S. HRG. 115–172

AGRICULTURAL RESEARCH: PERSPECTIVES ON PAST AND FUTURE SUCCESSES FOR THE 2018 FARM BILL

HEARING

BEFORE THE

COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

JUNE 15, 2017

Printed for the use of the
Committee on Agriculture, Nutrition, and Forestry

Available via the World Wide Web: http://www.govinfo.gov/

U.S. GOVERNMENT PUBLISHING OFFICE

28–501 PDF WASHINGTON : 2019

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CONTENTS

AGRICULTURAL RESEARCH: PERSPECTIVES ON PAST AND FUTURE SUCCESSES FOR THE 2018 FARM BILL

Thursday, June 15, 2017

UNITED STATES SENATE,
COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY,
Washington, DC

The committee met, pursuant to notice, at 9:33 a.m., in room 328A, Russell Senate Office Building, Hon. Pat Roberts, Chairman of the committee, presiding.

Present or submitting a statement: Senators Roberts, Boozman, Hoeven, Ernst, Grassley, Thune, Daines, Perdue, Stabenow, Brown, Klobuchar, Bennet, Gillibrand, Donnelly, Casey, and Van Hollen.

STATEMENT OF HON. PAT ROBERTS, U.S. SENATOR FROM THE STATE OF KANSAS, CHAIRMAN, COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY

Chairman ROBERTS. Good morning. I call this meeting of the Senate Committee on Agriculture, Nutrition, and Forestry to order.

Someone once said, "Today American agriculture is in the grip of a technological revolution, as vast and as rapid as any in history. It is a revolution which has made the American farmer the most efficient in history. It has made his productivity the marvel and envy of every nation. Experts from all over the world come to see our farms, study our techniques, and learn our methods, and the farm technology we have developed here in the United States holds out hope to the world, for the first time, that no man, woman, or child on Earth needs to go hungry again."

These words are as accurate today as they were in the past, when said by then President John F. Kennedy.

My colleagues, and those in the audience, times are pretty tough right now in farm country, and research is indeed the backbone that drives agriculture change, efficiencies, and productivity, and the U.S. must continue leading the charge to feed a growing population of an estimated 9.7 billion in the next several decades.

Discretionary spending on the research, education, and economics mission area at the Department has remained fairly flat for the past six years, and yet budgets are getting even tighter here in Washington. However, we must continue to focus on agriculture research, and in February of this year we kicked off the farm bill process by holding a field hearing in Manhattan, Kansas, at Kansas State University, and 600 were in attendance.

At that hearing, we heard from a variety of agriculture stakeholders, 21, about what they want to see in the next farm bill reau-

thorization, but that day just did not include the hearing. My day started at the Kansas Wheat Innovation Center, where I toured the research labs and a greenhouse, and spoke with some of the center scientists, and observed cutting-edge research that will help keep our wheat growers as the most efficient and productive in the world. The Kansas Wheat Innovation Center is just one example of why the United States produces the safest, most affordable and abundant food and fiber supply in the world.

In 2012, we celebrated the 150th anniversary of the United States Department of Agriculture. That same year, we celebrated the 150th anniversary of the Morrill Act, which established the land-grant college system. I might add that Kansas State University was the first land-grant institution created under that act. I well know——

[Laughter.]

Chairman ROBERTS. —the history with regards to Michigan State, and I will yield.

Senator STABENOW. Official.

Chairman ROBERTS. —the first official. I think you had a building and somebody just said that was official, and that we had the first land grant. Anyway, let us let that go.

Because of the early investment U.S. leaders made in agriculture research and extension efforts, our producers are better equipped to manage through drought, disease, floods, fires, and a great deal more that Mother Nature throws at them. Today there are additional challenges. Farmers are combating new pests and diseases and unpredictable weather patterns. Livestock producers rely on best management practices supported by accurate data and data to continually improve their production efficiencies. At the same time, scientists must work to ensure consumers have accurate science-based information regarding the nutritional benefits in foods that consumers are demanding.

My colleagues, we have our work really cut out for us with this farm bill reauthorization. We need to find ways to do more with less, to reduce burdens of overregulation, ask tough questions as we re-examine programs to determine their effectiveness, and if they are serving their intended purpose. Strong public-private partnerships have been the cornerstone of U.S. agriculture research.

Senator Stabenow and I were the original cosponsors of the bill that became the foundation for food and agriculture research in the 2000 Farm Bill. The foundation represents an opportunity to partner with the private sector and generate new funding streams in the light of budgetary constraints. In order to carry out bold and innovative agriculture research, this innovation should build upon and complement existing research at the Department of Agriculture.

I look forward to hearing more this morning about how the foundation has used the seed funding Congress provided to leverage additional resources that produces results. I also look forward to hearing from leaders at the Department, our universities, and producers about research priorities for the next farm bill.

So today's hearing is an opportunity to take stock in where we have come from and discuss where we are going in agriculture research. Through the leadership of the Department of Agriculture

and setting priorities, the federal funding at our universities, and the investment of the public sector, I am optimistic about our future and overcoming the challenges that lie ahead.

I look forward to hearing from our witnesses and thank them for coming and participating. I know you all have valuable time.

With that I am very pleased to recognize Senator Stabenow for any remarks she might want to make.

STATEMENT OF HON. DEBBIE STABENOW, U.S. SENATOR FROM THE STATE OF MICHIGAN

Senator STABENOW. Well, thank you very much, Mr. Chairman. I first want to express what all of us are feeling about the shooting yesterday and Representative Steve Scalise, the staff, the Capitol Police, and that we all are saddened and horrified by what happened.

I particularly want to lift up, though, a young man from Michigan, Matt Mika, who is very close to our staff. His mom and dad have flown in from Michigan and are now at the hospital. He has had one surgery, has to have another, and he is really in very serious condition, so we lift him up. He worked for two members of our congressional delegation in the House and is now with Tyson Foods, but we consider him part of the extended agriculture family and ask for specific prayers for Matt as he is going through tough times as well.

I also want to thank our expert witnesses for being here today to discuss the importance of agricultural research, education, and extension. I have always said that we do not have an economy unless somebody makes something and somebody grows something, and that is exactly what agriculture research helps us do. Research initiatives included in the 2014 Farm Bill provide the tools and the science that sustain Michigan agriculture, and all of agriculture.

I do want to indicate Michigan agriculture is our state's second-largest industry, supporting one out of four jobs. In fact every $1 invested in agricultural research creates more than $20 in return to the U.S. economy, which is a great investment. Michigan is home to the country's pioneer land-grant, my alma mater, Michigan State University. We will probably have to claim joint ownership at some point, depending on the timing here.

The innovative work happening every day at land-grant universities, like Michigan State and Kansas State and other agricultural research institutions protects and improves our food system. Land-grant universities are unique in that they implement their research findings in communities through extension work. When I was getting my graduate degree I appreciated being a part of extension and seeing it close up.

The Morrill Act of 1862 created the land-grant university system with the mission to serve rural communities. Since that time, the United States has led the world in agricultural research. However, over the last decade we have seen China, India and Brazil significantly increase their investment in agricultural research. China now has a 2-to-1 advantage over the U.S. in critical public investments to address emerging pests, disease, and extreme weather in the agriculture sector. If we allow our country to slip behind in ag-

ricultural research, our farmers could lose their global competitiveness.

Now, more than ever, it is critical to invest in public research and support our world-class agricultural research institutions that make our farms more productive and sustainable. From innovative robotic technology to precision agriculture, our scientists are pushing the bounds of what is possible to create new opportunities.

In Michigan, we are famous for our wide variety of specialty crops, from our cherry trees and apple orchards to our hops yards and wineries, but many of those crops would not be thriving if it were not for targeted investments like the farm bill Specialty Crop Research Initiative. For example, Michigan has been the number one domestic producer of blueberries over the last 70 years, contributing more than $118 million to Michigan's annual economy.

While it might be easy to find these nutritious berries in your grocery store—and they are really good—their widespread popularity is thanks, in part, to agricultural research. Crops like blueberries have depended on innovative research to meet the changing needs of consumers and growers alike. Michigan State has developed some of the most widely planted varieties, with traits that work best for commercial production.

But it is not just specialty crops that have benefitted. We are also growing jobs through research that strengthens the emerging bio-based economy. The 2014 Farm Bill supports the farms that produce our energy crops and provides innovative technologies for renewable energy projects across the country. Research breakthroughs have made it possible for bio-based products to enter the market, which contributes $393 billion to the U.S. economy and supports 4.2 million jobs, plus.

There are many other ways, Mr. Chairman, I see that my time is running out. I am going to place some other comments as to other examples in the record. But let me just say, every day our farmers face new and emerging challenges posed by disease and invasive pests as well. In Michigan, invasive species are destroying our cherry harvests, and in Florida citrus greening is devastating orange groves. In Kansas, stripe rust has struck wheat farmers.

