AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Proceedings of the 2017 AAAS
Charles Valentine Riley Memorial Lecture

# Joining Forces to Protect the Future of Agriculture and the Planet

Organized in collaboration with the Charles Valentine Riley Memorial Foundation and the World Food Prize Foundation

Presented June 15, 2017, Washington, DC

AAAS

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# Foreword

2017 marked the eighth year that the American Association for the Advancement of Science has hosted the Charles Valentine Riley Memorial Lecture. Together with our partners at the Charles Valentine Riley Memorial Foundation and the World Food Prize Foundation, we look forward each year to celebrating the legacy of Charles Valentine Riley, a major 19th-century figure who possessed a vision for enhancing the success of agriculture through new scientific knowledge.

With Professor Riley's vision in mind, the lecture is an important opportunity to examine the critical role that science plays in advancing agriculture and the conservation of natural resources to ensure a secure food supply and a sustainable economy.

This year's discussion focused on the science of genetically engineered agricultural crops and the challenges of communicating about this technology, which has been in development for more than 30 years. Many scientific bodies — including the National Academy of Sciences, as detailed in its latest consensus report in 2016 — have found that many GMOs are safe for human consumption, but there continues to be public concern and debate about their use. We are grateful to Dr. Robert Fraley, the members of the discussion panel and our guests for participating in a rich and thoughtful conversation.

On the pages that follow, you will find the full text of the 2017 AAAS Charles Valentine Riley Memorial Lecture and a brief summary of the lecture and panel discussion.

We thank our colleagues at the Charles Valentine Riley Memorial Foundation and the World Food Prize Foundation for their significant input. We also recognize and thank our sponsors for their continued investment in this critical discussion.

I hope you will find these proceedings interesting and useful.

**Rush D. Holt**
Chief Executive Officer, AAAS, and
Executive Publisher, *Science* Family of Journals

# Acknowledgements


This year's lecturer was chosen by a distinguished Selection Committee. We would like to thank the committee members for their efforts:

**Jay Akridge,** Glenn W. Sample Dean of Agriculture, Purdue University

**Daniel Bush,** Professor and Vice Provost for Faculty Affairs, Colorado State University

**Edward Derrick,** Chief Program Director, Center of Science, Policy & Society Programs, American Association for the Advancement of Science

**Mark R. McLellan,** Vice President for Research & Dean of Graduate Studies, Utah State University

**Ambassador Kenneth Quinn,** President, The World Food Prize Foundation

**Wendy Wintersteen,** Dean of the College of Agriculture and Life Sciences, Iowa State University; President, Charles Valentine Riley Memorial Foundation

We would also like to recognize and thank the following sponsors for their generous support of this year's lecture:

Charles Valentine Riley Memorial Foundation

USDA Economic Research Service
United States Department of Agriculture

USDA United States Department of Agriculture
Agricultural Research Service

USDA United States Department of Agriculture
National Institute of Food and Agriculture

MARS incorporated

# Lecture and Panel Discussion Summary

The latest biotechnologies are helping the agricultural industry lighten its environmental footprint by making global food production more efficient, said Robert Fraley in the 2017 AAAS Charles Valentine Riley Memorial Lecture.

Over the past two decades, Fraley said advances in biotechnology's precision gene-editing techniques, earlier genetic engineering methods and data science have transformed the way crops are bred, and the advances are "protecting and driving productivity" necessary to meet the food needs of a global population projected to reach 9.7 billion people by 2050.

He went on to add that advances in data science have put computing technology, sensors, drones and satellites in the hands of farmers, enabling them in real time to monitor moisture and nitrogen levels in the soil, track the health and growth rates of crops, more precisely target the use of irrigation, predict weather conditions, and even receive data updates from equipment deployed in the fields.

"Enabling farmers around the world to address these challenges — by providing them with better tools and technologies — will require significant increases in productivity fueled by accelerated R&D investment and increased collaboration across the agricultural and food sector," Fraley said. "Importantly, we will need to facilitate public discourse, policies and regulations that support the research and adoptions of new technologies."

A panel discussion led by Lisa Ainsworth, a research scientist at the Agriculture Department's Agricultural Research Service and associate professor of plant biology at the University of Illinois, followed Fraley's address. Gregory Bohach, vice president of Mississippi State University's Division of Agriculture, Forestry, and Veterinary Medicine; Mary Bohman, administrator at the Agriculture Department's Economic Research Service; and Andrew W. LaVigne, president and CEO of the American Seed Trade Association joined Fraley and Ainsworth.

Building on Fraley's presentation, the panel furthered the discussion on the essential need for improved communication with the public to better understand the implications of this rapid evolution of technologies. Through social media and other mechanisms, they encouraged all members of the agricultural community to develop clear messages that address the opportunities and challenges of these technologies for food security, the economy, the environment and beyond. The panel also discussed the need for an alignment of the "agricultural voice" to amplify a shared message to have greater reach and greater impact. They also called for stronger public-private partnerships that will help to advance basic research and ultimately drive innovation.

AAAS CHARLES VALENTINE RILEY MEMORIAL LECTURE

# Joining Forces to Protect the Future of Agriculture and the Planet


## Dr. Robert Fraley

Executive Vice President and Chief Technology Officer, Monsanto

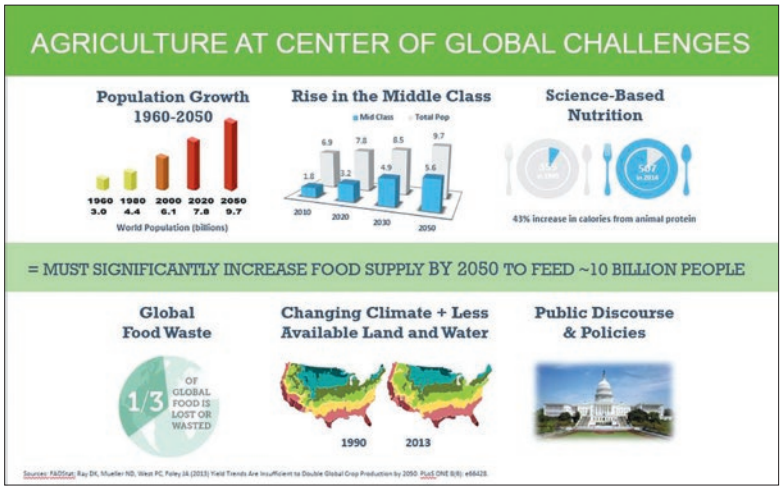
First, I'd like to thank Rush Holt, Wendy Wintersteen and the AAAS Selection Committee for inviting me to speak here today. Over the past month, I've watched all the Riley Memorial Lectures online — some more than once — and I am both humbled and honored to join the distinguished group of presenters and panelists, as well as be the first lecturer to offer a private industry perspective on how we can join forces to advance the future of agriculture, so we can provide food security and enhance the environment in which we live.

## Agriculture is at the Center of Global Challenges

As a global community, we are facing a challenge to a very basic human need — feeding ourselves and our children. Ambassador Quinn at the World Food Prize calls this, quite simply, "The Greatest Challenge Facing Mankind." Farmers will need to feed a population of nearly 10 billion people by 2050, which will require a 60–100% increase in global food production. Some estimates say we'll have to produce more food in the next 30+ years than we have since humans started farming.

The pressures of food demand are expected to be further exacerbated by consumption trends, particularly the demand for meat, milk and eggs, precipitated by higher incomes and the growth of the middle class, especially in emerging markets. The ability of farmers to meet global food demand will be constrained by water availability and the impact of climate change — **so we need to grow more crops, but we need to do it on less land, using fewer natural resources.**

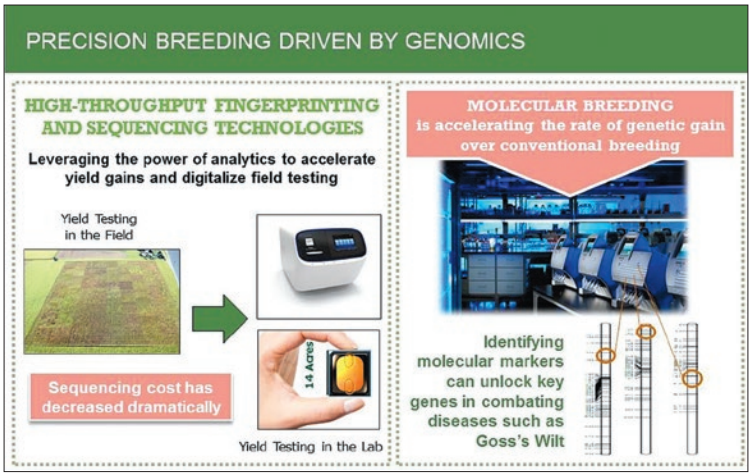
Changes in climate patterns will create a more volatile environment for farming, including shifts in rainfall patterns and planting zones, and increases in insect and disease pressure.

