTEMS: PUBLICLY SHARE AND CELEBRATE THE EXCITING STORIES OF HOW FOOD AND AG SYSTEMS ARE MOBILIZING TO SOLVE CLIMATE CHANGE

Our country relies on the productivity and stewardship of American farmers and ranchers to provide food and drive economic growth, and they can play key roles in mitigating and adapting to climate change. The profession of being a farmer or rancher, however, is getting harder, due to issues involving economics, trade, extreme and changing weather, and more. Even as we recognize the critical role that farmers and ranchers play in society, the profession is less celebrated than it used to be, and innovations and leadership tend to be less recognized. A key way to attract new people into agriculture and foster innovation to address climate and other sustainability challenges is to help make farmers heroes again – to recognize in bigger and more prominent ways the innovative work they do. Doing a better job of telling that story can build and reinforce a culture of innovation in agriculture.

THE SITUATION TODAY

- There are some organizations that have sought to recognize innovators and leaders, large and small, for their work to create a low-carbon, resilient future. Often, the focus of these is on politicians, big corporate leaders, and clean energy innovators.[125] Very **few of the people featured as leaders and innovators are farmers or ranchers**, despite the worthy work that some are doing.

- Some organizations that **recognize environmental leadership** have recognized farmers. For instance, the Goldman Environmental Prize recognized family farmer and water quality activist Lynn Henning in 2010, as well as, in other years, leaders renewing the soil in Mexico and promoting sustainable agriculture in Haiti.[126]

- In December 2018, the World Farmers' Organization (WFO) launched "**THE CLIMAKERS - Farmers Driven Climate Change Agenda**," a global alliance that invites farmers to "strengthen their capacity to influence the decision-making processes on climate change." [127]

- In 2015, the White House honored 12 **Champions of Change** for sustainable and climate-smart agriculture, who had implemented practices to reduce GHG emissions and improve sustainability.[128]

- Of the 19 leaders highlighted by the French nonprofit **Climate Heroes**, at least 3 have ties to agriculture, including permaculture pioneers in France, a developer of a salinity tester for farmers in Vietnam, and Indonesian villagers that grow sustainability-certified coffee beans and vegetables.[129]

INNOVATIONS & INSPIRATIONS

- Some professions have **captured the public imagination** after being featured in documentary films, reality TV shows and even fictional television shows that present a realistic view of the work. For example, the Food Network's many shows that illuminated the job of professional chefs are credited with the 39% growth in the number of postsecondary culinary programs in the U.S. and 25% growth in total graduates over four years.[130] Similarly, the movies "Cleaner" (2007) and "Sunshine Cleaning" (2009), along with social media, are seen as popularizing the profession of crime- and trauma-scene clean-up. The industry went from having a dozen or so companies to 500 to 800 by 2016 over about seven years.[131]

- **Innovation challenges** such as the X Prize have been effective both at featuring and inspiring bold solutions to daunting challenges while elevating the people and professions in consideration for the prize itself.

- **Retailers and food companies have a public platform** that could be leveraged to recognize and honor significant contributions and excellent performance from farmers and ranchers in addition to other suppliers. For example, Walmart currently recognizes suppliers who have signed on to and are demonstrating results from Project Gigaton, an initiative to avoid one billion metric tons (a gigaton) of greenhouse gases from the global value chain by 2030. Supplier logos appear in one of two categories – Giga-Gurus or Others Sparking Change.[132]

- **Open Farm Sundays** were launched in 2006 in the UK to provide an opportunity for people to reconnect with the country's farmers. Hundreds of farmers and thousands of volunteers have welcomed more than 1.5 million visitors to working farms in the years since this effort began. "Open Farm Sunday shows that we're proud of what we do and have nothing to hide. It also creates opportunities for the media to tell positive stories about who we are."[133] The same organizers have also set up The Farmschool where they host two to three school groups on the farm each week to show children what farming is really like today.

THOUGHT-STARTER QUESTION

How might we create public ways to recognize and celebrate people innovating climate solutions across the food and ag systems?

ENDNOTES

1. USDA, Lincoln's Milwaukee Speech: An Address by Abraham Lincoln Before the Wisconsin State Agricultural Society in Milwaukee, Wisconsin, September 30, 1859, https://www.nal.usda.gov/lincolns-milwaukee-speech

2. Feeding the Economy, U.S. Food and Agriculture Industries Economic Impact Study, 2019, https://feedingtheeconomy.com/

3. USDA Economic Research Service, Ag and Food Statistics: Charting the Essentials, Farming and Farm Income website, last updated Mar. 6, 2019, https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/farming-and-farm-income/

4. USDA Economic Research Service, America's Diverse Family Farms, 2018 edition, pp.3-6, https://www.ers.usda.gov/webdocs/publications/90985/eib-203.pdf?v=9520.4

5. University of Illinois, farmdoc website, last updated Feb. 7, 2019, http://www.farmdoc.illinois.edu/manage/uspricehistory/us_price_history.html; Food and Agriculture Organization of the United Nations (FAO), FAO Food Price Index, release date: Apr. 4, 2019, http://www.fao.org/fileadmin/templates/worldfood/Reports_and_docs/food_price_index_nominal_real_apr.xls