Our agricultural researchers are stepping up to the plate, over and over again, to address these challenges. That is why, in the last farm bill, Chairman Roberts and I worked together to create the Foundation for Food and Agricultural Research. I am thrilled to see some representatives from the foundation here today to update us. We owe so many of our accomplishments in agriculture to the scientists who conduct groundbreaking research. Every day they pave the way forward for farmers and food businesses.

So I am very pleased that you are all here today. I also want to indicate that we are, unfortunately, having national debates over scientific facts, and I am not afraid to say that I believe in science. I know that in this Committee, when we are talking about research, we are talking about science. Science-based agricultural research is good for our farmers, good for our consumers, good for our economy, and I look forward, in the next farm bill, to strengthening our efforts, working together, based on our past bipartisan victories.

Thank you, Mr. Chairman.

Chairman ROBERTS. I thank the distinguished Ranking Member. My colleagues, as you all know, we have three votes at 11:00. We are going to rotate back and forth during those votes to keep the hearing going. I only mention this to inform our panelists that we will keep going. If you can keep within the five-minute allotment that we have given you, despite the fact that both myself and the Ranking Member went over about 45 seconds, that would be fine.

I would say that, like King Tut, we are pressed for time, but that is a horrible pun that I will not bring up. Please, no groaning.

[Laughter.]

Welcome to our first panel of witnesses before the Committee this morning. Dr. Ann Bartuska serves as the Acting Deputy Under Secretary for Research, Education, and Economics within the Department of Agriculture. Prior to her work at the Department she served in a variety of roles at the Forest Service, including the Deputy Chief of Research and Development from 2004 to 2010. Welcome. I look forward to your testimony.

Dr. Sonny Ramaswamy has served as the Director of the National Institute of Food and Agriculture since May of 2012. He has also held a number of leadership positions at universities across the country, including Kansas State University, where he was a distinguished professor and head of the Entomology Department. Welcome, sir, and thank you for participating.

Dr. Chavonda Jacobs-Young has served as Administrator of the Agricultural Research Service, the Department of Agriculture's chief science in-house research agency, since February of 2014. Previously she worked in a variety of leadership roles at the Department, at the Agriculture Research Service, the Office of Chief Scientist, and the National Institute of Food and Agriculture. Welcome, and thank you for today's joining—to joining today's panel.

Dr. Sally Rockey serves as the first Executive Director for the Foundation for Food and Agriculture Research. Prior to this role, she led the Competitive Grants Program at the Cooperative State Research Education and Extension Service, what is now known as NIFA. Dr. Rockey also served as the Deputy Director for Extramural Research at the National Institutes of Health. Welcome, Dr. Rockey, and I look forward to your testimony.

We will begin now with Dr. Ann Bartuska. Doctor?

STATEMENT OF ANN BARTUSKA, PH.D., ACTING DEPUTY UNDER SECRETARY, RESEARCH, EDUCATION, AND ECONOMICS, UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, DC

Ms. BARTUSKA. Chairman Roberts, Ranking Member Stabenow, and distinguished members of the Senate Agriculture, Nutrition, and Forestry Committee, I am very pleased to be able to be here with you to provide an overview of the activities of the research branch of USDA, and particularly research education and economics, my mission area.

But before I begin my statement I would like to offer my sympathy from the entire USDA family to the victims of yesterday's shooting and share your thoughts, Senator Stabenow.

I am, as introduced, Dr. Ann Bartuska, Acting Under Secretary and Acting Chief Scientist of the USDA. I, however, was serving

as Deputy Under Secretary since 2010, and have really been privileged to be part of the REE mission area. REE has four agencies: the Agricultural Research Service, the Economic Research Service, National Agricultural Statistics Service, and the National Institute of Food and Agriculture. Two of the administrators are here today, as have already been introduced, Dr. Sonny Ramaswamy, the Director of NIFA, and Dr. Chavonda Jacobs-Young, who is the Administrator of Agricultural Research Service.

The United States and the world are facing critical problems and opportunities. Global population is expected to reach 9.7 billion people by 2050, almost two and a half billion more people than today. At the same time, we are struggling with extreme weather events and conditions that really impact so many agricultural production systems. Investments in research are a critical factor in meeting these and other challenges and opportunities, and it is the REE mission area agencies that support the critical research and analyses that our country needs to ensure farm profitability and strengthen our communities, improve nutrition and food safety for lifelong health, and safeguard sustainable use of natural resources, including an abundant and safe water supply.

REE's work in food and agricultural sciences is based on the premise that the Federal Government has a role in advancing scientific knowledge to promote our nation's social and economic wellbeing. REE does this by investing in areas in which for-profit industry does not invest, such as basic research. It also collaborates with public sector academic and the private sector to amplify research outcomes.

We know that the return on investment in agricultural research is $20 for every dollar spent. An under-investment or absence of investments in food and agricultural sciences diminishes the needed foundational knowledge base that fuels innovation—many of the things that Senator Stabenow mentioned in terms of precision agriculture and advances in technology are part of that innovation—and impacts our nation's global preeminence and economic wellbeing. It is with these goals in mind that the REE mission area agencies establish their priorities and conduct their work.

Expected gains in agricultural yield and production are unlikely to sustainably provide food, fiber, and fuel to meet the needs of 2050, without additional resources for research. As it has been pointed out, the U.S. is losing its global scientific dominance and research leadership to emerging countries in addressing agricultural productivity and profitability challenges. China has surpassed the U.S. and it continues to increase its investment in agricultural research.

Mr. Chairman, despite significant efforts by recent farm bill and annual spending bills to enhance agricultural science in the United States, we are at a crossroads. Although REE has made significant strides in our physical infrastructure, our human infrastructure, and big science capabilities, we are falling further and further behind. There is much to be accomplished. Our storied legacy of discovery, innovation, and international leadership in agricultural research, education, and economics is in jeopardy by insufficient investments in both money and in minds.

This is a challenge that we must all rise to meet and REE looks forward to rising to that challenge.

Thank you for giving me some time today.

[The prepared statement of Ms. Bartuska can be found on page 49 in the appendix.]

Chairman ROBERTS. Thank you so much for your testimony and for keeping within the time limit.

Next we have Dr. Ramaswamy.

STATEMENT OF SONNY RAMASWAMY, PH.D., DIRECTOR, NATIONAL INSTITUTE OF FOOD AND AGRICULTURE, UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, DC

Mr. RAMASWAMY. Good morning, Chairman Roberts, and Ranking Member Stabenow, and Committee members. Thank you so much for having us here this morning for me to share with you a little bit of information about the National Institute of Food and Agriculture, and we have submitted the written testimony that has got a lot more detail in it as well.

We have, in America, our food systems, collectively, according to the Economic Research Service, is pretty close to a trillion-dollar enterprise, and it supports 21 million jobs. The role of the National Institute of Food and Agriculture is to provide the research and extension underpinnings, and the educational underpinnings, of that enterprise itself.

I would like to say that what NIFA supports, across America, the science that we support is inspired by the end users, and once the work is done it is translated into innovations and solutions and delivered to the end users, and it transforms people's lives.

I want to share with you two examples of that.

The first example is Dr. Barbara Valent from Kansas State University, last year went to Kentucky, and discovered wheat blast disease on spring wheat seedlings. This is a particularly vexing disease that can potentially destroy almost 100 percent of the wheat, and the work that she did with funding from NIFA and her colleagues at University of Kentucky and the Agricultural Research Service has resulted in our ability to very rapidly determine what species of wheat blast we have, so that we can deploy the appropriate approaches to deal with it.

A second example, from Michigan, is the work that is done by our extension colleagues there at Michigan State University, and just yesterday we heard that the Attorney General of Michigan has filed charges against people involved in the Flint water situation—lead in the water situation. Our extension colleagues at Michigan State University were on the ground as soon as they discovered lead in the water, and started deploying information to those folks out there, and providing—in addition to providing just water, bottled water, they also provided information on improving the nutrition of the children so that if you can improve the nutrition of those children they will not have to suffer the long-term effects of lead itself.

So those are a couple of examples of the transformative work that NIFA supports. Our mission is to catalyze transformative research, education, and extension to solve societal challenges, and at the end of the day, the support that we provide is really about our

producers, our farmers and livestock producers in America. We want to make sure that they are able to remain profitable. That, at the end of the day, as you said, Mr. Chairman, farm incomes are depressed, have been depressed here in the last few years now, and we have got to do everything we can to give them a leg up.

So our budget is about $1.5 billion. It is split up into two big buckets. One supports the experiment stations extension and education, and the other funding is provided for competitive grants. These funds, as you noted, and Senator Stabenow noted, provides tremendous return to our nation, 20-to-1 return on the investments that we make.

Unfortunately, however, we are falling further and further behind, as has been noted by you and my colleague here, Dr. Bartuska, as well. We are falling further and further behind, so we have got to do everything we can to ensure that this innovation engine that we have got is going to be supported and protected.

We undertake stakeholder conversations throughout the year, and currently we are undertaking conversations about protecting the biosecurity for our food systems, about nutrition education, about youth education and 4–H, and about our 1994 tribal-serving institutions as well, and we hope to aspirationally incorporate those, as we go forward, to work with you and your colleagues in the farm bill itself, as we go forward as well.