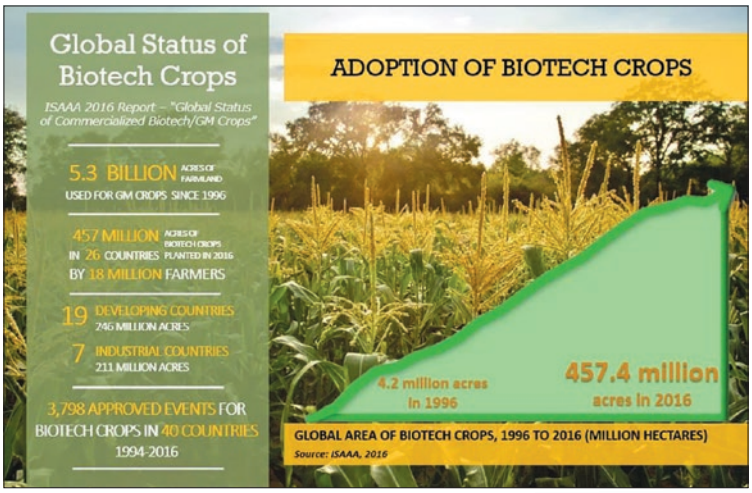



Enabling farmers around the world to address these challenges — by providing them with better tools and technologies — will require significant increases in productivity fueled by accelerated R&D investment and increased collaboration across the agricultural and food sector. Importantly, we also need to facilitate public discourse, policies and regulations that support the research and adoption of new technologies.

## Incredible Advances in Biological Sciences Powered by our Knowledge of Genetics

The incredible advances being made in the biological and data science fields can enable us to meet these challenges. It's important to recognize these technologies and tools are reshaping both academic and private research — to use a Silicon Valley term, they are actually "disrupting" the ag-food chain from farming to food! And that's a good thing!




## Plant Breeding

I've seen a lot of changes to the ag industry since I started at Monsanto in 1980, especially over the past two decades. Our collective knowledge of genetics — from all the incredible private and public research that's been made available — has literally transformed the way we breed crops today. DNA marker and genome sequence information allows breeders unique insights into creating new germplasm combinations. Today we can literally breed gene by gene. And the cost of sequencing has gone down dramatically. It cost billions of dollars to sequence the first human genome less than 20 years ago. Today, for less than $10 per sample, we can sequence enough of a corn genome to predict its yield potential in an early generation yield trial. And importantly, the low cost makes these tools broadly applicable to all crops, including vegetables and smallholder "orphan" crops.

Automated technologies like Monsanto's seed chipper machine can shave small samples from millions of seeds — so they're still viable — and allow for each seed's DNA to be analyzed without the need to wait for the plant to grow. This allows our scientists to breed seed by seed — saving enormous time and cost and dramatically accelerating genetic gain over conventional breeding.

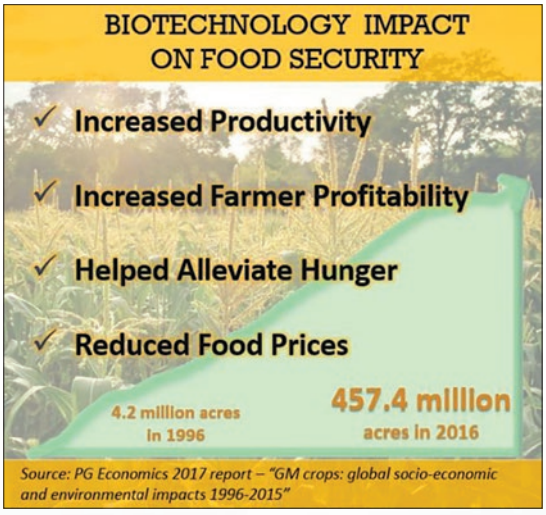
## Adoption of Biotech Crops

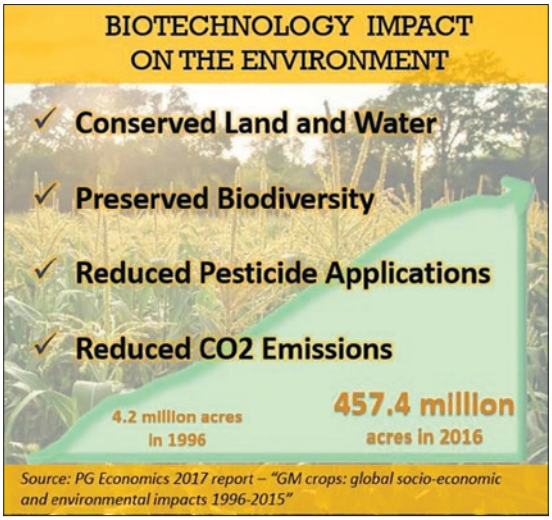
Gene modification has played an important role in protecting and driving productivity for farmers for more than 20 years. I was with a group of farmers last week and asked them how genetically modified (GM) crops have affected their farming — one of them said, "this has had as big an impact as when my grandfather transitioned from horses to tractors" — enough said. GM crops are one of the most rapidly adopted technologies in the history of agriculture. According to the latest ***ISAAA Global Status of GM Crops*** report, which was released in May 2017:

- 5.3 billion acres of farmland have been planted with GM crops since 1996.
- Last year, 457 million acres of biotech crops were planted in 26 countries by 18 million farmers — and more GM acres were planted in developing countries than in industrial.

## Biotechnology Impact on Food Security

How does that translate into progress toward achieving our goal of food security in 2050? GM crops make farming more productive by controlling damage and losses from insects and weeds — which are two of the major causes of crop loss and food waste. Genetic modification has been used to save some crops, like the Hawaiian papaya, from being completely destroyed by viral disease. There are new biotech traits for drought protection and for reducing food waste in potatoes and apples. There's an incredibly exciting pipeline of new biotech traits; since 2013, over 2,200 applications have been made for permits to develop traits by over 130 unique companies and research institutions. And new, promising research like that from Dr. Steve Long at the University of Illinois (a past Riley Memorial lecturer), who has demonstrated an increase in photosynthesis efficiency, will continue to add to the possibilities.




This increase in productivity results in increased farmer profitability and helps alleviate poverty, particularly among rural and smallholder farmers. In 2015, for every extra dollar a farmer in a developing country invested in biotech crop seeds, he/she made more than $5. That is life-changing for subsistence farmers. GM crops have also benefited consumers by ***lowering food prices by 6–10%***.

## Biotechnology Impact on Environment

In addition to increasing production yields, **biotech crops have helped reduce agriculture's impact on the environment — which is a message that I don't think we share nearly enough.**

Between 1996 and 2015, productivity gains through biotechnology saved 430 million acres of land from plowing and cultivation (***2016 ISAAA Brief Executive Summary***). No-till farming significantly reduces the release of carbon dioxide into the air, reduces soil erosion, improves water and nutrient retention, and promotes improved biodiversity. By reducing the need to till the soil, we have, over the past

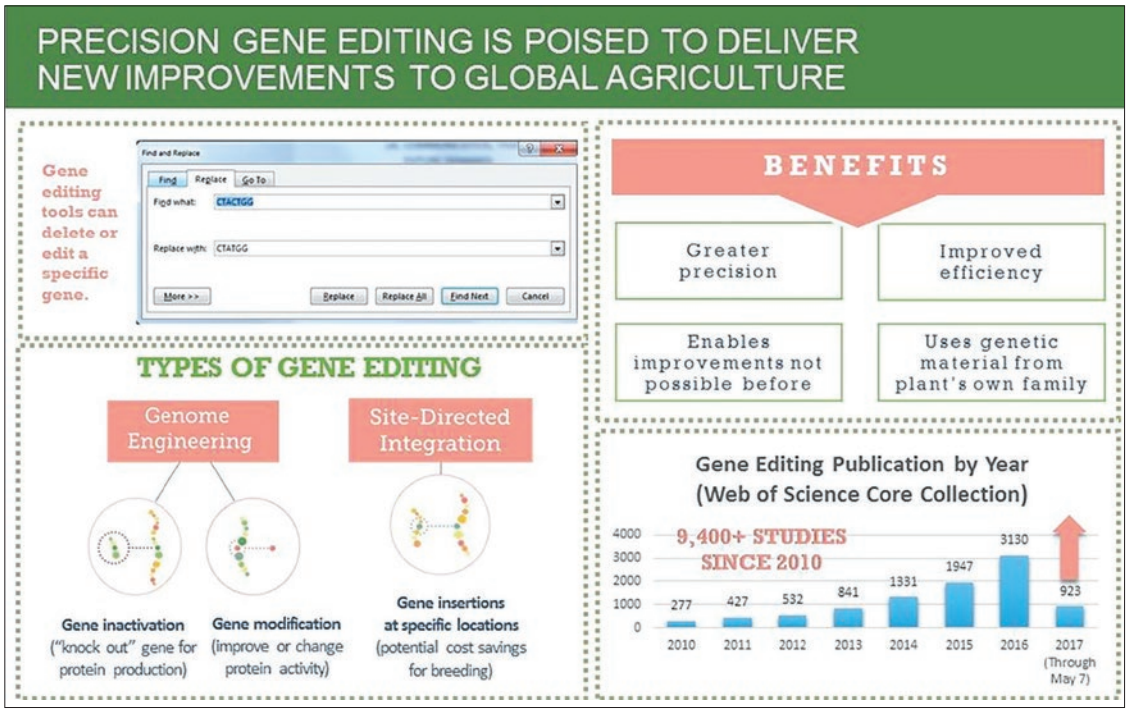
20 years, reduced ***carbon dioxide emissions from farm operations by 26.7 billion kilograms*** — an amount equivalent to removing ~12 million cars off the road for one year.