6. USDA ERS, Food dollar application, last updated Mar. 14, 2019, https://data.ers.usda.gov/reports.aspx?ID=17885&reportPath=/FoodDollar/Real

7. USDA ERS, Farm-level average net cash income, last updated Mar. 6, 2019, https://data.ers.usda.gov/reports.aspx?ID=17841

8. Gina Heeb, America's farmers are swimming in $409 billion of debt, Markets Insider, Feb. 27, 2019, https://markets.businessinsider.com/commodities/news/americas-farmers-swimming-in-409-billion-of-debt-2019-2-1027990718; USDA ERS, Assets, Debt, and Wealth website, last update Mar. 6, 2019, https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/assets-debt-and-wealth/

9. Jesse Newman and Jacob Bunge, 'This One Here Is Gonna Kick My Butt' – Farm Belt Bankruptcies Are Soaring, The Wall Street Journal, Feb. 6, 2019, https://www.wsj.com/articles/this-one-here-is-gonna-kick-my-buttfarm-belt-bankruptcies-are-soaring-11549468759

10. Jacob Bunge and Jesse Newman, To Stay on the Land, American Farmers Add Extra Jobs, The Wall Street Journal, Feb. 25, 2018, https://www.wsj.com/articles/to-stay-on-the-land-american-farmers-add-extra-jobs-1519582071

11. Austin Frerick, Fixing our Food System — and Reviving Rural America — Means Breaking Up Big Ag, Civil Eats, Feb. 28, 2019, https://civileats.com/2019/02/28/fixing-our-food-system-and-reviving-rural-america-means-breaking-up-big-ag/; Institute of Medicine and National Research Council, A Framework for Assessing Effects of the Food System, 2015, pp.173, 186, https://www.nap.edu/read/18846/chapter/10

12. Agrilyst, State of Indoor Farming, 2017, https://www.agrilyst.com/stateofindoorfarming2017/; Amy Crawford, Big Data Suggests Big Potential for Urban Farming, CityLab, Feb. 15, 2018, https://www.citylab.com/environment/2018/02/big-data-suggests-big-potential-for-urban-farming/552770/

13. Cassie Slane, Fake milk is real news, as synthetic alternatives threaten traditional dairy farms, CNBC, Feb. 20, 2019, https://www.cnbc.com/2019/02/20/fake-milk-is-real-news-as-synthetic-alternatives-threaten-traditional-dairy-farms.html; Michael Pellman Rowland, JUST Egg 2.0 Is About To Go Nationwide At Whole Foods, Forbes, Mar. 6, 2019, https://www.forbes.com/sites/michaelpellmanrowland/2019/03/06/just-egg-wholefoods/#ca5a35d297da

14. USDA Economic Research Service,Beginning Farmers and Age Distribution of Farmers website, last updated Apr. 13, 2017, https://www.ers.usda.gov/topics/farm-economy/beginning-disadvantaged-farmers/beginning-farmers-and-age-distribution-of-farmers/

15. USDA Economic Research Service,Socially Disadvantaged Farmers: Race, Hispanic Origin, and Gender website, last updated Apr. 13, 2017, https://www.ers.usda.gov/topics/farm-economy/beginning-disadvantaged-farmers/socially-disadvantaged-farmers-race-hispanic-origin-and-gender/

16. Id.; USDA National Agricultural Statistics Service, 2012 Census of Agriculture: Table 60: Selected Farm Characteristics by Race of Principal Operator: 2012 and 2007, May 2014, https://www.nass.usda.gov/Publications/AgCensus/2012/Full_Report/Volume_1,_Chapter_1_US/st99_1_060_060.pdf

17. Kenneth Johnson and Daniel Lichter, Rural Depopulation in a Rapidly Urbanizing America, University of New Hampshire, Carsey School of Public Policy, Feb. 6, 2019, https://carsey.unh.edu/publication/rural-depopulation

18. USDA ERS, Farm Labor website, last updated Dec. 20, 2018, https://www.ers.usda.gov/topics/farm-economy/farm-labor/

19. Eduardo Porter, Short of Workers, U.S. Builders and Farmers Crave More Immigrants, The New York Times, Apr. 3, 2019, https://www.nytimes.com/2019/04/03/business/economy/immigration-labor-economy.html; David Goldstein, 'Crops go unharvested and animals go uncared for.' Concerns about farmworker shortage grow, Tri-City Herald, July 27, 2018, https://www.tri-cityherald.com/latest-news/article215518595.html

20. Non-Operating Landowners and Conservation on Rented Farmland, The Nature Conservancy, March 2019

21. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016, 2018, https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf; USDA, U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2013, 2016, https://www.usda.gov/oce/climate_change/AFGG_Inventory/USDA_GHG_Inventory_1990-2013_9_19_16_reduced.pdf

22. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016

23. Cornell University Cooperative Extension, The Carbon Cycle and Soil Organic Carbon, Agronomy Fact Sheet Series, Fact Sheet 91, 2016, http://nmsp.cals.cornell.edu/publications/factsheets/factsheet91.pdf; U.S. Global Change Research Program, Second State of the Carbon Cycle Report: Report in Brief, Nov. 2018, p.14, https://carbon2018.globalchange.gov/downloads/SOCCR2_RIB.pdf