With that, I want to go ahead and thank you very much for giving me the opportunity to share some thoughts with you about the National Institute of Food and Agriculture. Thank you again.

[The prepared statement of Mr. Ramaswamy can be found on page 84 in the appendix.]

Chairman ROBERTS. Doctor, thank you very much for your very fine extemporaneous report, and we appreciate your observing the time limit.

Dr. Jacobs-Young.

STATEMENT OF CHAVONDA JACOBS–YOUNG, PH.D, ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, DC

Ms. JACOBS-YOUNG. Good morning, Chairman Roberts and Ranking Member Stabenow and the distinguished members of the Committee.

My USDA colleagues and I represent the agencies that exemplify the mandate expressed in President Abraham Lincoln's 1862 executive order establishing the Department of Agriculture, which the Department was charged with conducting practical and scientific experiments to improve the quality and security of agriculture in the United States.

As U.S. Department of Agriculture's chief scientific in-house research agency, ARS has about 1,900 scientists at 90 laboratories located throughout the United States, that carry out the mission and constitute an important component of USDA's science enterprise. We have world-class research laboratories from Maine to Hawaii, and we maintain research facilities in France, China, Argentina, and Australia, that serve as bases for our insect, pest, and biocontrol collection efforts.

ARS has internationally recognized scientists working on every issue affecting American agriculture today, be it disease and insect pest, water use, soil erosion, drought, improving production yields, food safety, or crop and animal management strategies. Key to our success has been our strong partnerships and our collaborations. We work closely with our land-grant university partners, scientists from other federal agencies, international organizations, and many industry scientists and producers.

ARS scientists have played an important role in providing the objective science that action and regulatory agencies depend on as they set their policies. ARS's institutional capacity, our wide-ranging expertise, and our geographic reach allows us to conduct coordinated and integrated research, targeting national and regional agricultural priorities of importance to our many stakeholders.

Since its inception, USDA has recognized the importance of having both intramural and extramural scientific research. The strength of having an intramural agency provides ARS and the USDA, and the United States, with unique capabilities, and we have huge responsibilities. We are responsible for conducting that research that is inherently governmental—public service, public good research.

We support the action of regulatory agencies within USDA and across the Federal Government with sound scientific data. We maintain essential germplasm collections. In fact, we have the largest germplasm collection in the world. We conduct long-term nutritional studies and maintain very, very important databases. We operate long-term experimental watershed facilities. We respond to emergencies and national disasters. We engage in long-term research to meet national goals.

This infrastructure expertise and nationwide network of partnerships is needed to respond quickly to national agricultural emergencies, for example, the H1N1 swine flu virus, the highly pathogenic avian influenza, or soybean rust, and to prepare for those emerging diseases such as Ug99, stem rust disease of wheat, or foot-and-mouth disease of cattle that are not yet here in this country, but we will be prepared.

So how does all of this benefit America? Over the years, our public investment and the cooperation in agricultural research among the private sectors, universities, and government has given Americans the safest, most nutritious, and most abundant—and might I say most affordable—food supply anywhere.

So agriculture has formed the foundation of our nation, the national economy, for the past 200-plus years, and our agricultural research has been the key to that success. Thank you.

[The prepared statement of Ms. Jacobs-Young can be found on page 75 in the appendix.]

Chairman ROBERTS. Yes, ma'am. Thank you for a very strong statement.

Dr. Rockey.

STATEMENT OF SALLY ROCKEY, PH.D., EXECUTIVE DIRECTOR, FOUNDATION FOR FOOD AND AGRICULTURAL RESEARCH, WASHINGTON, DC

Ms. ROCKEY. Mr. Chairman, Ranking Member Stabenow, and members of the Committee, I am Sally Rockey and I am the Executive Director of the Foundation for Food and Agricultural Research, known as FFAR. I am honored to have the opportunity to testify before you as Congress considers its priorities in the next farm bill.

As you know, FFAR is an independent 501(c)(3) nonprofit organization, established with bipartisan support in the 2014 Farm Bill to serve as a new and unique model in our nation's mission to be the global leader in food and agricultural sciences. We fund innovative science that is solving real-world problems, by filling research gaps and accelerating science through partnerships. An essential part of this model is our ability to leverage private sector funds to deliver huge value for the American taxpayer. The U.S. government's $200 million investment in FFAR eventually returns more than $400 million in valuable science.

FFAR unites researchers with funding partners like venture capitalists, industry, philanthropies, and expands the funding pool for agricultural science by coalescing groups together around common priorities. The foundation is also nimble and efficient, with the ability to award grants very quickly, and in some cases as little as in one week.

Building a foundation from scratch was really no small task, but since I came on board in late 2015, FFAR has hired talented staff and developed reliable systems to protect the taxpayers' investment. Our esteemed board of directors has grown, and we have established advisory councils to guide us in our research.

To date, FFAR has delivered $32.4 million and 22 grants with more than 41 funding partners. By the end of the year, we will have obligated about half of our $200 million in public funding, leveraging, as I said before, another $100 million in additional funds.

Our first major research project was funded with the Samuel Roberts Noble Foundation. It was to increase the use of cover crops and create new cover crop resources, with the goal of significantly improving soil health, one of the most valuable resources for our farmers.

We recently awarded our first Rapid Outcomes from Agricultural Research, or as we call it, ROAR, grant, in partnership with the Cherry Marketing Institute and Michigan State University, to combat an invasive pest that will benefit the fruit industry in eight states. This program demonstrates our ability to accept applications as critical issues arise, and to fund them very quickly.

FFAR also is positioned to fund science that adapts to industry needs. For example—and you may have just read about the story this morning in The Washington Post—FFAR just announced a $2 million effort to address the emerging issue in cage-free egg production, to improve the health and productivity of cage-free hens.

This week, we awarded a very innovative grant to the University of Illinois who is bringing together the latest in plant simulation models to predict how plants respond to their environment, which

can vastly accelerate the pace and the development of new crops with beneficial traits.

More robust funding and research will allow the United States to maintain its science prominence, and will give our producers the opportunity to apply cutting-edge research results and technologies to their operations. However, as was already stated, Federal funding for agricultural research has been relatively stagnant over the last decade. FFAR offers an opportunity to not only increase the overall funding pool but increase it for cutting-edge science.

Not only does science drive our economy but it is also progressing at, really, what is a breath-taking pace. We are becoming a pivotal player at FFAR in seizing emerging scientific opportunities in the food and agricultural research community, and we know our model will serve us well in driving innovation in the future.

One innovative process that FFAR is exploring now is photosynthesis. Photosynthesis is what makes a plant a plant, and it allows it to acquire energy from the sun. By increasing photosynthetic capacity, we can dramatically increase crop yields.

We are grateful for the opportunity to continue to work with Congress to ensure FFAR is reauthorized and fully funded in the next farm bill, consistent with the bipartisan legacy, as an institution contributing to the long-term competitiveness of our nation's food and agriculture sector.

To the members of this Committee who were so instrumental in establishing FFAR, I thank you on behalf of the entire food and agriculture community. Thank you.

[The prepared statement of Mr. Rockey can be found on page 94 in the appendix.]

Chairman ROBERTS. Thank you, Dr. Rockey.

Dr. Ramaswamy and Dr. Jacobs-Young, we are in the first week of the wheat harvest in Kansas. Not good news. We have lost about 40 percent of our crop due to a very late freeze. We had that 11-county, 850,000-square-mile prairie fire, a freeze before that. I have no idea what we have done to Mother Nature but she sure has taken it out on us.

Your testimony references the work of Dr. Valent at K-State, and what she has been doing in coordination with AFRI and ARS on wheat blast. You mentioned that in your comments. I understand that ARS research has been conducted through the wheat strip initiative, the wheat scab initiative, and the Insect Biotechnology Products for Pest Control and Emerging Needs in Agriculture projects. That is a lot of folks.

Can you provide an update on these projects? Are there any partnership arrangements that are key to this work? How can the Department work be improved in these areas? Please, first, Dr. Ramaswamy.

Mr. RAMASWAMY. Thank you very much, Chairman Roberts. Indeed, the National Institute of Food and Agriculture is investing significant resources in helping develop new varieties of wheat that can withstand those early freezes, then the flooding situation, and then you have got the drying up and the drought situation as well. New varieties of wheat that are coming along, work being done at Kansas State University, at the University of Minnesota, at multiple universities across America, are going to have traits, charac-

teristics in them that will allow them to withstand not just the biological constraints, such as wheat blast and other, insect problems as well. In addition, they will be able to withstand the environmental conditions, the extreme weather events that you referenced as well.

We are, hoping that these varieties that are going to come along here, the investments that we are making now, will result in offering our producers better ways of dealing with the challenges that they face.

Chairman ROBERTS. Dr. Jacobs-Young, any comments?