Biotech crops also ***reduced the spraying of crop protection products by 619 million kilograms,*** a global reduction of 8.1%. This is equal to ***more*** than China's total crop protection product use each year.

Perhaps most importantly, it's estimated that in 2015 alone, ***biotechnology spared nearly 50 million acres of wetlands, forests and prairies from conversion to farmland*** that would have been needed to grow the same amount of food if the technology was not available. That's an area equivalent to more than all the land in my home state of Missouri.

## Gene Editing

Of course, gene editing is the new technology that everybody's talking about — and it offers great potential across many industries, not just agriculture. Gene editing allows scientists to make precise and targeted improvements within a plant's or animal's DNA. Similar to a "Find and Replace" function in a word processing document, gene editing makes it possible to delete, replace or edit a specific gene to achieve a desired or improved characteristic. Gene editing tools, such as Zinc Fingers, Talens, CRISPR/Cas9, CRISPR/cpf1 and other novel systems being developed, will help scientists integrate desirable traits, like disease- and drought-resistance, longer shelf life, or improved nutrition or taste, into improved seed products with more efficiency and precision than ever before.

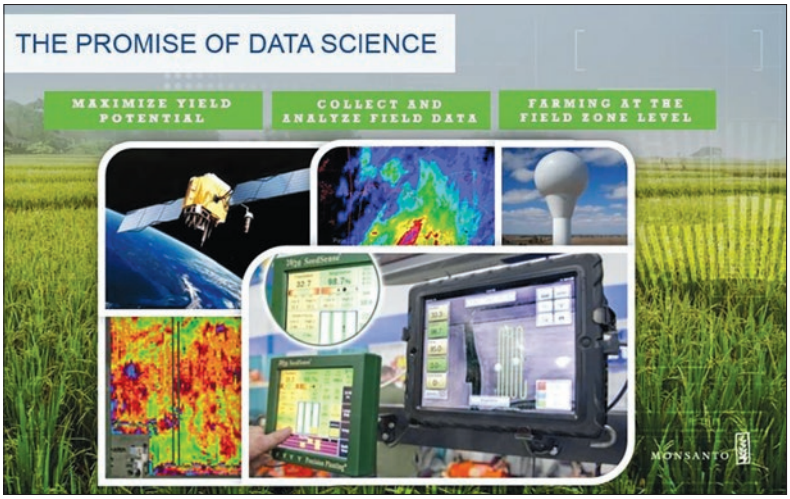


I see gene editing playing out very differently than GMOs. Back in the early days of biotechnology, Monsanto was one of the only players in the GMO space. In sharp contrast, gene editing is being researched today by many pharmaceutical and agricultural companies, universities, hundreds of startup companies … and even some high school science fair students! Nearly, 10,000 gene editing research studies have been published since 2010 (Web of Science Core Collection, as of May 2017). I believe the broad support for this science is going to make a big difference when it comes to both public acceptance and crop and geographic adoption. Importantly, since gene editing introduces changes identical to those achieved through plant breeding and selection, the regulatory approval process is expected to be significantly less than that required for GMO crops. After an expedited USDA consultation, the gene-edited anti-browning mushroom developed by a professor at Penn State University was cleared for commercialization.

## The Promise of Data Science

As you know, the world of agriculture is being transformed by data science. "Modern ag," as we like to call it, is becoming digitized. Today's farms and ranches are using a sophisticated mix of data, math, hardware and software, and unique algorithms to go beyond what the eye can see. Drones are buzzing over fields assessing crop health and soil conditions, monitoring crop growth rates, spraying crops with pesticides, and even spotting disease.

Farmers are using sensors to gather data on soil moisture and nitrate levels across their fields. With advanced software and analytics, that data can then be processed and, when appropriate, trigger precision-controlled irrigation or signal the need for targeted application of nutrients. GPS technology on tractors and other equipment helps farmers with field mapping,




soil sampling and crop scouting. Farmers can monitor their equipment in the fields from inside the house … and autonomous tractors are on the way!

Here's one way I think about the impact of digital ag. Over a season, farmers make about 40 key decisions, from planning to planting to harvest. I remember my dad making some of those decisions sitting around the kitchen table at night at our farm in central Illinois. Some were based on his seed salesman's advice or the university extension agent's recommendation; sometimes he made those decisions based on what he wished he would have done the prior year or what our neighbors were doing. Today, every one of those decisions — which crop to plant, what seed population, which hybrid, how much fertilizer, which weed control treatment and so on — can all be done based on the exact knowledge of the field, the plant's unique genetics, and the field soil and local weather conditions. Making those 40 decisions based on a data-driven approach … and making each one just slightly better … over the course of the year adds up to a huge deal!

## Crucial to make Technology Available to Developing Countries/Smallholder Farmers

Here's an important thing to keep in mind when you think about achieving global food security. Over 500 million smallholder farmers grow more than 40% of the world's agriculture and provide about 80% of the food in developing countries, mostly in Asia and Africa. Smallholders make up about 90% of all farmers globally, and are key to food security in regions around the world. But they face some of the biggest challenges, including rural isolation and limited agronomic resources.

As Bill Gates has pointed out, "The technology and new approaches that are transforming agriculture in other parts of the world can be applied in new ways, and help Africa flourish too."

**Accelerating agricultural productivity for smallholders must be at the core of a comprehensive strategy to sustainably feed the world.** With more than 75% of the world's poor heavily dependent on agriculture for their direct subsistence food needs as well as for income, agricultural development through improved productivity is one of the most powerful ways they can rise out of poverty.

Advanced biology and data science tools are key to bridging the innovation gap to ensure farmers have access to the best agronomic tools and advice. Approximately 70% of smallholder farmers own cell phones, providing a ready-to-use platform for the delivery of free, relevant agronomic information. These insights can enable smallholders to be more productive, conserve their resources and increase their incomes. And whether we can give them better seeds or better access to data, both are easily and rapidly adopted by smallholders. I put it this way: We can use the latest advanced breeding, biotech and gene editing tools to improve a seed … and every farmer, whether large or small, knows what to do with that seed and can benefit from it!

As part of Monsanto's efforts to support farmers all around the world, we have empowered smallholders through a free platform called FarmRise™. Introduced in 2010 and available primarily in India, FarmRise™ uses mobile phones to provide more than 4 million smallholders with access to agronomic advice. It offers weather forecasts and commodity prices via text (SMS); advisories on seeds and on planting, and pest and disease management, through voice-recorded messages; and personalized interaction through a call center.

And WEMA, or Water Efficient Maize for Africa, is a great example of a public-private partnership working to improve food security and rural livelihood among smallholders and their families in sub-Saharan Africa by developing and deploying new drought-tolerant and insect pest-protected maize varieties. The project is led by the African Agricultural Technology Foundation (AATF) based in Kenya, and it is funded by the Bill and Melinda Gates Foundation, the Howard G. Buffett Foundation and USAID. Monsanto has donated both germplasm and biotech traits to this project and is proud to be one of the partners.

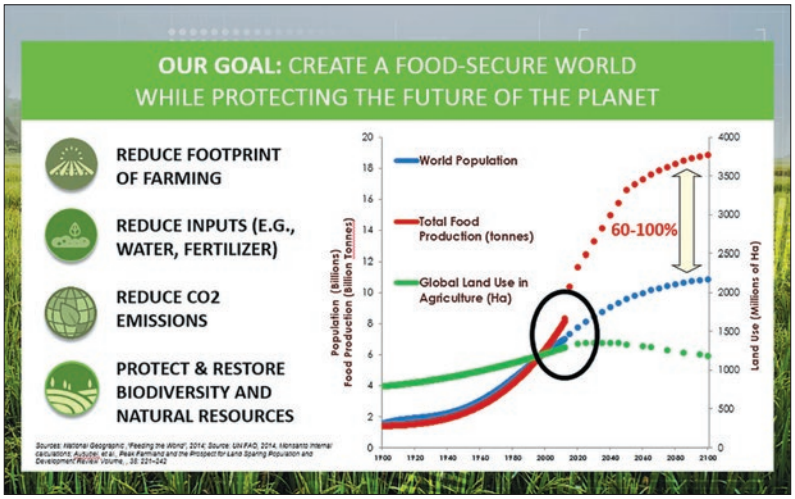
The WEMA partnership is in its 10th year, and smallholder farmers in sub-Saharan Africa now have access to higher-yielding, conventional white WEMA maize hybrids with promising harvest results. More than 90 conventional white maize hybrids have been released and adopted by more than 350,000 farm families. Most recently, the first biotech white maize hybrid from the WEMA partnership is now in the marketplace, which is an exciting step toward the future.