24. William McDonough, Carbon is not the enemy, Nature, Nov. 14, 2016, https://www.nature.com/news/carbon-is-not-the-enemy-1.20976

25. USDA NRCS, Soil Health Management, https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/mgnt/; Cornell University Cooperative Extension, The Carbon Cycle and Soil Organic Carbon; USDA, U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2013

26. The 4 Per 1000 Initiative, Welcome to the '4 Per 1000' Initiative, https://www.4p1000.org/

27. National Academies of Sciences, Engineering, and Medicine, Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, 2019, pp.96-97, https://www.nap.edu/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda

28. USDA, Tillage Intensity and Conservation Cropping in the United States, Sept. 2018, https://www.ers.usda.gov/webdocs/publications/90201/eib197_summary.pdf

29. Soil Health Partnership, https://www.soilhealthpartnership.org/

30. Soil Carbon Coalition, https://soilcarboncoalition.org/

31. National Academies of Sciences, Engineering, and Medicine, Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, p.112

32. EPA, Sources of Greenhouse Gas Emissions: Agriculture Sector Emissions, last updated Oct. 9, 2018, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture; USDA, U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2013; Technical Working Group on Agricultural Greenhouse Gases (T-AGG), Assessing Greenhouse Gas Mitigation Opportunities and Implementation Strategies for Agricultural Land Management in the United States, Nov. 2011, https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_r_11-09.pdf; EPA, AgSTAR, https://www.epa.gov/agstar

33. USDA, U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2013; Jeff Mulhollem, Feed Supplement Greatly Reduces Dairy Cow Methane Emissions, Penn State News, press release, Aug. 4, 2015, https://news.psu.edu/story/364787/2015/08/04/research/feed-supplement-greatly-reduces-dairy-cow-methane-emissions; Terence Chea, Study Tests Whether Seaweed in Cattle Feed Reduces Emissions, AP, Aug.31, 2018, https://www.apnews.com/835789442443441baab77a3077870634

34. See, e.g., Project Drawdown, Food: Reduced Food Waste, https://www.drawdown.org/solutions/food/reduced-food-waste, and Food: Composting, https://www.drawdown.org/solutions/food/composting

35. Jan Lewandrowski et al, The greenhouse gas benefits of corn ethanol – assessing recent evidence, Biofuels Journal, Mar. 25, 2019, https://doi.org/10.1080/17597269.2018.1546488; EPA, Economics of Biofuels, last updated Feb. 2, 2018, https://www.epa.gov/environmental-economics/economics-biofuels

36. Andy Balaskovitz, Michigan revisits policy that limits solar development on farmland, Energy News Network, Apr. 10, 2019, https://energynews.us/2019/04/10/midwest/michigan-revisits-policy-that-limits-solar-development-on-farmland/

37. USDA NRCS and Colorado State University, COMET-Farm website, last updated Mar. 7, 2019, http://cometfarm.nrel.colostate.edu/

38. Institute for the Study of Earth, Oceans and Space, University of New Hampshire, User's Guide for the DNDC Model (Version 9.5), Aug. 25, 2012, http://www.dndc.sr.unh.edu/model/GuideDNDC95.pdf

39. U.S. Global Change Research Program, Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, Summary Findings and Chapter 10 (Washington, DC: Government Publishing Office, 2018), https://nca2018.globalchange.gov/; Nicola Lacetera, Impact of climate change on animal health and welfare, Animal Frontiers, Vol. 9, No. 1, Jan. 2019, pp.26-31, https://doi.org/10.1093/af/vfy030

40. Jeremy Cox, Sea level rise: Saltwater intrusion laying waste to Delmarva farms, Delmarva Now, Mar. 29, 2019, https://www.delmarvanow.com/story/news/local/maryland/2019/03/29/sea-level-rise-saltwater-intrusion-laying-waste-delmarva-farms/3276897002/

41. Humeyra Pamuk et al, U.S. farmers face devastation following Midwest floods, Reuters, Mar. 20, 2019, https://www.reuters.com/article/us-usa-weather-agriculture/us-farmers-face-devastation-following-midwest-floods-idUSKCN1R12J0; Samantha Harrington, Did climate change cause the flooding in the Midwest and Plains?, Yale Climate Connections, Apr. 2, 2019, https://www.yaleclimateconnections.org/2019/04/did-climate-change-cause-midwest-flooding/

42. Andrew Hoell et al, "Anthropogenic Contributions to the Intensity of the 2017 United States Northern Great Plains Drought", in Explaining Extreme Events of 2017 from a Climate Perspective, Bulletin of the American Meteorological Society, Dec. 2018, http://www.ametsoc.net/eee/2017a/ch6_EEEof2017_Hoell.pdf

43. Anna King, Massive Loss of Thousands of Hives Afflicts Orchard Growers and Beekeepers, NPR, Feb. 18, 2019, https://www.npr.org/sections/thesalt/2019/02/18/694301239/massive-loss-of-thousands-of-hives-afflicts-orchard-growers-and-beekeepers

44. U.S. Global Change Research Program, Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, Chapter 10; International Service for the Acquisition of Agri-Biotech Applications, Pocket K No. 43: Biotechnology and Climate Change, http://www.isaaa.org/resources/publications/pocketk/43/default.asp.