Ms. JACOBS-YOUNG. Yes. ARS manages the Wheat and Barley Scab Initiative, which is a coalition of university, federal, and industry partners. I would just like to say that they have been working very hard on developing new varieties that increase resilience and reduce vulnerability, and because of their efforts, over the past 10 years we have been able to reduce the amount of mycotoxin in wheat by 32 percent in durum wheat. We see some real evidence of the work that they have done in the varieties that have been released.

We have also identified wheat that is resistant to Ug99, and while we do not have it here in the United States we have developed varieties that are being planted around the world. So we will be prepared. We have a diagnostic to determine the difference between Ug99 rust and other rust pathogens, and our wheat quality laboratories, which you are very familiar with, around the country, have been so instrumental to the wheat industry.

So we are working very hard in releasing varieties that have increased tolerance or resistance to some of the diseases that we are being faced with.

Chairman ROBERTS. Dr. Rockey, as one of the original co-sponsors of FFAR, and a strong advocate for investment in agricultural research, we are certainly hoping for the long-term success of the foundation. I appreciate your efforts to keep our committee updated as FFAR gets up and running. The last bill, as you have indicated, provided $200 million in mandatory funds as a seed investment to establish FFAR.

In a time when there are almost no new programs being created, what are your plans to generate new funds and demonstrate project outcomes in order to enable FFAR to be a sustainable tool to support AG research into the future? I am especially interested in long-term investments. I know that you have a good record here in the last few months—well, the last six months—with short-term projects that are paying off with private partnerships. What about long-term?

Ms. ROCKEY. Thank you for that question, Chairman. We have been working quite a bit on thinking about long-term sustainability as an organization. If you think about the model that was defined in the original 2014 Farm Bill, that model really only works when we have a continued financial investment from Congress. Really, the Federal funds are what attract our partners, and we are able to leverage them and bring in additional funds. So we leverage their funds and they also leverage the Federal funds, and that allows us to create this unique partnership and bring additional funds to the table for agriculture.

But the reauthorization of FFAR as an organization really allows us to solidify as a viable research entity and a viable research institution, capable of funding our partners.

We continue, as you noted, to fund projects. Some of our projects are very short-term. For example, in our rapid response program, grants are for year-long projects. We are able to put money on an issue quickly while the USDA then comes back in with some longer-funded projects. However, we also are funding some long-term projects. Our grants can range up to five years, and will continue to, depending on the type of science that comes across our transect. We will fund either long or short-term projects, depending on the goals of the particular project.

However, as an organization, we continue to think about how to build on these short-term successes and our plans for the future. We have built a credible organization. We have established our research priorities. We are securing additional funds. We have a low operating cost right now, as an organization. We have launched a giving program. We are looking at ways to generate IP revenue, and we are seeking major gifts.

So all of this is no small task but we are building on the success that we have had of late, for our long-term sustainability. We are really establishing our reputation, and I think that is a lot of what is going to take us into our future.

But I want to make something very clear to you, that we will be a successful organization, and we will fulfill every intent that you had in authorizing us in the first place. We have demonstrated now that the model really does work, and it will, but it will be dependent on our continued support from Congress.

Chairman ROBERTS. I thank you. Senator Stabenow.

Senator STABENOW. Well, thank you, Mr. Chairman, and thank you to each of you, and Dr. Rockey, I was pleased to hear your comments, and I appreciate the grant that has been given most recently, two weeks ago, to tackle some specialty crop issues. I know there was a slow start, but things are moving now and I think it is very, very important that we continue to support this effort as a long-term effort.

I did want to just comment, Dr. Jacobs-Young. You were talking about the Wheat and Barley Scab Initiative. It takes me back. I was a new House member in 1997. I authored that initiative with a then new Republican colleague, Roy Blunt, and we are now both in the Senate. But when my constituents would excitedly ask me what was my first bill, and I said "wheat and barley scab," it was not really exciting, but I am really pleased to know that it is still going on and is actually making a difference, so thank you for that.

I wanted to ask Dr. Bartuska about the whole question on scientific integrity. We are here talking about research, how important this is. We know, fundamentally, this is so important for our farmers and food safety and the food economy. But there is a lot of debate right now, and public scrutiny, about science, and about facts. Under the last Administration, USDA developed its first scientific integrity policy, as well as fostered a culture of scientific integrity.

So I wonder if you could talk a bit about what the USDA has done to gain the trust of the public and demonstrate it is con-

ducting unbiased scientific research, and how you are addressing issues around scientific integrity.

Ms. BARTUSKA. Thank you very much for that question. We are very proud of our scientific integrity policy, not only that we initiated it very early on, among all the science agencies, but that we have since improved it and we have gone back out to many of the state of the art scientific integrity policies, in terms of what kinds of language you should have in a policy. What does a platinum version of a scientific integrity policy look like? We have refined it. We had a scientific integrity officer over the entire department. He, unfortunately, left but we were recently approved to hire a new one, even in a hiring freeze and at the time of some resource limitations.

So the commitment USDA is making to a formal scientific integrity process is very high. It is investing in our own employees by providing training to all of our scientists. But we just recently agreed, many of the agencies, to extend that training to technicians and to those who use science but who are not scientists themselves.

So again, there is a very strong commitment within USDA. I have to say, we were very pleased that the Union of Concerned Scientists, who had initially reviewed our first draft scientific integrity policy and found it wanting, have since reviewed all of the policies and have given us a very positive green light on what we have been able to accomplish.

We believe that we have responded to the community and that we now have implemented a policy and an implementation that is demonstrating the highest standards of scientific integrity, and I think it is through our publications and the peer review process that the currency of science is reinforced.

Senator STABENOW. Thank you very much. Dr. Ramaswamy, I wanted to ask you a little bit about organic research. All parts of agriculture are obviously incredibly important. Organic agriculture now counts for over 5 percent of the total retail food sales, as you know, making it one of the fastest-growing parts of agriculture, and bringing more people into focus, in terms of the importance of growing food and the agriculture economy.

We know that the Organic Research and Extension Initiative has contributed to that success, and I wonder if you might talk about how other research programs at USDA help those organic producers address challenges and meet the increasing demands for their products.

Mr. RAMASWAMY. Thanks very much, Senator Stabenow, for that question, and, indeed, to your point, organic agriculture is one of the fastest-growing segments of our agricultural enterprise in our nation, and it constitutes about $40 billion of farm value as we are looking at it, and continues to grow as well.

The Organic Research and Extension Initiative, along with the Organic Transitions program are two of the programs specifically geared to provide funding for, research and extension efforts that support our organic producers. Along with that, the Agriculture and Food Research Initiative and our Specialty Crops Research Initiative also encourage applicants to submit grant proposals in support of organic efforts as well.

So the sum total of funding that goes to organic type enterprises, within the competitive grants arena, is in the neighborhood of around about $40 to $50 million a year. Along with that, the support that we provide for experiment stations and extension, adds an additional $30 to $50 million of investments that the land-grant universities are making.

So those discoveries, that knowledge, is certainly of significant use, whether it is pest control, pest management, or dealing with the soil health and other issues as well.

Senator STABENOW. Thank you. Thank you, Mr. Chairman.

Chairman ROBERTS. Senator Bennet.

Senator BENNET. Mr. Chairman, I want to thank you for holding an excellent hearing. This is a great panel, and timely, I think, because of the budget that has been submitted. So I really appreciate it.

Dr. Jacobs-Young, for 110 years the Central Great Plains Research Station in Akron, Colorado, has been working with local groups like the Colorado Wheat Growers to research crop varieties that grow best in local conditions. That is a very big challenge, as in my state. They also focus on new management techniques to conserve water and soil resources, helping the environment and improving the bottom line for farm businesses, generation after generation, for more than a century.

Despite this, the President's fiscal year '18 budget proposes closing this station and 16 other similar research stations across the country. I wonder if you could tell the panel a little bit about the role these research field stations play and how they work to provide useful information to local growers and producers.

Ms. JACOBS-YOUNG. Thank you so much for your question, Senator.

As Dr. Bartuska shared, and the Chairman as well, we have a huge goal ahead of us, of feeding 9.7 billion people by 2050, and ARS is right at the center of helping us achieve that goal. We were faced with the task of having to find $161 million in reductions for ARS, and through that process——

Senator BENNET. Who gave you that task?

Ms. JACOBS-YOUNG. It is a part of our President's budget proposal.

Senator BENNET. Yes.

Ms. JACOBS-YOUNG. —ARS has the reduction of $161 million.

Senator BENNET. Yes.

Ms. JACOBS-YOUNG. As you can imagine, over the past years, because budgets have not grown tremendously, we have done a big job of trying to look across our portfolio, using data to streamline and consolidate.

So we are at the point where every decision we make today is a tough one. Everything that we give up today, is important, but we have to make the decision to make these reductions and we used three criteria for how we are doing this.

The first one, we looked at our employees. ARS is who it is because of our people. How do we minimize the impact to our ARS scientific workforce? Therefore, we looked at extramural funding. The second one is that we looked at those things that preserve ARS's infrastructure—our germplasm collections, our LTAR net-

work, our critical databases, et cetera, et cetera. So we looked at those things and said that we needed to protect those because they are uniquely what ARS provides to the scientific community.