## Our Goal: Create a Food-Secure World While Protecting the Future of the Planet

There are differing opinions about exactly how much we need to increase food production over the next 30 years. I personally like the ***Global Harvest Initiative's approach*** of focusing on how much we need to increase the rate of total factor productivity, or TFP, which measures changes in the efficiency with which all inputs are transformed into food, feed, fiber and biofuels.

GHI believes that doubling agricultural productivity from 2005 to 2050 is the right goal and is aligned with the ***UN Sustainable Development Goal (SDG) 2 target*** of doubling agricultural productivity and incomes of small-scale farmers and food producers. To track our progress, GHI has developed the benchmark tool you see here, the GAP Index™.

According to GHI's calculations, TFP must increase annually by 1.75%; but recent data shows that for the third straight year, *global* TFP growth is not accelerating fast enough, with a rate of only 1.73%. Most concerning is that for low-income countries, productivity is only increasing at 1.31%, well below the UN SDG 2 target.




This chart shows the projected growth for world population along with an estimate of the increase in food production, including reduction in food waste, required to feed that population. The circle indicates where we are right now. Based on Monsanto's internal calculations, it is possible to meet the food demand that will exist by 2050 … and do it farming even less land than we're using now. The more we can grow on each acre, the more land we can convert to grassland and forests. In fact, the data show that reducing the footprint of global farming by 300 million acres by 2050 would have an enormous positive environmental impact, with the potential to reduce greenhouse gas emissions from agriculture by an additional 10%.

The application of new technologies that improve the environment has great public interest and acceptance. Advances that reduce crop-chemical or fertilizer use or help us better manage water resources are highly valued. As we embark on research toward implementing a new production tool or technology, we need to ask ourselves how we measure — and how we communicate — the environmental benefit of each new innovation:

- Does it help reduce the footprint of farming?
- Does it require less water or fertilizer?
- Does it help reduce $CO_2$ emissions?
- Does it help protect and restore biodiversity and other natural resources?

**Focusing our communications on the positive environmental benefits of ag and food innovations is one of the keys to building public and policymaker support.**

## Addressing the Decline in Public Funding

Historically, public funding of agriculture research has benefited global agriculture by disseminating improved knowledge and technology, conservation practices, and higher profitability for producers (***2016 GAP report***). U.S. public agricultural R&D expenditures grew at least 2.6% annually in real terms in the years following World War II, and this growth continued at a strong pace until leveling off in the early 1980s. But starting in 2000, the rate of growth in public investment began to decline.

Meanwhile, private sources of funding for R&D in agriculture production and food manufacturing picked up the pace after 2000. **However, research by the private sector does not replace basic foundational research by the public sector.** Private sector R&D focuses primarily on taking results from public sector research and creating marketable products for growers and consumers. Private sector funding is also subject to greater volatility.

While the funding debate goes on, many universities are responding to technological advances and budget constraints with creative initiatives. The Association of Public Land-grant Universities' (APLU) ***Challenge of Change*** report, released in May 2017, had several recommendations for universities to help meet global food needs by 2050. One of those recommendations was that universities should make improvements and structural changes to facilitate integration among natural and social sciences, including restructuring traditional departments and creating integrated R&D platforms with other non-agricultural departments.

This was echoed recently when I spoke with Dr. Jay Akridge, dean of Agriculture at Purdue University, who told me, "Purdue realizes the need to change within our own walls. The

College of Ag has formed relationships with the Schools of Engineering and Health & Human Sciences to collaborate and get others excited about finding solutions to ag challenges."

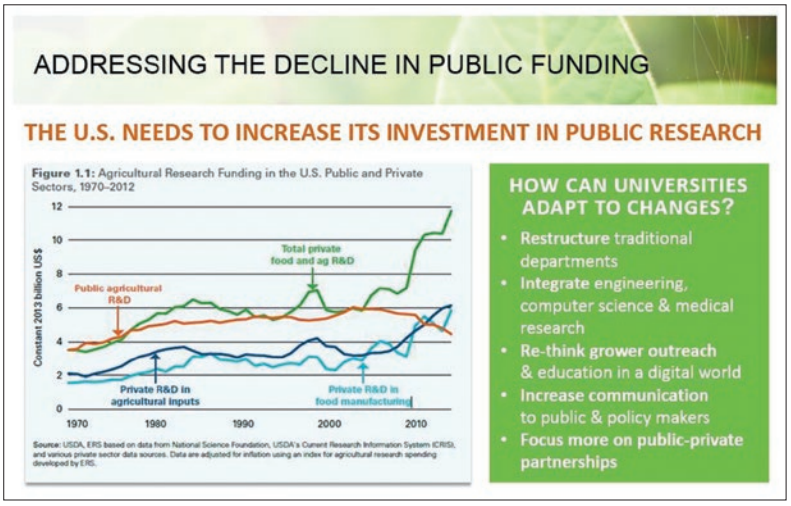
Universities are also rethinking long-standing extension and grower education programs in this new digital world. The constant access to data at our fingertips provides a new vehicle to educate and communicate to fulfill the evolving role of extension. Dr. Wendy Wintersteen, endowed dean of the College of Agriculture and Life Sciences at Iowa State University, whom you also know as president of the Charles Valentine Riley Memorial Foundation, has long stressed the importance of "collaborating with industry to ensure that local retailers — who are often the key advisors to farmers and the last to speak with them before they make big decisions — have the latest information and data to make the best recommendations."

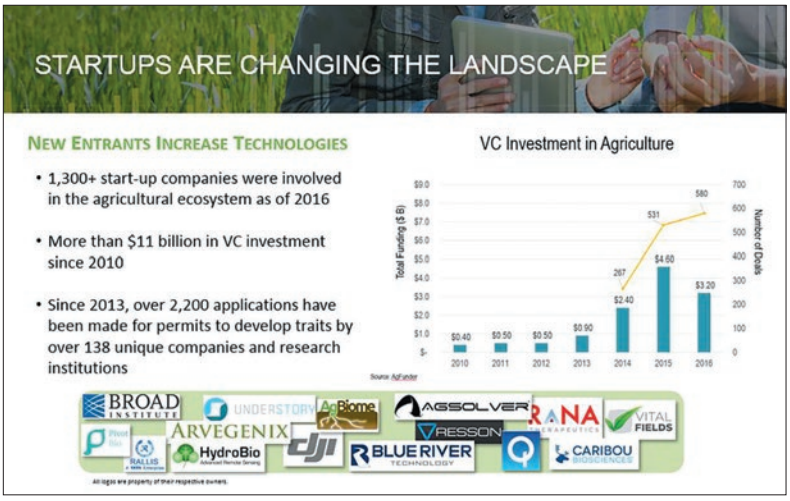
### Other areas of important focus for universities are:

- Educating a new generation of students with broader perspectives on global challenges.
- Increasing support for research parks and startup incubators, and fostering an entrepreneurial spirit on campus.
- Increasing communication to the public and policymakers on importance of R&D innovation.
- And placing even greater emphasis on public-private partnerships.

## Startups Changing the Landscape

One of the real bright spots in agricultural research and development has been the dramatic increase in private equity and venture capital investment into the ag-food sector. **Over the past seven years, *more than $11 billion has been invested in agricultural startups.*** (For perspective, $11 billion is two to three times bigger than the R&D budget of the top five companies in the ag-food sector, and nine times bigger than the USDA Agricultural Research Service budget). Today, there are literally 1,000 new startup companies focused on digital agriculture (satellites, sensors, advanced imagery, autonomous farm equipment, etc.); advanced biology (gene editing, RNAi, soil microbiome, etc.); food processing innovation (meat and milk substitutes, novel nutrient and vitamin production, food storage and preservation, etc.); and vertical farming. Some of their logos and names are shown here; many are the result of public-private partnerships.



## Public-Private Partnerships have been a Cornerstone of US Competitive Advantage

Public-private partnerships have been essential to the advancement of science, innovation and agriculture. For decades, an explosion in agricultural productivity — largely led by public-private research partnerships involving land-grant universities — has changed the way Americans and the worldwide community live. They have a long history of success with transforming discoveries into products such as hybrid corn, antibiotics, vaccines, gene editing ... the list goes on and on. Today, many partnerships are focused on the role modern agriculture can play in mitigating the effects of climate change. As one example, the Soil Health Partnership is a national leader in the research and communication of the benefits of improved soil health, and an innovative example of collaboration among diverse organizations. It's a farmer-led initiative of the National Corn Growers Association. Partners include the USDA Natural Resources Conservation Services and Monsanto, along with other ag industry organizations, environmental groups and universities, including Kansas State, University of Missouri, Cornell and Purdue.

As another example, the Iowa Monarch Conservation Consortium is a community-led organization working to enhance monarch butterfly reproduction and survival in Iowa through collaborative and coordinated efforts of farmers, private citizens and their organizations. The consortium was established by Iowa State University, the Iowa Department of Agriculture and Land Stewardship, and the Iowa Department of Natural Resources, with private partners that include Monsanto, Pioneer, Syngenta and BASF.


These partnerships, in addition to advancing science and product development, help create a compelling message of unity and collaboration among public, private and government institutions — all working toward the same goals and sharing information for the common good.