45. U.S. Global Change Research Program, Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, Chapter 10

46. USDA, Climate Change and Agriculture in the United States: Effects and Adaptation, 2012, p.6, https://www.usda.gov/oce/climate_change/effects_2012/CC%20and%20Agriculture%20Report%20(02-04-2013)b.pdf

47. U.S. Global Change Research Program, Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, Summary Findings; Georgina Gustin, Farmers, Don't Count on Technology to Protect Agriculture from Climate Change, InsideClimate News, Nov. 30, 2018, https://insideclimatenews.org/news/29112018/climate-change-agriculture-risk-farm-technology-science-report

48. Cedar Rapids, Middle Cedar Partnership Project website, http://www.cedar-rapids.org/residents/utilities/middle_cedar_partnership_project.php

49. AeroFarms, https://aerofarms.com/

50. "How to Feed the World After Climate Change," Slate, April 2012. http://www.slate.com/articles/technology/future_tense/2012/04/heat_resistant_seeds_ecological_agriculture_growing_food_after_climate_change_.html

51. https://www.pioneer.com/CMRoot/Pioneer/US/products/seed_trait_technology/see_the_difference/AQUAmax_Product_Offerings.pdf

52. Mustroph, A. Improving Flooding Tolerance of Crop Plants. Agronomy 2018, 8, 160.

53. Is another genetic revolution needed to offset climate change impacts for US maize yields? https://iopscience.iop.org/article/10.1088/1748-9326/aae9b8/meta

54. Knorr and WWF, Future 50 Foods, Feb. 2019, https://www.wwf.org.uk/sites/default/files/2019-02/Knorr_Future_50_Report_FINAL_Online.pdf; Eleanor Beardsley, For a Healthier Planet, Eat These 50 Foods, Campaign Urges, NPR, Mar. 24, 2019, https://www.npr.org/sections/thesalt/2019/03/24/706004242/for-a-healthier-planet-eat-these-50-foods-campaign-urges

55. Brad Buck, Making a heat-tolerant cow, Farm Progress, Jun. 27, 2017, https://www.farmprogress.com/livestock/making-heat-tolerant-cow

56. Daniela Galarza, Watch: John Oliver Tackles Food Science and Its Outrageous Claims, Eater, May 9, 2016, https://www.eater.com/2016/5/9/11639328/john-oliver-science-studies; Navjoyt Ladher, Nutrition science in the media: you are what you read, BMJ, Apr. 7, 2016, https://www.bmj.com/content/353/bmj.i1879.full

57. Is farm-animal abuse the exception or the rule?, Minnesota Public Radio News, Aug. 16, 2013, https://www.mprnews.org/story/2013/08/16/daily-circuit-ag-gag

58. Jane E. Brody, Are G.M.O. Foods Safe?, The New York Times, Apr. 23, 2018, https://www.nytimes.com/2018/04/23/well/eat/are-gmo-foods-safe.html

59. University of Illinois at Urbana-Champaign, Future of US citrus may hinge on consumer acceptance of genetically modified food, ScienceDaily, Feb. 13, 2019, https://www.sciencedaily.com/releases/2019/02/190213124448.htm

60. Molly Leavens, Do food miles really matter?, Harvard University, Sustainability, Mar. 7, 2017, https://green.harvard.edu/news/do-food-miles-really-matter

61. Sustainable Apparel Coalition, https://apparelcoalition.org/

62. Responsible Care, https://responsiblecare.americanchemistry.com/

63. Matthew Campbell et al, How Volkswagen Walked Away From a Near-Fatal Crash, Bloomberg Businessweek, Mar. 29, 2018, https://www.bloomberg.com/news/features/2018-03-29/how-volkswagen-walked-away-from-a-near-fatal-crash

64. Label Insight, Driving Long-Term Trust and Loyalty Through Transparency: The 2016 Label Insight Transparency ROI Study, 2016, http://www.labelinsight.com/hubfs/2016_Transparency_ROI_Study_Label_Insight.pdf

65. Mary Ellen Shoup, Rabobank: What can big food companies do to rebuild consumer trust?, FoodNavigator-USA, July 5, 2018, https://www.foodnavigator-usa.com/Article/2018/07/05/Rabobank-What-can-big-food-companies-do-to-rebuild-consumer-trust

66. Virginia Commonwealth University, Class trains student journalists to better report on science news, VCU News, Nov. 11, 2016, https://news.vcu.edu/article/Class_trains_student_journalists_to_better_report_on_science

67. Sense About Science USA, https://senseaboutscienceusa.org/

68. Sense About Science, https://senseaboutscience.org/ and http://askforevidence.org/index

69. Oliver Moore, Digitization, Technology, and Farming – Who's Got the Power?, Food Tank, Feb. 2019, https://foodtank.com/news/2019/02/digitization-technology-farming-who-got-the-power/

70. Open Ag Data Alliance, http://openag.io/

71. Agricultural Data Coalition, http://agdatacoalition.org/

72. Nicole Heslip, Climate Corp's New Partnership Set to Streamline Crop Reporting, Brownfield Ag News, Nov. 21, 2018, https://brownfieldagnews.com/news/climate-corps-new-partnership-set-to-streamline-crop-reporting/