The third one was we had to balance the portfolio, and using data to determine the capacities of all of our research projects in our locations. So when we took a look across the portfolio, we looked at those locations and projects that might be challenged, from a resource perspective human capital, infrastructure, IT, and dollars.

So we used a data-driven process to look at everything, to make those decisions. Unfortunately, Akron is on the list for proposed cuts in FY 18.

Senator BENNET. Well, it is not——

Ms. JACOBS-YOUNG. I assure you it was a data-driven process and it was not an easy one.

Senator BENNET. Well, it is not. I can tell you that it is not going to be acceptable to me, and I don't think to the United States Senate, to cut it, because there is no replacement for it, and, frankly, I hope I speak for other members of the Committee when I say that because of the leadership of the Chairman and the Ranking Member in the last farm bill, this is the only committee that actually created deficit reduction. This committee did. The people that we represent in farm country in the United States stepped up to the plate, when no other committee in the Congress did that. No other committee did that. For them to be presented with a 30 percent cut to the Department of Agriculture is an insult. It is worse than an insult. It is a war on rural America, I think, and rural Colorado.

There is not a replacement for the Akron Research Station. There is not anybody else who is going to help our wheat farmers do what they need to do, or wheat growers do what they need to do, year after year, because of changes in the climate and changes in the environment.

So I can appreciate that you made a "data-driven" decision and I think it is a terrible decision, for the people that I represent in my state, and I think, in the context of this Committee doing its work in a way that, because of your leadership, Mr. Chairman, and Senator Stabenow from Michigan, it is entirely unacceptable to me that they are trying—and they do not even balance the budget. So they have an unbalanced budget that they are trying to balance on the backs of our farmers and our ranchers, and it is absolutely unacceptable to me, because of the work that we have already done. The sacrifices that have already been made in an environment with commodity prices where they are, it adds insult to injury and it is utterly unacceptable.

Thank you, Mr. Chairman.

Chairman ROBERTS. Senator Bennet, thank you very much for reading the speech that I wrote.

[Laughter.]

Senator BENNET. I hope I put the emphasis in the right places.

Chairman ROBERTS. Some of the adjectives were a little out of line, but I think we can do that.

Senator BENNET. Thank you. I am always happy to repeat your words.

Chairman ROBERTS. The President proposes and we dispose. I do not know of any—this is not an admonition I would like to expound upon, but the President proposes, we dispose. There has been a lot of talk about this budget, more especially in my view on crop insurance, AG research, et cetera, et cetera. That is not going to happen. It is simply not going to happen. We are in dire circumstances, and as you have indicated, we have given and given. We have got crop insurance cuts, $6 billion, and then seeing what they have done, like Lizzie Borden taking an ax and cutting another $6 billion. Then there was another three in the omnibus, which we saved.

We stand ready to do what we have to do and meet our budget responsibilities, and I thank you for your comments.

We have—Senator Donnelly is gone. It will be Senator Casey. Thank you.

Senator CASEY. Mr. Chairman, thank you. Thank you and the Ranking Member for having this hearing, and what a great panel, and I wish we had even more time.

I wanted to start with Dr. Bartuska with regard to the Chesapeake Bay and nutrient management. I will also, in the interest of time, to try to get at least to a second major question for Dr. Ramaswamy on lead in soil.

But let me start with the Chesapeake Bay. In Pennsylvania, our state is the source of much of both the fresh water for the Chesapeake Bay and also much of the nitrogen and phosphorus pollution that enters the Chesapeake Bay, so I am particularly concerned in nutrient management tools, technologies, and practices that can help Pennsylvania's farmers meet Chesapeake Bay restoration goals.

Could you tell us about the work of USDA with regard to nutrient management, either on the modeling and forecasting side or the actual on-farm nutrient management?

Ms. BARTUSKA. I would be happy to. Actually, as a born-and-raised Philadelphian, I am well aware of the connection between Pennsylvania and the Bay, and actually worked in that area about 20-some years ago. I am glad to say we have made improvements, partly because we have recognized what can be done on farm to reduce runoff. Bringing those practices into place through extension has been really important. I have to commend our University Park ARS lab, partly, for some of the research, as well as our competitive grants program.

But in particular, connecting our research and science as information through extension and Natural Resource Conservation Service, Farm Service Agency, so that they know what those practices are, to help encourage them to adopt them but also to give them the tools they need to be able to do that.

When it comes to lower down in the watershed we are increasingly looking at tools to reduce the impact locally. Can we do remediation on site? Can we be doing better modeling—I am sorry—monitoring of those sites, including in water columns, so you get real-time estimates of what nitro and phosphorus loading is happening and can take action?

You mentioned modeling. That has been one of the areas where we, with the university community, have really tried to better con-

nect a specific practice with what it does, in terms of the nutrient loading, and then address those loadings.

Then, lastly, I have to acknowledge the Economic Research Service that has done quite a bit of work on the economics and the decision-making of farmers—why they choose practices, why they choose some practices over other practices, and identifying how can we provide them the tools to make a better decision.

We really have everything from biogeochemistry and the chemistry of the site to the water quality, measuring to the monitoring to the modeling, and then the extension piece.

Senator CASEY. How about kind of the appropriations budget question, which is, do you have the resources to do what you just talked about? Any—do you have a sense of what your resources are to carry out that task?

Ms. BARTUSKA. I think we are still assessing what the specific implications of the '18 President's budget is and what projects and what specific activities take place. I do know that through NIFA's competitive grants—and Dr. Ramaswamy might talk to this—the water challenge area is continuing to focus on that.

We will continue to support the highest priority work and nutrient management is part of the portfolio that we believe is very important for agricultural producers.

Senator CASEY. Well, I hope if you need more resources, obviously, we hope you tell us over time, when you have a sense of that.

Thank you very much, Doctor, for that. You were born in Philadelphia, you said?

Ms. BARTUSKA. Yes.

Senator CASEY. That is great. Well, we always want you to come back.

Ms. BARTUSKA. Yes, from East Falls.

Senator CASEY. Oh yeah. Thank you so much.

I also wanted to raise a question on lead with Dr. Ramaswamy. I have heard from constituents across our state, obviously in the context of what happened in Flint, Michigan, with regard to water, but in our state, a major challenge is lead, lead paint in the old homes, and the numbers might be even higher there. But also, I just got off the phone this morning with a reporter investigating lead in the soil, and I know that is not what your testimony was directly about, but your testimony indicated that NIFA worked with Michigan State Extension and Edible Flint on a program focused on lead in the soil if you want to grow—if people want to grow their own food.

Is there anything you can tell us about that initiative, or initiatives like it, that would be helpful in the context of just folks that might have lead in their soil in their back yard and they may not be growing food. But what would you recommend and what could you do to help on that?

Mr. RAMASWAMY. Yeah. Indeed, I would like to, Senator Casey, speak to the work that is going on in your state, in Pennsylvania, and folks at Penn State, as well as the Rodale Institute, are—they have received funding from NIFA, both competitive funding as well as what we refer to as capacity funds for the experiment station and extension.

Very specifically, to address the question that you asked of Dr. Bartuska as well, in regards to the eutrophication of the Chesapeake Bay with excess nutrients going through, and also tied to soil health itself, very recently, Professor Heather Gall received an Agriculture and Food Research Initiative funding on that question of developing approaches to mitigating the movement of these nutrients that are impacting the Chesapeake Bay. Also, Joseph Keller at Penn State is looking at improving soil health. By growing certain types of crops and trees and things like that, that can—there have been some poplar trees that have been developed, varieties that have been developed, that can specifically go in and remove lead and other heavy metals, like arsenic and things like that, as well.

We continue to invest resources in soil. If we do not have good soil health, as you know, we will not have good crops and livestock in our agricultural systems. We are going to be hurt.

I want to get back to, specifically, after you asked the question, do we have enough resources and things like that, and, the funding rate within the Agriculture and Food Research Initiative today, we do a three-year rolling average over the last three years, sits around 13 percent. Over the last three years, on average, we have received pretty close to 3,000 proposals, of which the grants panels, these peer panels that we have, have recommended over 1,200 of those to be funded. Many outstanding, many in high priority. Unfortunately, we have only funding to support just about 480 of those proposals.

Senator CASEY. Out of 1,200.

Mr. RAMASWAMY. Yes, sir. So a lot of them——

Senator CASEY. Then we have got to go——

Mr. RAMASWAMY. —are, left on the floor.

Senator CASEY. He is tapping.

Mr. RAMASWAMY. Yes, sir.

Senator CASEY. Thank you, Mr. Chairman. Thank you, Doctor.

Chairman ROBERTS. Senator Boozman.

Senator BOOZMAN. Thank you, Mr. Chairman. Dr. Ramaswamy, in your testimony you mentioned how NIFA collaborates with other government agencies such as DOD, NIH, NSF, VA, and a host of others. Can you discuss, in more detail, how collaboration works, and perhaps give us some examples of the work done through collaboration?