## New Barrier to Partnerships: FOIA

The biggest barrier for academic researchers used to be applying for competitive grants; now they have to worry about being "FOIAed." You've probably seen the headlines. Recently, a special-interest group called U.S. Right to Know (USRTK) has called into question collaborations between ag companies and researchers at several major public universities. The USRTK group has used the Freedom of Information Act, or FOIA, and state open-records laws to request copies of communications between researchers at these universities and employees of various ag companies, and various firms and trade associations. While we respect open-records laws as a vital safeguard in a democratic society, we share the concern of many scientific organizations, like AAAS, that agenda-driven interest groups can also exploit these laws as a means to silence scholars and researchers who speak out on important topics — in this case, agricultural biotechnology.

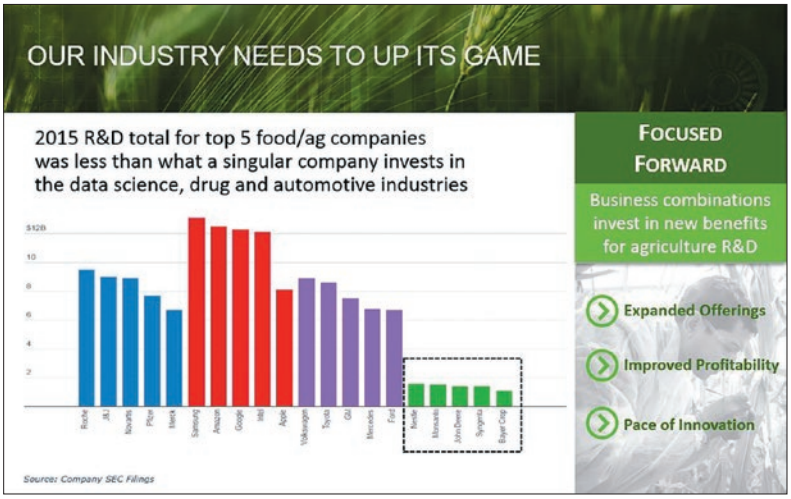
It is a big deterrent to collaboration if academic researchers have to worry that if they work with a company like Monsanto — or even email with a private researcher — they'll be called a shill and tormented by activists, making their life and work much harder.

That's not to say we don't need transparency about the financial relationships involved in public-private partnerships. **We do.** Such transparency is essential to the creation and maintenance of public trust. But we also need to maintain our long tradition of public-private partnerships — and in fact, celebrate and augment them more than ever.

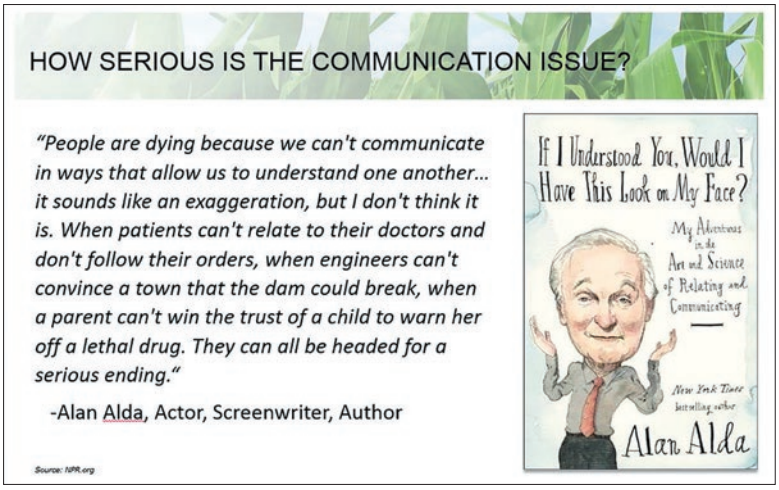
## Private Industry Needs to Up Its Game

Let's take a quick look at R&D in the ag-food private industry sector. The landscape may surprise you. In preparation for testifying before a Senate committee on industry consolidation, I asked our team to add up all the different companies in the global ag-food chain (including seed companies, equipment companies, companies involved with delivery of services to growers, retailers, companies involved in everything from irrigation to grain collection), and it was stunning: 4,000 companies represent the global ag-food sector. It's a sector that is undergoing dramatic change and modernization — and needs to be!

Here's why: This graph (from ***Company SEC Filings***) shows the total R&D investment for the five biggest companies in the ag-food, pharmaceutical, data science and automotive industries in 2015. From it you can see that leading pharmaceutical companies are investing $8 to 9 billion/year. Pharma companies are investing heavily in the next generation of advanced biology tools like gene editing, RNAi, etc. The data science companies like Amazon, Google, Samsung, etc., are investing over $10 to 12 billion/year in R&D, with strong focus on artificial intelligence and machine learning. And leaders in the digitally driven automotive industry are investing $6 to 8 billion/year on sensors, displays and self-driving cars.


In the ag-food sector, Monsanto, Nestle and a few others are spending just over a billion dollars a year. Now I must point out that I feel privileged that Monsanto is able to invest at this level — but if our industry is going to continue developing new innovative biological and data science products, we need to increase R&D funding. **We need to up our game!** This recognition has led to an increase in merger activity across the ag-food industry sector.




## How Serious is the Communication Issue?

But even if we solve all the budget and funding scenarios across the public and private sectors, there is one very important bridge we must cross before we can meet our food security and sustainability goals.

We ***must*** tackle the huge challenge of learning to communicate effectively about science in a consistent, uniform and impactful way. We need to be able to help people understand what we're working on, how the technologies are achieving all the benefits I've been talking about … and how those innovations benefit them personally. Improved communication is the ***gateway*** to meeting our other challenges.

How bad are our communications? You may have heard ***recent interviews with Alan Alda*** (and yes, that's Alan Alda the actor from "MASH", the host of "Scientific American Frontiers" on PBS and an AAAS member), as he just published a book on the subject of science communication. It's called ***If I Understood You, Would I Have This Look on My Face?*** As Alan points out in his book, nothing could be more serious than this communication barrier across all sciences — not just agriculture.

He writes: *"People are dying because we can't communicate in ways that allow us to understand one another … it sounds like an exaggeration, but I don't think it is. When patients can't relate to their doctors and don't follow their orders, when engineers can't convince a town that the dam could break, when a parent can't win the trust of a child to warn her off a lethal drug. They can all be headed for a serious ending."*

You could also add: When people suffer from diseases that could be easily prevented by vaccinations; or when they spend $30 billion/year on supplements and "miracle cures" touted by Dr. Oz and the Food Babe; or when governments let smallholder farmers suffer, along with those who rely on them, because they won't let them grow genetically modified crops.

In many ways, GM crops are the poster child for a science that is widely misunderstood — and for how that lack of understanding can create major obstacles to adoption. We have tens of thousands of academic and industry scientists who have spent their careers working on research that they believe will make the world a better place. But there are detractors out there spreading the message that GMOs are poison, using examples like ***Seralini's debunked rat study*** as "evidence" — and if that's the first or only message people have heard about GMOs, they're likely to believe it.

As the person who helped pioneer the first genetically modified crops, at the company that later took the first commercial GM seeds to market, I will readily admit that part of the blame for that belongs with Monsanto. When we launched the first commercial GM seeds in the mid-1990s, we focused our communications on our customers — farmers — and didn't work hard enough to help consumers understand the benefits. That was a big mistake, and in our absence of communication, other individuals and groups were able to position the technology in a negative sense.

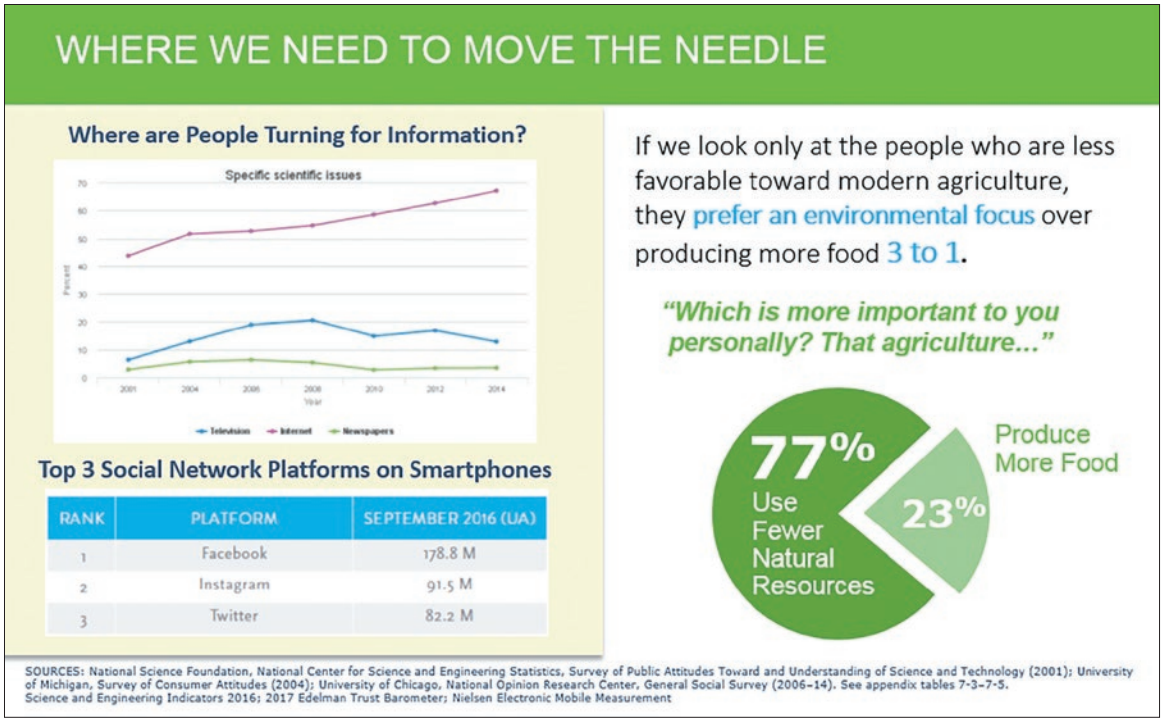
## Where We Need to Move the Needle

We have conducted extensive market research to help us understand where and how to reach society, and how to communicate about science in a way that is easily understandable and resonates with people's core values.