73. USDA FSA, The Acreage Crop Reporting Streamlining Initiative (ACRSI) website, https://www.fsa.usda.gov/programs-and-services/initiatives/acrsi/index

74. IBM Food Trust, https://www.ibm.com/blockchain/solutions/food-trust

75. Sam Bloch, If farmers sold their data instead of giving it away, would anybody buy?, The New Food Economy, July 19, 2018, https://newfoodeconomy.org/farmobile-farm-data/

76. Kate Monica, How Health Data Standards Support Healthcare Interoperability, EHR Intelligence, https://ehrintelligence.com/features/how-health-data-standards-support-healthcare-interoperability; U.S. Department of Energy, Green Button website, https://www.energy.gov/data/green-button

77. Kate Clancy, Feedback loops, Journal of Agriculture, Food Systems, and Community Development, Vol. 3, Issue 3, Spring 2013, pp.5-7, https://www.foodsystemsjournal.org/index.php/fsj/article/download/168/164/; Åsa Svenfelt et al, On the importance of tightening feedback loops for sustainable development of food systems, Food Policy, Apr. 2005, https://www.researchgate.net/publication/222542219_On_the_importance_of_tightening_feedback_loops_for_sustainable_development_of_food_systems

78. Lee Hart, Farmers weigh in on "consumer demand", Grainews, Feb. 10, 2016, https://www.grainews.ca/2016/02/10/farmers-weigh-in/; Amanda Radke, 3 Ways To Be More Transparent With Consumers, Beef Daily, July 17, 2013, https://www.beefmagazine.com/blog/3-ways-be-more-transparent-consumers

79. Living in a World of Decreasing Resources & Increasing Regulation: How to Advance Animal Agriculture, Information synthesized from the 2012 Annual Conference of the National Institute for Animal Agriculture, Mar. 26-29, 2012, https://www.animalagriculture.org/Resources/Documents/Conf%20-%20Symp/Conferences/2012%20Annual%20Conference/2012%20Annual%20Conference%20White%20Paper.pdf

80. Lucy Craymer, Your Avocados and Olives Are Pricier Because Fat Is In Fashion, The Wall Street Journal, Feb. 25, 2019, https://www.wsj.com/articles/your-avocados-and-olives-are-pricier-because-fat-is-in-fashion-11551090603

81. Jillian Kramer, Apparently Fewer People Want to Buy Cage-Free Eggs Than Expected, Food & Wine, June 14, 2017, https://www.foodandwine.com/news/cage-free-egg-surplus-2017; Tom Polansek, U.S. faces oversupply of antibiotic-free chicken: Sanderson Farms, Reuters, Jan. 16, 2018, https://www.reuters.com/article/us-sanderson-farms-chicken-antibiotics/u-s-faces-oversupply-of-antibiotic-free-chicken-sanderson-farms-idUSKBN1F6021

82. https://www.feedingamerica.org/hunger-in-america/rural-hunger-facts

83. Tracy Hmielowski, Improving the nutritional value of pulse crops, CSA News Magazine, Oct. 7, 2016, https://dl.sciencesocieties.org/publications/csa/articles/61/10/4

84. Ross M. Welch and Robin D. Graham, Agriculture: the real nexus for enhancing bioavailable micronutrients in food crops, Journal of Trace Elements in Medicine and Biology, Vol. 18, Feb. 2005, pp.299-307, https://hos.ifas.ufl.edu/media/hosifasufledu/documents/IST31188-Agriculture.pdf

85. Stephanie Mercier, Improving Food Safety Through Better Information, AgWeb, Aug. 28, 2018, https://www.agweb.com/blog/straight-from-dc-agricultural-perspectives/improving-food-safety-through-better-information/

86. https://www.wired.com/story/can-lettuce-survive-climate-change/

87. Institute of Medicine and National Research Council, A Framework for Assessing Effects of the Food System, 2015, https://www.ncbi.nlm.nih.gov/books/NBK305165/

88. Reshma Kamath, Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM, Journal of the British Blockchain Association, Vol. 1, Issue 1, June 2018, https://jbba.scholasticahq.com/article/3712-food-traceability-on-blockchain-walmart-s-pork-and-mango-pilots-with-ibm

89. "Not for attribution" interviews with food companies (documentation available upon request)

90. Barilla, https://www.barilla.com/en-us/product-results/pasta/range/legume?sort=alpha and Barilla Center for Food and Nutrition, https://www.barillacfn.com/en/magazine/food-and-sustainability/we-need-a-food-revolution-to-feed-our-children/

91. Johns Hopkins University Bloomberg School of Public Health, FoodSpan website, http://www.foodspanlearning.org/

92. Encourage Capital, NRCS and Investment Capital: Investing in America Together, Sept. 2017, http://encouragecapital.com/wp-content/uploads/2017/09/EC_Private-Capital-Report_Reduced-Size_091417.pdf