Mr. RAMASWAMY. Thanks so much for that question. I was hoping that one of you was going to ask me that question.

Indeed, the innovations and collaborations with the National Science Foundation, the National Institutes of Health, U.S. Agency for International Development, the Environmental Protection Agency, the Department of Defense, Veterans Administration, we have a number of those. I will give you two examples in the field of, biophysical sciences, and then I will give you an example in regards to the opioid crisis that we have got as well.

So we have got, with NSF and NIH, we partner with them in this area. We refer to it as the Ecology and Evolution of Infectious Diseases. There are a number of infectious diseases that impact animals, plants, honeybees, as well as livestock animals and humans. There is a commonality in some of these things, and some

of them get vectored, carried by insects and other, species of arthropods and invertebrates. So trying to understand how these diseases, the epidemiology of the ecology of it, and things like that, and whether it is foot-and-mouth disease or colony collapse disorder in honeybees and others, we have collaboratively provided funding and we have this ongoing relationship with those agencies now.

For every dollar NIFA invests, it leverages about $5 to $10 from those other agencies. We partner, by the way, with the British Biotechnology Research and Science Council as well on those topics.

In regards to our relationships with the Veterans Administration and the Department of Defense, and Health and Human Services, we partner with those agencies and the substance abuse and mental health service agency, SAMHSA, and deploying funding that they provide to us through interagency agreements, that goes through extension to address the opioid crisis, for example, amongst our veterans and active duty service members' families, children and their families as well.

Then, as you know, we have got this terrible scourge of the opioid crisis across the United States, and those partnerships are critically important because the—our extension community is in every one of our 3,141 counties, boroughs, and parishes. We have got a footprint throughout the nation. That is being utilized to deploy information to help those communities.

A good example of that is in Michigan and Ohio and Indiana, amongst the Amish community. Their children are exhibiting significant use and abuse of drugs and opioids. Our extension folks at Purdue University and Michigan State University and Ohio State University are working together to address the opioid crisis as well.

So those are a couple of examples.

Senator BOOZMAN. Very good. That is excellent.

Dr. Jacobs-Young, can you describe, in more detail, the importance of the ARS extramural research projects? How is ARS able to leverage what you learn with the extramural research with what you learn at your intramural facilities?

Ms. JACOBS-YOUNG. So one of the beauties of having an intramural agency is that all of our employees are Federal employees, outside of just our contractors, our postdocs, and others, so the expertise we do not have internal to the agency, we are able to use the extramural funding to partner with expertise at universities, at corporations. We are able to use those extramural funds to sort of bridge the gap between the expertise we have inside ARS. Most of those extramural grants are with our land-grant partners, and so we leverage those resources to get the job done.

I think it is also important to note that sometimes those extramural resources are used as a convening resource, to bring together groups of people to work on some high-priority topics. That is how we use the extramural funding inside of the agency.

Senator BOOZMAN. Very good. Thank you, Mr. Chairman.

Chairman ROBERTS. Senator Gillibrand.

Senator GILLIBRAND. Thank you, Mr. Chairman. Dr. Bartuska, how will you direct ARS to conduct targeted on-farm data collection of antibiotic use?

Ms. BARTUSKA. I am sorry, can you repeat that?

Senator GILLIBRAND. How will you direct ARS to conduct targeted on-farm data collection of antibiotic use?

Ms. BARTUSKA. The antimicrobial resistance work that we have going on across USDA has become a really high priority, and working specifically with ARS and NIFA, we have identified, principally through the partnership with HHS, on a portfolio of research that needs to be accomplished. The agencies will then build that into their programs and priority investments as they shape their fiscal year planning. For ARS, in particular, something we have worked with them through our priority-setting process out of the Under Secretary's office. We use the REE action plan, which was driven by the farm bill, to establish a set of priorities, and the antimicrobial resistance work is built into the overall priorities.

Senator GILLIBRAND. Do you feel you need any additional authorities to enhance the AMR collection?

Ms. BARTUSKA. Actually, I would like to defer that to Dr. Jacobs-Young.

Ms. JACOBS-YOUNG. Thank you. So ARS partners with the Food and Drug Administration where we are a part of NARMS, the National Antimicrobial Resistance Monitoring Program. We are their technical arm to do a lot of the on-farm data collection and analysis. We have been partnering with them for a number of years, and we look forward to continuing that on-farm data collection, because it helps us be able to trace where the antimicrobial resistance begins, and learn a little bit more about management practices.

We have been partnering with the FDA on that and we have a huge portfolio in antimicrobial resistance inside of ARS, looking at immune systems between animals, zoonotic diseases, looking for alternatives to antibiotics, looking at probiotics, for example, for use in chickens, that is in use right now, FloraMax, which was developed by ARS. It is currently in use to minimize the prevalence of enteric diseases in poultry and are actively advancing vaccine development.

We have been working and we have a lot of great experts working on AMR, and I think the agriculture community could benefit from a lot of information for decision-making.

Senator GILLIBRAND. I agree. I would be grateful if you would work with my office on further issues on this.

Ms. JACOBS-YOUNG. Would love to do that.

Senator GILLIBRAND. Mr. Ramaswamy, did you want to add something.

Mr. RAMASWAMY. Yes, if I may, Senator Gillibrand. So NIFA's portfolio funding in the world of antibiotics and antimicrobial resistance over the last few years, particularly in relation to this interagency collaborative effort, we are investing—we have been investing between $5 and $15 million each year on looking at it from the farm to the dinner table, rather than just focusing on any one small part of it, looking across the food chain, the value chain itself, and the data that are coming out now in regards to improved animal husbandry and management, how might that help mitigate the amount of antibiotics to use, et cetera. These are all, new data that are really driving the management of our herds in many, many situations, and poultry flocks as well.

Senator GILLIBRAND. Well, to the extent you need any additional resources or authorities, please let us know, because we would like to provide that with you, because I think this needs to be a national priority.

On the question of organics, Dr. Bartuska, how do you intend to increase the resources available to organic farmers or those that are transitioning, so that we can meet the domestic demand without having to rely so heavily on imports?

Ms. BARTUSKA. We have noted, through the Census of Agriculture, as well as through work done by the Economic Research Service, there is increasing demand by those who are going into farming, to want to go into organic farming. Programs such as the ones at NIFA that Dr. Ramaswamy has already mentioned have been made available. We are actively promoting these programs through extension to these new farmers who want to move into organics.

Part of it is also creating more tools for them, lot of the organic production is in specialty crops, and so growing the specialty crop program is another way that we see it as being very important for them to do.

I might defer to both Dr. Ramaswamy and Jacobs-Young to talk more about their specific programs, if that would be all right.

Mr. RAMASWAMY. Yeah, so picking up where Dr. Bartuska left, we have the Organic Research and Extension Initiative and the Organic Transitions Program funding that is provided, and collectively they provide in the neighborhood of around $20-plus million. We also have proposals that are submitted to us through our other competitive grants as well, so that is one part of it.

Then the Beginning Farmers and Ranchers Development Initiative, that brings in literally thousands of new aspirants wanting to get into the food and agricultural enterprise, there is a tie-in that is being provided that allows them to develop the knowledge and skills, the marketplace, the credit, the capital, et cetera, that is definitely needed in the world of organic agriculture.

Senator GILLIBRAND. Thank you, Mr. Chairman.

Chairman ROBERTS. Thank you, Senator. We are awaiting Senator Daines who would like to ask a question, specifically, and I will give him about 30 seconds to show up.

[Laughter.]

Senator GILLIBRAND. I have a question for the record, if I could ask, Dr. Rockey.

Chairman ROBERTS. I would be delighted——

Senator GILLIBRAND. Okay.

Chairman ROBERTS. —to have you ask a question of Dr. Rockey.

Senator GILLIBRAND. It is about the pollinator health fund, and I know the next panel will talk about pollinators as well, but to the extent you could tell us about the fund, some of the partner groups, and what research you expect to see supported by this initiative, I would be grateful, because, obviously, for upstate New York, for the Hudson Valley, our pollinators are essential. We grow a lot of fruits and vegetables. So the colony collapse disorder has created enormous worry and strain amongst our—both beekeeper populations but also our farmers.

So to the extent you could just do a briefing for us on the status, and any authorities, money, research you need added in the farm bill. Thank you.

Chairman ROBERTS. Senator Brown.

[Pause.]

Senator BROWN. I ask consent for another 60 seconds for Senator Gillibrand.

Chairman ROBERTS. You have already used 30 seconds. Let us go.

[Laughter.]

[Pause.]

Chairman ROBERTS. It is that second page.

Senator BROWN. Yes. Thank you, Mr. Chairman. I apologize. I was at two other hearings today and I apologize for not being right now in the moment.