The research shows that people are overwhelmingly turning to the internet for information on specific scientific issues. Much of the time spent online is on social network platforms using smartphones. The top three social network platforms on smartphones are Facebook, Instagram and Twitter — so those need to be some of our key target channels for communication.

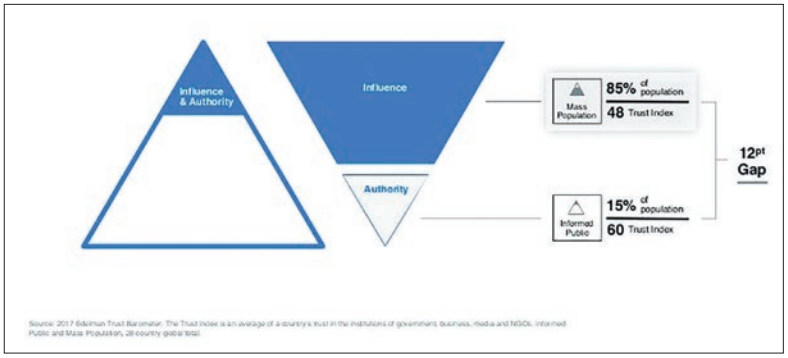
When we asked people who are less favorable toward modern agriculture, "Which is more important to you personally — that agriculture produces more food or uses fewer natural resources?" 77% said fewer natural resources. **They prefer an environmental focus over producing more food 3-to-1 — which is why we have to do a better job of reframing our messages to drive home the environmental benefits of agricultural science.** When it comes to language, we learned that society cares more about the words land, water and energy than the term "sustainability."

The research also shows that **we can't lead with facts and data in a world that doesn't understand science and agriculture.** Instead, we need to first find common ground, identifying topics that we all care about, like keeping our kids safe and helping the environment. Then we need to connect on a more emotional level, using storytelling that the average person can relate to. After we have cultivated a level of trust, people will be more open to hearing about the data.



## Today's Landscape of Ag Influencers

The top trusted voices for societal influence on scientific issues still include experts — medical leaders, nutritionists/dieticians, academic institutions, university scientists and farmers — but there is now a new segment of trusted voices: personal networks. People are saying that if enough of their friends are sharing information and saying it's true, they'll believe it. And that becomes a problem when your friends aren't experts, but you're still willing to take their word over that of a scientist who has spent decades researching the issue.




This has led to an inversion of influence — or the "End of Experts" as some have called it — where mass population can sway public belief simply by sharing information someone they know and trust has shared with them — even if there is no evidence to back it up. That's why it's so important for the voices of agricultural science supporters to be in the mix. But are we?

Given that we know what categories of voices influence societal audiences, and that people are increasingly heading to social media for information about important topics, Monsanto's internal researchers looked at one channel where we know we need to reach people — Twitter — to try and understand how these societal influencer categories are doing, and how they could do better.

When we look across a broad food/ag discussion over the past nine months (September 2016 – May 2017), there are **more than 2 million** actively engaged people (meaning that they tweet at least once a week) — including both the positive voices that support ag science and the negative voices who oppose it. But **only about 2% of the actively engaged positive voices** fall into the categories that we know influence society.

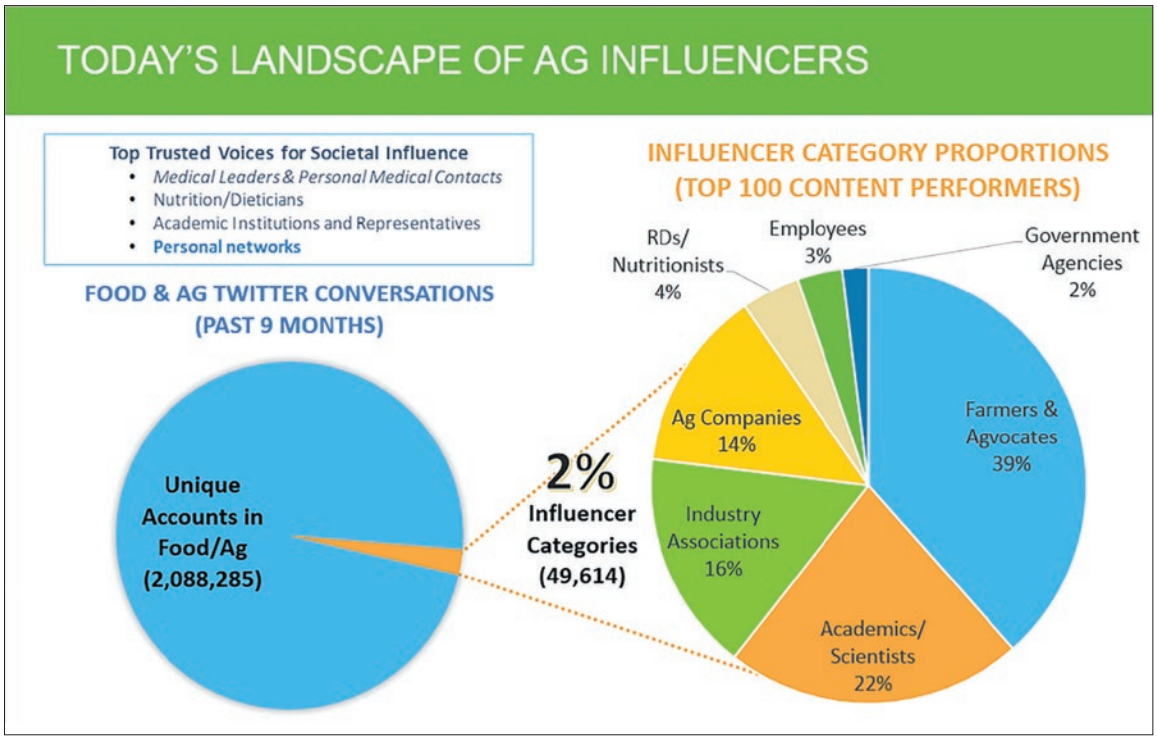
For example, **medical leaders who support modern ag science are absent from this food/ag conversation** on Twitter. Not one voice that is actively engaged. On the flip side, we know that there ***are*** a handful of "doctors" actively promoting alternative science and influencing society's perceptions negatively toward modern ag science and biotech. If those are the only doctors regularly participating in the food/ag conversation on that channel, and they are seen as trusted influencers, why wouldn't someone who knows nothing about agriculture believe what they have to say?

When we look at the number of tweets from the top 15 *most active* negative voices and top 15 *most active* positive voices in the ag/food space over the same period, **our data show that top negative voices are approximately FOUR TIMES as active in the ag/food space.** There were approximately 20 thousand tweets from the most active supporters and 94 thousand tweets from the most active detractors. That disparity presents a huge opportunity for us to jump in and start tilting the scales in the other direction.

And let's not forget that we are competing with messages coming from opponents of modern science and technology not just in agriculture, but ***broadly***. We must outcompete these negative narratives with good science from voices that we know move the needle.

**So what is the path forward? We have to acknowledge that the communication of our work is just as important as the science part — in today's world, they go hand in hand. And then we need to work hard at learning to be better communicators.**

I can tell you how that process has looked at Monsanto over the past few years. We have put a great deal of focus on engaging with people at in-person events and online, through new websites, earned media, paid advertising campaigns and an extended social media presence — not only on the corporate level but also through thousands of employee advocates.




In the spirit of listening to what matters to consumers, being transparent and cultivating trust, we've made it easy for people to ask us questions they may have about our company and our role in the food chain, through ***our website*** and social media pages. We've also been working with third parties to address and promote key topics.

Our latest awareness campaign, "Modern Ag," was designed to help society better understand modern agriculture, explaining how farmers are "giving back by moving forward," using digital tools and other advances to grow more food while using fewer natural resources. If you visit ***ModernAg.org***, you'll find that all the topics and language choices are based on our communications research. But this website wasn't built for only Monsanto's benefit. Our vision is to help align the industry around common language and messages, so that we present a unified voice to society. And to that end, we have been meeting with many of our partners to share what we're doing with that campaign and see how we can collaborate.