93. USDA NRCS, NRCS Funding Opportunities website, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=stelprdb1048817

94. USDA, Farm Certifications website, https://www.nal.usda.gov/afsic/farm-certifications; Katherine Harris, 10 Certification Agencies Creating a More Sustainable Food System, Food Tank, Oct. 2015, https://foodtank.com/news/2015/10/ten-certification-agencies-creating-a-more-sustainable-food-system/

95. Whole Foods Market, Animal Welfare Standards, https://www.wholefoodsmarket.com/about-our-products/quality-standards/animal-welfare-standards

96. USDA ERS, Organic Market Overview, last updated Apr. 4, 2017, https://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture/organic-market-overview.aspx

97. Institute for Sustainable Solutions,Portland State University, Ecosystem Services Case Study: Clean Water Services, Tualatin River, Washington, https://www.pdx.edu/sustainability/sites/www.pdx.edu.sustainability/files/CleanWaterServices_CaseStudy.pdf

98. Maryland Department of the Environment and Department of Agriculture, Maryland Nutrient Trading website, http://www.mdnutrienttrading.com/

99. Genevieve Bennett et al, An Atlas of Ecosystem Markets in the United States, Forest Trends' Ecosystem Marketplace, Oct. 2016, pp.3-4, 14-15, https://www.forest-trends.org/wp-content/uploads/2017/03/doc_5440.pdf

100. Ecosystem Marketplace, Unlocking Potential: State of the Voluntary Carbon Markets 2017, May 2017, https://www.forest-trends.org/wp-content/uploads/2017/07/doc_5591.pdf

101. Farmers for Monarchs, State Planting Resources, https://farmersformonarchs.org/state-resources/

102. Encourage Capital, NRCS and Investment Capital: Investing in America Together, Sept. 2017, http://encouragecapital.com/wp-content/uploads/2017/09/EC_Private-Capital-Report_Reduced-Size_091417.pdf

103. Tim Smedley, Forget carbon offsetting, insetting is the future, The Guardian, Jan. 9, 2015, https://www.theguardian.com/sustainable-business/2015/jan/09/carbon-offsetting-insetting-supply-chain

104. Noble Research Institute, Voluntary Ecosystem Services Market, https://www.noble.org/ag/market/; Noble Research Institute, Ecosystem Services Market: December 2018 Update, Dec. 24, 2018, https://www.noble.org/news/releases/ecosystem-services-market-december-2018-update/

105. Nori, https://nori.com/

106. Indigo Agriculture, Indigo Certified Crops, https://www.indigoag.com/for-buyers/indigo-certified-crops; Indigo Agriculture, Indigo Agriculture Raises an Additional $250M and Launches Digital Grain Marketplace, Press release, Sept. 18, 2018, https://www.indigoag.com/pages/news/indigo-raises-250m-and-launches-digital-marketplace

107. The Rockefeller Foundation, Redd+ Acceleration Fund, https://assets.rockefellerfoundation.org/app/uploads/20170706180732/Redd-Acceleration-Fund.pdf; Sophie Edwards, New acceleration fund to drive investment in forests, Devex, Nov. 11, 2016, https://www.devex.com/news/new-acceleration-fund-to-drive-investment-in-forests-89115

108. AGree Conservation and Crop Insurance Task Force, http://www.merid.org/ccitf

109. American Association for the Advancement of Science (AAAS), Historical Trends in Federal R&D: Total R&D by Agency, 1976-2018, https://www.aaas.org/sites/default/files/s3fs-public/Agencies%253B.xlsx

110. FFAR, https://foundationfar.org/; ARPA-E, https://arpa-e.energy.gov/?q=arpa-e-programs/terra

111. FFAR, Challenge Areas and Open Opportunities websites, https://foundationfar.org/challenge-areas, https://foundationfar.org/open-opportunities/

112. USDA, Crop Research Technology Readiness Level (TRL), Nov. 2016, https://nifa.usda.gov/sites/default/files/resources/Crop%20Research%20Technology%20Readiness%20Level.docx

113. USDA ERS, Agriculture Improvement Act of 2018: Highlights and Implications: Research, Extension, and Related Matters: Title VII website, last updated Feb. 15, 2019, https://www.ers.usda.gov/agriculture-improvement-act-of-2018-highlights-and-implications/research-extension-and-related-matters/

114. Jon Marcus, The Decline of the Midwest's Public Universities Threatens to Wreck Its Most Vibrant Economies, The Atlantic, Oct. 15, 2017, https://www.theatlantic.com/business/archive/2017/10/midwestern-public-research-universities-funding/542889/

115. AgFunder AgriFood Tech Investing Report 2018, AgFunder.

116. Corporate Biotech Venture Funding Rises Again, March 23, 2019, https://techcrunch.com/2019/03/23/corporate-biotech-venture-funding-rises-again/

117. A Tale of the haves and have-mores, McKinsey, December 20, 2015 https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Digital%20America%20A%20tale%20of%20the%20haves%20and%20have%20mores/MGI%20Digital%20America_Executive%20Summary_December%202015.ashx

118. Why the Food & Ag Industry Needs Positive Impact Now, Better Food Ventures

119. Valuing the SDG Prize in Food and Agriculture, The Business and Sustainable Development Commission, October 2016.

120. USDA ERS, Agriculture Improvement Act of 2018: Highlights and Implications: Research, Extension, and Related Matters: Title VII website