Dr. Ramaswamy, thank you for—all of you on the panel, thank you for your work. Thanks for walking the Committee through the work USDA does on the opioid crisis. In my state, more people die from opioid overdose than any state in the country. We are not the highest per capita; we are among them. But the tragedy particularly hits rural Ohio hard. That is one of the reasons that so many of us are alarmed at efforts in this body to take away insurance from people getting opioid treatment. In my state alone, 200,000 people right now are getting opioid treatment, many of them in rural Ohio, getting opioid treatment right now, and who are getting the treatment because they have insurance through the Affordable Care Act. So thank you for running through that.

I want to talk for a moment about extension agents and how extension agents are so many faces in USDA. I think back on our—I went to the county extension agent in Richland County, Ohio, when my brothers and I were going to plant apple trees on our family farm, and I remember that the extension agents said, "Now when you prune these apple trees, prune them until you think you have killed them and then prune them a little more." We only followed their advice on about half the trees, because we just could not bring ourselves, as novices, to prune them as far back as we should, and those ones we pruned as far back as the AG extension agents told us were the ones that thrived the most. So thank you for the accumulated wisdom of decades of ag extension and what you do.

How do we—700 folks at OSU Extension in Ohio, 700 folks, from helping small dairies to improving water quality to help, in my case, again, an urban gardener in Cleveland, Ohio, grow tomatoes. I did not stay on that family farm. Sorry. I want to ask this. How do we continue to empower these individuals to continue to address the ever-changing challenges inherent in agriculture and to interact with the increasing number of constituents who are interested in how their food is grown, where it comes from, and, in many cases, even growing it themselves? How do we sort of empower ag extension, a group of very committed, very talented men and women?

One more point. John McCracken, in my office, was talking about the mission statement and sort of the history of ag extension, and

it just is—it is so important, and they love their jobs so much and what they contribute to our society. Dr. Ramaswamy?

Mr. RAMASWAMY. Senator Brown, thanks so much, and I appreciate your kind words that you spoke about our extension community, and you are absolutely right. Without extension—this is a model that the rest of the world wants to emulate—our nation—and I truly believe this—would not be globally pre-eminent. Our ability to translate knowledge and deliver that knowledge in the form of innovations and solutions, the hallmark of extension, is truly at the basis of why we have such, affordable food that is safe and nutritious, that the rest of the world wants to emulate as well.

We have seen, over the last about 20 years or so, with the continuing challenges in America with our budgets, at the state level, at the county level, and at the Federal level, our extension footprint, across America, on average, in every state, has been reduced by 30 percent. We have lost a number of those boots on the ground, even in Ohio. What they have done is rather than going and having extension agents in every county they have now had to reduce that and create what we refer to as districts, so that you have agents servicing multiple counties. We see this across America, and that is the challenge that we have got.

All of us need to wake up and really be concerned that this is going to be, putting us in a significantly challenging situation if we are not able to make sure that extension agents are not going to be working together.

So in regards to your question, how do we empower them, we continue to work with the land-grant universities and, obviously, funding is one part of it but we also host stakeholder conversations and make sure that the researchers and the extension folks are all working together. But the challenges that are being felt—and, earlier I said that what NIFA does is inspired by the end users. So the contact with the end users is critically important for the work that needs to be done.

Then the work that is undertaken, the research that is undertaken, that is translated and delivered by our extension folks, transforms people's lives, and that is sort of an empowerment that we have had, historically, and we continue to do so, despite the fact that we are facing these budget challenges and things like that. It really comes from partnering with other agencies, partnering with the non-governmental sector, the Farm Bureau, the various commodity groups and other, and understanding what it is, and being a little bit more effective and smart in delivering that information, and utilizing technology as well, in, really looking at a multi-faceted approach to staying engaged with the end users.

Senator BROWN. Thank you. Mr. Chairman, could I do—could I ask Dr. Jacobs-Young a question that she can respond to?

Chairman ROBERTS. Very quickly.

Senator BROWN. Okay. Thank you.

Chairman ROBERTS. I know we are coming up on vote.

Senator BROWN. Central State University in Wilberforce, Ohio, is the newest 1890 land-grant, even though it has been around for a while, Dr. Jacobs-Young, as you know. If you would just, in writing, respond, because of time, and because Senator Klobuchar just arrived, and Senator Daines has questions. Could you tell us how

ARS works with Central State and other HBCUs to increase capacity at the university, at best utilize its existing strengths? CSU has already started a STEM summer program for middle school students, and if you would give us an answer to that in writing—I apologize for doing it that way.

Ms. JACOBS-YOUNG. Okay.

Senator BROWN. Okay. Thank you so much, Mr. Chairman.

Senator DAINES. Thank you, Mr. Chairman, Ranking Member Stabenow. Thank you for coming before this committee. I want to thank Chairman Roberts for joining me in Montana earlier this month. We had a Montana Ag Summit and it was a home run. I tell you, the people of Montana were very appreciative of you being there, Mr. Chairman.

Chairman ROBERTS. My pleasure.

Senator DAINES. Thank you for coming. I have got to tell you, just before we get into the questions here, there is a picture today, I just got tweeted, that warms my heart. It shows a picture of the Governor of Nebraska with a few great big boxes. They are air-freighting U.S. beef into Shanghai today, and that is really a huge moment. The second-largest beef import market in the world, China, and it is open now to U.S. beef, and that is a real milestone here for agriculture.

Chairman ROBERTS. If the Senator would yield, I would like to pay credit to him for going to China, because of his background and prior serving in this body, I want to thank you for your initiative.

Senator DAINES. Thank you, Mr. Chairman. Well, it was a great team effort and we are glad to see U.S. beef moving into China now.

One theme that stood out in the summit that the Chairman was at in Great Falls, Montana—really, it is in the heart of the Golden Triangle, our wheat country in Montana—was the importance of ag research in ensuring that producers in Montana and the U.S. at large continue to be the most productive and most efficient farmers and ranchers in the world.

Dr. Jacobs-Young, you highlighted, in your testimony, the importance of ARS labs throughout the United States, and I could not agree more. Montana farmers and ranchers value the great work conducted at ARS labs, in Sidney and Miles City, Dubois, Idaho, that provide research essential to our Montana grain-growers, ranchers, wool-growers, producers across the state as well as the nation.

Could you speak about the range and livestock lab, actually, in Miles City, and the Sheep Experiment Station in Dubois, Idaho, that we are currently working on?

Ms. JACOBS-YOUNG. So in Dubois, Idaho, one of the things that we are working on there is sheep production, and one of the beauties and the unique nature of the Dubois location is the opportunity to graze at higher elevations, to be able to study the interface between wildlife and domestic animals.

As you most likely know, for many years we have not been able to graze in those higher elevations because of legal challenges to the interface, and the possibility of impact on grizzly bears and bighorn sheep, and so we have been faced with those lawsuits since 2007. We have had some difficulty completing our mission at

Dubois, Idaho, in terms of the grazing patterns we are trying to research.

In Miles City, Montana, we also look at rangeland management of livestock and beef. We have some very important work that is being conducted there where the goals of the work at both of those locations are critically important, and in some cases we have some challenges being able to conduct that research.

Senator DAINES. Well, thank you, and while all these stations discussed have been targeted by prior administration, they provide invaluable research. I have spent time out in Miles City, spending time with the researchers. It is invaluable research to our farmers and ranchers across a state like Montana.

You know, we are from a pretty arid state.

Ms. JACOBS-YOUNG. Right.

Senator DAINES. We do not get a lot of rain, and it is so important to understand the grasses and so forth and these interfaces you talk about. In fact, the Bighorn Sheep Foundation is now—their headquarters is in my hometown of Bozeman——

Ms. JACOBS-YOUNG. Yeah.

Senator DAINES. —and we are working constructive with the wool-growers, our sheep operations, the folks of the Bighorn Sheep Foundation, to ensure we can have both, and I think we can. We are going to need this research. So we are going to continue to work hard to prevent these closures from occurring, and keep them moving forward.

I want to shift gears and talk about our tribes. Montana is home to 12 federally recognized Indian tribes, 7 Indian reservations, and the state recognizes the Little Shell Tribe. Ag play an essential role in Indian country economies. Montana also has seven tribal colleges, spread throughout the state, in fact, the most of any state in the United States. These colleges play a critical role in disseminating research and best practices to tribal farms and ranchers.

Dr. Ramaswamy, how is USDA working with tribes and tribal colleges to ensure that tribal producers have access to the latest research and are aware of the research-related services made available by the USDA?

Mr. RAMASWAMY. Thank you very much, Senator Daines, and, indeed, the U.S. Department of Agriculture, broadly writ, works very closely with our tribal populations and tribal colleges, and specifically my agency, NIFA, the National Institute of Food and Agriculture works with the 36 institutions we have across America and the 7 in your state as well.

There are a number of projects that we support. We offer funding for research, for education, for extension. There is also what is referred to as the Federally Recognized Tribal Extension Program as well, that partners with our 1862 institutions to bring knowledge to our tribal populations.

We provide funding and the good thing is that very recently several tribal colleges, they partnered together to work on bison, for example—this is part of their heritage—on improving the breeds of bison—breeding of bison. That is a project that we provided funding through our Agriculture and Food Research Initiative. There is another one that is developing varieties of relevance to tribal populations that we have provided funding to as well.