Twitter represents one opportunity for us to amplify our voices to positively impact society's views on agriculture and science. I can tell you that I'm out there trying to do my part. If you follow me on Twitter (and if you don't, you should — I'm *@RobbFraley*), I'm tweeting every day about some of the work we're doing at Monsanto, but also networking with other science and agriculture supporters and sharing the great stories and infographics that they're posting.

For example, the Cornell Alliance for Science — *@ScienceAlly* on Twitter — is producing some very compelling videos about public sector biotech, such as interviews with smallholder farmers about how these advances have changed their lives. That type of storytelling is vital to building an emotional connection with our audience.

The U.S. Farmers and Ranchers Alliance *(@USFRA)* has also done a good job of producing content that builds awareness about "smart farming" and adding the voices of farmers and ranchers to food dialogues


happening in traditional and social media. If you saw the film "Farmland," that was a USFRA initiative. USFRA recently relaunched its digital platform, ***fooddialogues.com***, and continues to activate conversations on Facebook.

But the great content that is being produced will only be effective if it is shared enough that people will see it. That's where you come in. You may think you're not cut out for social media — or you're too old — but it's very easy to share that content with your own networks on Twitter, LinkedIn or Facebook. You don't have to re–create the wheel to participate — you just have to be present and engaged.

If you need some other ideas to get you started, check out CropLife International (@*CropLifeIntl*), the Council for Biotechnology Information (@*agbiotech*) and ISAAA's Twitter channels (@*isaaa_org*). Then see who they're following and what content they're sharing from other groups, and link into those networks. You can also see what hashtags they're using to help people find content on certain topics, such as #WithNature, #Biotech or #ModernAg.

It's critically important for you to be a part of the online conversation — especially if you fit into one of the key influencer categories — because the conversation about ag and food production is going to happen with or without you. As a collective group, we really only have one choice to make: to participate or let the other side do all the talking.

## Developing Future Innovators

Finally, let's not forget that to continue to meet the challenges that surround food security and sustainability, we need a large STEM talent pool that will keep innovating into the future. The need for professionals in the science and agriculture fields is astounding:

- A ***2015 Purdue Ag Employment Outlook*** report (produced with grant support from the USDA National Institute of Food and Agriculture) estimated that the agriculture, food and natural resources sectors of the U.S. economy will generate approximately 58,000 annual openings for individuals with degrees or advanced degrees in related areas between 2015 and 2020.
  - 27% will be STEM-related roles.
  - Nearly 40% of these positions — or 22,500 roles — may go unfilled because of a lack of qualified candidates.

In addition, a recent study by economics professors at Ohio State says the ranks of scientists are aging faster than those of other workers. From 1993-2008, the share of American scientists aged 55 and older increased by nearly 90%, while the share of all American workers in that age group increased by little more than 50% during that period. ***So, who is going to replace my generation when we retire?***

The sad part is that many talented students will never pursue a STEM career in the food and ag sectors simply because they don't know what types of jobs are available. That's why improved communication is part of addressing the education challenge as well.. We need to be better advocates for innovation, science and science-based decision-making. We need more STEM education and communication in schools and society — particularly around the science of agriculture. The earlier we can get students excited about science and technology, the better chance they have of pursuing it as a lifelong passion.

With less than 1% of the U.S. population now living on farms, most young people today have never even seen a real farm. Their only concepts

of farming come from books, TV shows and movies — so they're likely picturing Dorothy's Kansas from *The Wizard of Oz* instead of the greener version of Silicon Valley. We must do a better job of teaching kids about all the new STEM roles — including data science and engineering — that exist in modern agriculture.

I mentioned Alan Alda earlier. The Alan Alda Center for Communicating Science at Stony Brook University's School of Journalism takes a different approach. Its goal is to help scientists learn to communicate more effectively with the public, including policymakers, students, funders and the media. And we definitely need more of that type of training for scientists young and old.

## Communication and Acceptance of Ag Technologies are Essential to Meet Future Demands

The global food security challenge is big, and so is the communication challenge we face. But I believe that better communication, transparency and public acceptance of ag technologies are the most important challenges that we need to address before we can achieve our goal of creating a food-secure world while protecting the future of the planet.

If there are only three things that stick with you today, I'd like you to remember these:

1. The new innovations in modern agriculture are spectacular and truly disruptive; they are transforming everything about our industry — in the lab, on the field and even in our organizational operations. We have to keep looking for ways to be more efficient and collaborative to make the most of limited R&D funding.
2. Explaining modern agriculture's role in the impacts of climate change and helping the environment will be key to gaining widespread public acceptance of new technologies.
3. If we can't find ways to communicate and engage more effectively, nothing else will matter.

Every one of us has the power to help move the needle on communications, so I urge you to use your voice to drive constructive online dialogue around ag and food. Get out there and engage in channels where you will be heard.

If we can't solve the communication and trust issues, it will ultimately threaten our freedom to operate. A lack of public acceptance and trust will jeopardize our ability to get more R&D funding. It will have a negative effect on policy and regulatory decisions and will discourage more beneficial partnerships, and could prevent our ability to use the new tools and technology we develop.

We are on a noble mission to feed a growing population and save the environment. But if we don't overcome these communication issues, we may never get there. When we all join forces to move the needle on public acceptance, we will be helping farmers, helping the hungry, helping the environment and, ultimately, protecting the future of agriculture and the planet.

Thank you.


To view Dr. Fraley's full presentation, go to ***www.aaas.org/riley-lecture.***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# Participant Bios

## Robert Fraley

Dr. Fraley is executive vice president and chief technology officer at Monsanto. He has been with the company for 35 years, and currently oversees the company's global technology division, which includes plant breeding, plant biotechnology, ag biologicals, ag microbials, precision agriculture and crop protection. Often recognized as the father of agricultural biotechnology, he developed the first genetically modified organisms (GMOs) in the early 1980s as a solution for farmers battling pests and weeds that threatened their yields. Throughout his career, he has contributed to years of agricultural development through a number of significant activities, including authoring more than 100 publications and patent applications relating to technical advances in agricultural sciences. Dr. Fraley's discoveries and applications of science are also routinely recognized for the tremendous impact they've had in supporting farmers and the agriculture demands of our planet. Some of his most distinguished honors include being recognized as a World Food Prize Laureate in 2013, receiving the National Medal of Technology from President Clinton in 1998 and receiving the National Academy of Sciences Award for the Industrial Application of Science for his work on crop improvement in 2008, among other recognitions. He holds a Bachelor of Science and a Ph.D. in microbiology/biochemistry from the University of Illinois, an executive degree in business management from Northwestern University, and was a biophysics postdoctoral fellow at the University of California, San Francisco.

## Lisa Ainsworth

Dr. Ainsworth is a USDA ARS scientist and an associate professor of plant biology at the University of Illinois. She earned her B.S. from the University of California, Los Angeles, and her Ph.D. from the University of Illinois. Her research applies physiological, biochemical and genomic tools to understand plant responses to global climate change and environmental stress. Her current research is quantifying genetic variation in response to elevated ozone concentrations among diverse inbred and hybrid maize lines in the field, developing and using high-throughput phenotyping techniques to identify ozone sensitivity in maize and soybean, and identifying the genes and gene networks underpinning the ozone response in maize and soybean. Dr. Ainsworth won the Charles Albert Shull Award from the American Society of Plant Biologists and the President's Medal from the Society of Experimental Biology, and was named a University scholar by the University of Illinois.

## Gregory Bohach

Dr. Bohach began serving as vice president of the Mississippi State University (MSU) Division of Agriculture, Forestry and Veterinary Medicine (DAFVM) in 2009. As vice president, he provides leadership for the Mississippi Agricultural and Forestry Experiment Station, College of Agriculture and Life Sciences, Forest and Wildlife Research Center, College of Forest Resources, College of Veterinary Medicine, and the MSU Extension Service. During his tenure, MSU has remained in the top 10 in agricultural science research and development expenditures for 17 years, and in 2014 was number eight in the nation, as reported by the National Science Foundation. DAFVM's ongoing commitment to Mississippi's producers and to global food security helped push MSU into the top 100 research institutions in the country. In addition to serving as vice president, Dr. Bohach is a professor of biochemistry and molecular biology in the MSU College of Agriculture and Life Sciences and an adjunct professor of basic sciences in the MSU College of Veterinary Medicine. Over the course of his career as a microbiologist specializing in human and animal infectious diseases, he has trained 14 graduate students, published 125 articles in peer-reviewed publications and received $23.5 million in funding from the National Institutes of Health and the United States Department of Agriculture. He holds two patents and one invention disclosure.

## Mary Bohman

Dr. Bohman is the administrator of the Economic Research Service. She joined ERS in 1997 and has served as director of the agency's Resource and Rural Economics Division, deputy director for research in the Market and Trade Economics Division (MTED), and chief of MTED's Europe, Africa and Middle East branch. Other public sector positions held include details to the White House Office of Science and Technology Policy and to the USDA's Under Secretary for Farm and Foreign Agricultural Services. From 1990 to 1997, she was on the agricultural sciences faculty at the University of British Columbia. Dr. Bohman first worked in agriculture and rural development as a Peace Corps volunteer for cooperative development in Togo, West Africa, in the early 1980s. She received her Ph.D. from the Department of Agricultural Economics at the University of California, Davis, and her B.S. from the School of Foreign Service at Georgetown University.