121. Naomi Starkman, Digested: Can Tech Money Help Real Food Scale Up?, Civil Eats, July 8, 2016, https://civileats.com/2016/07/08/digested-can-tech-money-help-real-food-scale-up/

122. Rob Trice, Looking From Inside The Mixing Bowl in 2019, Forbes, Jan. 6, 2019, https://www.forbes.com/sites/themixingbowl/2019/01/06/looking-from-inside-the-mixing-bowl-in-2019/#6e025ed31cc3

123. AgThentic, The AgriFood Tech Startup Resources Tool, http://resources.agthentic.com/#/

124. Center for Environmental Farming Systems, https://cefs.ncsu.edu/; Minnesota Institute for Sustainable Agriculture (MISA), https://www.misa.umn.edu/

125. See, e.g., The onEarth 10, onEarth, Natural Resources Defense Council, Nov. 25, 2015, https://www.nrdc.org/onearth/onearth-10;

126. The Goldman Environmental Prize, Prize Recipients, https://www.goldmanprize.org/prize-recipients/?topic%5B%5D=Climate+%26+Energy&topic%5B%5D=Food+%26+Agriculture

127. https://www.theclimakers.org/alliance/

128. Angela Barranco, The White House, Acting on Climate through Sustainable Agriculture: White House Champions of Change, Oct. 27, 2015, https://obamawhitehouse.archives.gov/blog/2015/10/27/acting-climate-through-sustainable-agriculture-white-house-champions-change

129. Climate Heroes, Meet the Heroes, https://climateheroes.org/heroes/

130. Culinary Schools Speed Rise of Hopeful Chefs, The New York Times, March 18, 2014, https://www.nytimes.com/2014/03/18/education/culinary-schools-speed-the-rise-of-hopeful-chefs.html

131. Business is booming for crime-scene cleaners, Chicago Tribune, August 14, 2016, https://www.chicagotribune.com/news/ct-crime-scene-cleaners-met-20160814-story.html

132. https://www.walmartsustainabilityhub.com/supplier-recognition

133. Farmers must help the public understand their important work, Des Moines Register, Oct. 13, 2014 https://www.desmoinesregister.com/story/opinion/columnists/2014/10/14/farmers-demonstrate-public-importance/17235971/

APPENDIX: ADVISORY COUNCIL BIOGRAPHIES

CHRIS ADAMO, DANONE NORTH AMERICA

Chris is Vice President of Federal and Industry Affairs at Danone North America, where he works to strengthen the role of business and drive social and environmental good. Prior to Danone, Chris served in the Obama Administration at the White House Council on Environmental Quality.

TOWNSEND BAILEY, MCDONALD'S CORPORATION

Townsend leads sustainability strategy for McDonald's North American markets. He joined the company in 2011. He has also served as the Global Lead for Packaging and Happy Meal premiums in McDonald's worldwide supply chain. Townsend started his career as a high school teacher and coach.

DAVID BENNELL, WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT

David is the North American Manager of Food, Land, and Water for the WBCSD. He previously worked for Microsoft, REI, and LL Bean in leadership development, product development, and sourcing positions. He also held a five-year adjunct faculty position at MIT, where he taught sustainable design and development.

CHIP BOWLING, CHAIRMAN, U.S. FARMERS & RANCHERS ALLIANCE (USFRA), AND PAST CHAIR, NATIONAL CORN GROWERS ASSOCIATION (HOST)

A host of the Honor the Harvest Forum, Chip became chair of USFRA in November 2018 and represents the National Corn Growers Association. He and his family will host the Forum on their farm near the Chesapeake Bay, where Chip's family has farmed since the early 1700s. The Bowling family raises grain crops.

ERIN FITZGERALD, U.S. FARMERS & RANCHERS ALLIANCE (USFRA) (HOST)

A host of the Honor the Harvest Forum, Erin was appointed CEO of USFRA in June 2018 to uphold the American farmers' and ranchers' legacy in defining the sustainable food systems of the future. She previously served at the Innovation Center for U.S. Dairy, a part of Dairy Management Inc.

GREG GERSHUNY, THE ASPEN INSTITUTE (HOST)

A host of the Honor the Harvest Forum, Greg serves as the Interim Director of the Aspen Institute Energy and Environment Program (EEP) and is the Managing Director and the James E. Rogers Energy Fellow of the program. Prior to joining the Aspen Institute, Greg served in the U.S. Department of Energy Office of Energy Policy, the White House Office of Presidential Personnel, and the White House Office of Science and Technology Policy.

SECRETARY DAN GLICKMAN, FORMER SECRETARY OF THE USDA

Secretary Glickman led the USDA as its 26th secretary, appointed by President Bill Clinton in 1995. Previously, he served for 18 years in the U.S. House of Representatives representing Kansas' 4th Congressional District.

BRAD GREENWAY, NATIONAL PORK BOARD (NPB), AND PAST CHAIR, USFRA

Brad is the immediate former chair of USFRA and represents the NPB. He owns a wean-to-finish operation that markets 6,400 hogs annually and raises corn, soybeans, wheat, and alfalfa on 1,700 acres in Mitchell, SD.

JENNIFER HOUSTON, AT-LARGE MEMBER, USFRA, AND PRESIDENT, NATIONAL CATTLEMEN'S BEEF ASSOCIATION (NCBA)

Jennifer is an at-large board member of USFRA and currently serves as the 2019 NCBA president. She has been active in the beef industry for more than 30 years. She and her husband Mark own and operate East Tennessee Livestock Center in Sweetwater, TN.

SECRETARY A.G. KAWAMURA, FORMER SECRETARY OF CALIFORNIA'S FOOD AND AGRICULTURE DEPARTMENT

A.G. was appointed Secretary of California's Food and Agriculture Department by Governor Arnold Schwarzenegger in 2003. Previously, as a third-generation farmer, he was a founding partner of Orange County Produce LLC, where he manages the company's 600 acres of growing and harvesting operations in Southern California.

PHIL LEMPERT, SUPERMARKET GURU

Known as The Supermarket Guru®, Phil is a distinguished author and speaker who founded The Lempert Report and SupermarketGuru.com, where he offers food ratings, analyzes trends in food marketing and retail, and features health advice, unique recipes, nutrition analysis, allergy alerts, and other resources.

ANNE MEIS, SECRETARY AND BOARD MEMBER, USFRA, AND NEBRASKA SOYBEAN BOARD (NSB)

Anne is currently a board member of USFRA and represents the first district for the NSB. She and her family own and operate Meis Farms in Elgin, NE, where they farm corn, soybeans, and alfalfa and raise beef cattle.

MICHAEL PARRISH, AT-LARGE MEMBER, USFRA, AND BAYER

Michael is Vice President of Government Relations at Bayer, where he leads community engagement and country-wide corporate employee volunteer programs.

AMBASSADOR KENNETH QUINN, THE WORLD FOOD PRIZE FOUNDATION

Dr. Quinn is the former U.S. Ambassador to the Kingdom of Cambodia and currently the president of The World Food Prize Foundation.

DR. SALLY ROCKEY, THE FOUNDATION FOR FOOD AND AGRICULTURE RESEARCH (FFAR)

Dr. Rockey in 2015 became the inaugural executive director of FFAR. Previously, she served as a leader in the USDA's Cooperative State Research, Education, and Extension Service and served as the department's Chief Information Officer.

JACK SCOTT, NESTLÉ GLOBAL

Jack serves as Nestlé's Vice President of Sustainability and Responsible Sourcing. He joined Nestlé's pet care operating company Purina in 2003 as a brand manager.

ROB TRICE, THE MIXING BOWL

Rob is founder of The Mixing Bowl, connecting innovators in food, agriculture, and information technology. He also founded Better Food Ventures, making seed-stage investments to apply IT to the food and agriculture industries.

BLAIR VAN ZETTEN, TREASURER, USFRA, AND PAST CHAIRMAN, AMERICAN EGG BOARD

Blair is currently a board member of USFRA and president of Oskaloosa Food Products Corporation in Oskaloosa, IA, where he leads an industry in dried, liquid, and frozen egg products that serves domestic and international markets.

SCOTT VANDERWAL, VICE CHAIR, USFRA, AND AMERICAN FARM BUREAU FEDERATION (AFBF)

Scott is currently Vice Chair of USFRA and vice president of AFBF. He is a third-generation corn and soybean farmer and cattle feeder from Volga, SD, where he farms with his family and operates a custom harvesting operation.

SECRETARY TOM VILSACK, FORMER SECRETARY OF THE U.S. DEPARTMENT OF AGRICULTURE (USDA)

Secretary Vilsack led the USDA as its 30th secretary, appointed by President Barack Obama in 2009. Previously, he served two terms as Governor of Iowa, served in the Iowa State Senate, and as mayor of Mt. Pleasant, IA.

HEATHER ZICHAL, THE NATURE CONSERVANCY

Heather is Vice President of Corporate Engagement for The Nature Conservancy, where she brings expertise in environmental and climate policy and an international reputation for forging stakeholder relationships. She previously served as President Barack Obama's top White House advisor on energy and climate change from 2009-2013.

ACKNOWLEDGMENTS

This paper is a product of the partnership between the U.S. Farmers & Ranchers Alliance and the Aspen Institute Energy & Environment Program. We would like to thank Chip and Lynn Bowling for their gracious hospitality. We would also like to thank the leaders who joined the Honor the Harvest Forum Advisory Council. In addition, we appreciate the dozens of people who, through interviews and conversations, helped inform this paper.

We would also like to thank Dave Grossman of Green Light Group for his assistance in preparing this paper.

-Erin Fitzgerald & Greg Gershuny

We are grateful for the incredible support and leadership from our inaugural sponsors. You helped to make this event possible and believed in the power of convening a group of leaders. Without you this event would not be possible. Thank You!

PLATINUM SPONSOR

United Soybean Board™

GOLD SPONSOR

FFAR

SILVER SPONSORS

AEM Association of Equipment Manufacturers

National Biodiesel Board

BRONZE SPONSORS

CoBANK

Innovation Center for U.S. Dairy
Healthy People • Healthy Products • Healthy Planet

USDA