## Andrew W. LaVigne

Mr. LaVigne is currently the president and chief executive officer of the American Seed Trade Association (ASTA). He joined ASTA in February 2006. Mr. LaVigne has had a 30-year career in government relations, industry representation, public affairs advocacy and management. His core areas of expertise include agriculture, food policy and international trade. Prior to joining ASTA, he was executive vice president and CEO of Florida Citrus Mutual, representing citrus growers on issues affecting their business. Previous to this position, he spent four years as president and executive director of the Florida Fertilizer and Agrichemical Association (FFAA), a nonprofit agricultural trade organization representing companies that specialize in crop protection and plant nutrition products. Before his role at FFAA, Mr. LaVigne spent eight years in Washington, D.C., working in the U.S. Congress and the U.S. Department of Agriculture (USDA). He served as legislative director for Congressman Charles Canady, Agriculture Committee staffer for Congressman Tom Lewis and on the staff of USDA Secretary Ed Madigan. He is a native of Florida, and holds a B.A. in political science, with a minor in economics, from the University of Florida.

# About Charles Valentine Riley (1843-1895)

"Professor Riley," as he was generally known, was born in Chelsea, London, England, on September 19, 1843. He attended boarding school in Dieppe, France, and Bonn, Germany. Passionately fond of natural history, drawing and painting, he collected and studied insects and sketched them in pencil and in color. At both Dieppe and Bonn, he won prizes in drawing and was encouraged to pursue art as a career.

At the age of 17, he came to the United States and settled on an Illinois farm about 50 miles from Chicago. Soon his attention was drawn to insect injuries of crops, and he sent accounts of his observations to *The Prairie Farmer*. At the age of 21, Riley moved to Chicago and worked for this leading agricultural journal as a reporter, artist and editor of its entomological department. His writings attracted the attention of Benjamin D. Walsh, the Illinois state entomologist. It was through Walsh's influence as well as the recommendation of N.J. Coleman of *Coleman's Rural World* that Riley was appointed in the spring of 1868 to the newly created office of entomology of the state of Missouri. From 1868 to 1877, in collaboration with T.W. Harris, B.D. Walsh and Asa Fitch, Riley published nine annual reports as state entomologist of Missouri, which unequivocally established his reputation as an eminent entomologist. Today, authorities agree that these nine reports constitute the foundation of modern entomology.

From 1873 to 1877, many western states and territories were invaded by grasshoppers from the Northwest. In some states, the destruction of crops was so serious that it caused starvation among pioneer families. Riley studied this plague and published the results in his last three Missouri annual reports, and worked to bring it to the attention of Congress. In March 1877, he succeeded in securing passage of a bill creating the United States Entomological Commission, and the Grasshopper Commission administered under the director of the Geological Survey of the U.S. Department of the Interior. Riley was appointed chairman; A.S. Packard Jr., secretary; and Cyrus Thomas, treasurer.

***Charles Valentine Riley Examining an Insect.***

*Undated. Charles Valentine Riley Collection. Special Collections, National Agricultural Library, Beltsville, Maryland. http://www.nal.usda.gov/speccoll/.*

All this time, Riley, with the help of Otto Lugger, Theodore Pergrande, and others, was also making brilliant contributions to the knowledge of the biology of insects. Besides studying the life cycles of the 13- and 17-year cicadas, he studied the remarkable Yucca moth and its pollination of the Yucca flower, a matter of special evolutionary interest to Charles Darwin. In addition, he conducted intensive life history studies of blister beetles and their unusual triungulin larvae, and the caprification of the fig.

In the spring of 1878, Townend Glover retired as entomologist to the U.S. Department of Agriculture, and Riley was appointed his successor. After a year in this position, Riley resigned because of a disagreement with the Commissioner of Agriculture over Riley's practice of making independent political contacts; he then continued the work of the U.S. Entomological Commission with others, from his home. Two years later, after the inauguration of President James A. Garfield in 1881, Riley was reappointed, and remained chief of the Federal Entomological Service until June 1894, when the service was renamed the Division of Entomology of the U.S. Department of Agriculture. In 1882, Riley gave part of his insect collection to the U.S. National Museum, now The Smithsonian Institution, at which time he was made honorary curator of insects. In 1885, he was appointed assistant curator of the Museum, thus becoming the Museum's first curator of insects, whereupon he gave the Museum his entire insect collection consisting of 115,000 mounted specimens (representing 20,000 species), 2,800 vials and 3,000 slides of specimens mounted in Canadian balsam.

One of Riley's greatest triumphs while chief of the Federal Entomological Service was his initiation of efforts to collect parasites and predators of the cottony cushion scale, which was destroying the citrus industry in California. In 1888, he sent Albert Koebele to Australia to collect natural enemies of the scale. A beetle, *Vedalia cardinalis*, now *Rodolia cardinalis*, was introduced into California and significantly reduced populations of the cottony cushion scale. This effort gave great impetus to the study of biological control for the reduction of injurious pests, and established Charles Valentine Riley as the "Father of the Biological Control." For a review of the cottony cushion scale project, see Doutt, 1958.

A prolific writer and artist, Riley authored over 2,400 publications. He also published two journals, the *American Entomologist* (1868-80) and *Insect Life* (1889-94). Riley received many honors during his lifetime. He was decorated by the French government for his work on the grapevine *Phylloxera*. He received honorary degrees from Kansas State University and the University of Missouri. He was an honorary member of the Entomological Society of London and founder and first president of the Entomological Society of Washington. He and Dr. L.O. Howard, Riley's assistant in the Federal Entomological Service, were among the founders of the American Association of Economic Entomologists, which became part of the Entomological Society of America in 1953.

Tragically, on September 14, 1895, Riley's life was cut short by a fatal bicycle accident. As he was riding rapidly down a hill, the bicycle wheel struck a granite paving block dropped by a wagon. He catapulted to the pavement and fractured his skull. He was carried home on a wagon and never regained consciousness. He died at his home the same day at the age of 52, leaving his wife and six children.

## Acknowledgements

AAAS would like to thank the U.S. Department of Agriculture, National Agricultural Library (NAL) for providing Professor Riley's biographical information and accompanying image. The Charles Valentine Riley Collection at NAL includes correspondence, unpublished lectures, photographs, news clippings, drawings, reprints, books and artifacts covering the time period from 1868 to 1919.

# About the Lecture and Partner Organizations

Launched in 2010, the AAAS Charles Valentine Riley Memorial Lecture aims to promote a broader and more complete understanding of agriculture as the most basic human endeavor and to enhance agriculture through increased scientific knowledge.

## The American Association for the Advancement of Science

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journals *Science* (sciencemag.org), *Science Signaling* (sciencesignaling.org), *Science Translational Medicine* (sciencetranslationalmedicine.org), *Science Robotics* (robotics.sciencemag.org), *Science Immunology* (immunology.sciencemag.org) and *Science Advances* (advances.sciencemag.org). AAAS was founded in 1848, and serves 262 affiliated societies and academies of science, reaching 10 million individuals. *Science* has the largest paid circulation of any peer-reviewed general science journal in the world. The nonprofit AAAS (aaas.org) is open to all and fulfills its mission to "advance science and serve society" through initiatives in science policy, international programs, science education and more. For the latest research news, log on to *EurekAlert!* (eurekalert.org), the premier science-news website, a service of AAAS.

Charles Valentine Riley Memorial Foundation

## Charles Valentine Riley Memorial Foundation

The Charles Valentine Riley Memorial Foundation (RMF) is committed to promoting a broader and more complete understanding of agriculture and to building upon Charles Valentine Riley's legacy as a "whole picture" person with a vision for enhancing agriculture through scientific knowledge. RMF, founded in 1985, recognized that agriculture is the most basic human endeavor and that a vibrant and robust food, agricultural, forestry and environmental-resource system is essential for human progress and world peace. RMF conducts a wide range of program activities that include discussion groups, forums, roundtables, workshops, briefing papers and lectures on various parts of the food, agricultural, forestry and environmental-resource system. RMF's goal is to have all world citizens involved in creating a sustainable food and agriculture enterprise within a responsible rural landscape. More information is available at www.rileymemorial.org.

## World Food Prize Foundation

Founded by Nobel laureate and "Father of the Green Revolution" Dr. Norman E. Borlaug, the World Food Prize is a $250,000 award presented annually for breakthrough achievements in science, technology and policy that have improved the quality, quantity and availability of food in the world. Termed "the Nobel Prize for Food and Agriculture" by several heads of state, it is presented each October in conjunction with a week of events that includes the international "Borlaug Dialogue" symposium, and gathers pre-eminent global leaders and experts representing over 65 countries. The 2017 World Food Prize events took place October 18–20 in Des Moines, Iowa. Information about the World Food Prize events, highlights from past Borlaug Dialogue symposia and nomination criteria are available at www.worldfoodprize.org.

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