So there are a number of projects that we provide funding, both through our competitive grants programs as well as through the regular capacity funds that we provide.

Senator DAINES. Dr. Ramaswamy, I am out of time now, but thank you. You have answered the question well. I am going to turn it back to the chairman.

Chairman ROBERTS. Thank you. Senator Klobuchar.

Senator KLOBUCHAR. Thank you very much. I am back. I had another hearing and good to see all of you. I know many questions have been asked but I have not asked them, so here we go.

The research is very important in my state, and even with all the advances that you have made, I think you know that it has been estimated that we will need to produce more than twice as much food as we do today to feed 9 billion people in the world. Do you think additional investment will be necessary to meet future demands in the ag sector when it comes to research?

Anyone can take that.

Ms. BARTUSKA. Let me go ahead and start and then pass it over to the administrators. We definitely have produced, from our research, the ability to grow more food on less land, more efficiently, and that has continued to be the driver. We see it as absolutely critical. This figure of 9.7 people in 2050 is just looming in my brain, and every day I think about what we have to do to make our investments the most efficient.

Within our resources available, we are going to continue to focus on that, with laser-like attention, and I think this is where we need to continue to be innovative.

One of the things that I mentioned earlier, is that we know that if we make these investments in agricultural research the benefits are great, and so we need to improve that—continue on that track.

Senator KLOBUCHAR. Thank you.

Ms. BARTUSKA. But there is not enough land to grow the amount of food——

Senator KLOBUCHAR. Right.

Ms. BARTUSKA. —so we have to be creative, and one of the areas that is in the area of——

Senator KLOBUCHAR. I want to ask some specific questions now——

Ms. BARTUSKA. Okay.

Senator KLOBUCHAR. —but I appreciate that. One of the specific things that affects my state, recent outbreaks of avian influenza, the PEDV and other emerging diseases highlight the significant threats facing animal agriculture and the need for more research in this area, one of the reasons I am so concerned about budget cuts proposed by the Administration to USDA.

Dr. Ramaswamy, can you talk about the importance of the National Animal Health Lab Network, and are more resources necessary for that research.

Mr. RAMASWAMY. Senator Klobuchar, thank you so much for that question. Absolutely. We have, across America, several enterprises that protects the biosecurity for our food systems—the National Animal Health Laboratory Network, the National Plant Diagnostic Network, and other efforts of that sort that protect the biosecurity.

Unfortunately, when we look at cybersecurity—this has been on the news lately here, with the Chinese and the Russians hacking us—we are spending about $75 billion to protect our cybersecurity. To protect the biosecurity of our food systems we are spending a sum total of about $38 million in America. I joke, but very seriously, if all of our computers are hacked, we can go back to using paper and pencil. If our food systems are hacked, we are in serious trouble.

Senator KLOBUCHAR. Yes.

Mr. RAMASWAMY. So the National Health Laboratory Network and these other networks we have got are critically important for us to ensure that we are meeting the needs of protecting the biosecurity, and I agree with you that I dare say we are, really, really short in the investments that we are making. These networks that were created post 9/11 are falling apart, and we have to make sure we protect them.

Senator KLOBUCHAR. Okay. Thank you. Dr. Jacobs-Young, researchers at the U of M in my state are increasingly working the area of phenomics, which focuses on measuring the physical and biochemical traits of organisms as they change in response to environmental influences. Can you talk about the value of emerging plant science techniques, like phenomics?

Ms. JACOBS-YOUNG. Absolutely, and back to your original question, I think this one is very relevant.

You know, agriculture is a very high-tech industry. We do not just put the seed in the ground and hope something happens. We have many, many plant breeders, both on the classical—what we call classical breeding side, as well as our advanced technology side, and it is important for us to be able to generate data that enables us to speed up the process.

I would like to just share that, Dr. Edward Buckler from our Cornell location in ARS, received the first prize for food and agriculture from the National Academies of Science, and it is through partnership with the Foundation for Food and Agriculture Research. He received that prize because his work in the genetic evaluation of maize has saved lives. It has helped deal with the vitamin A deficiencies around the world which result in stunting. But, he is only able to do that because we have been generating data for years and years and able to turn that data into solutions. That is why genomics and phenomics and all the other "omics" are extremely important to us as we try to innovate in agriculture.

Senator KLOBUCHAR. Okay. Very good. I appreciate it. On the record I will ask a question about research initiatives to expand the use of ag commodities in non-food markets, so thank you for your work.

Chairman ROBERTS. Thank you. Senator Hoeven.

Senator HOEVEN. Thank you, Mr. Chairman. Thanks to all of our witnesses for being here, and I want to express my very strong support for agricultural research. Growing up in western North Dakota we grew primarily small grains, and now, thanks to the incredible ag research and development that has been done we can grow amazing variety of crops, ranging from corn and soybeans to all the pulse crops, to oilseed crops, as well as all of the small grain crops.

Diversity in agriculture has truly been a real benefit, certainly for farmers, and for our ranchers, but for the American people, because we can grow so much more food and provide that variety, and, as I say, about agriculture every chance I get, our farmers and ranchers provide the highest quality, lowest cost food supply in the history of the world, and ag research is a really big part of it. It is a big, big deal. So we need to support ag research funding in the budget, and I chair Ag Appropriations so I have every intention—we have every intention of doing that, and I know our Ag Committee Chairman and Ranking Member share that sentiment.

I think, as a matter of fact, he even has some pretty good ag research in Kansas, and I know there is some pretty good ag research probably in Michigan too.

Chairman ROBERTS. You do not want to go there, but go ahead. [Laughter.]

Senator HOEVEN. There is a little rivalry between North Dakota State and K–State.

My question is, how do we leverage, private and other public investment with our ag research funds? So what are—because we want to fund ag research but we want to try to leverage those funds.

So from each of you, just talk a little bit how we can do more to leverage private, and other public funding, with the funds that we provide for ag research.

Ms. BARTUSKA. How about if I start and we end with Dr. Rockey, who probably has the home run answer.

Part of it is we really do need to be reaching out to an emerging group of private partners, those that we have not necessarily worked with in the past, and to really understand what their needs are, where they need to be in 5 or 10 years, and be able to build that knowledge into our programs. So for me it is expanding those partnerships by reaching out to new individuals and new organizations.

Senator HOEVEN. Are you actively doing that?

Ms. BARTUSKA. Sorry?

Senator HOEVEN. Are you doing that? I mean, how do we do that——

Ms. BARTUSKA. Well, part of it——

Senator HOEVEN. —in a concerted way.

Ms. BARTUSKA. I would say one way we are doing that is the composition of our National Advisory Board, the NAREEE board, the National Agriculture Research Education Extension Economics Advisory Board, who advised us.

By choosing qualified members and being able to have a nomination process to ensure that we have new and diverse members applying for that board, and then working with them as they are on the board, and then after they leave.

We are really expanding our connections, so that is one example that has been a very productive approach to take. The other is just really reaching out to the business community, to be able to reach out to those who are in agricultural research, those who use the National Ag Statistics data, they are ones who are very interested in how can they continue to grow our databases to be able to make

better assumptions about the crops and the commodities they are dealing with.

So those are two really big areas that are very ripe for more partnerships and more outreach.

Mr. RAMASWAMY. Senator Hoeven, good to see you again, sir.

Senator HOEVEN. Good to see you. Thanks for your good work.

Mr. RAMASWAMY. Well, thank you very much. From NIFA's perspective, we leverage, for every dollar that NIFA invests there is $1.86 that is returned in leverage, and there are several tools that you, Congress, has provided us to be able to do that, this leverage of the public-private leveraging, non-governmental organizations, and others. For example, in the last farm bill we have the commodity board provision, which we match, dollar for dollar, and commodity boards come to us and they say they want us to invest on particular topics, and so NIFA co-invests with them. That is one approach that we have used.

A second approach that we have used, again, thanks to what Congress did in the previous farm bills, particularly with the 2008 Farm Bill, which created NIFA, we created what we refer to as coordinated agricultural projects. These are the huge grants that we have provided. You know, these are like $10, $20, $40 million grants. One of those grants was given to a consortium of institutions that includes a bunch of private sector folks as well, led by Washington State University. They had an airplane fly out of Seattle-Tacoma airport back in November, on November the 14th, with their congressional delegation that came to Reagan National, flying on "woodchips." That project——

Senator HOEVEN. Flying on what?

Mr. RAMASWAMY. Flying on woodchips. The woodchips were converted into——

Senator HOEVEN. You are making that up. I know you are.

[Laughter.]

Mr. RAMASWAMY. Seriously. Get your head wrapped around that image, right? That particular project, for a $40 million investment, has leveraged almost $200 million of additional from the private sector, from the non-governmental sector that have come in and invested resources as well. That includes some of our Native American tribal populations in the Northwest as well.

So those are a couple of examples, and I am going to pass to Dr. Jacobs-Young.

Ms. JACOBS-YOUNG. So just very quickly, I would like to say that at ARS, we deliver a lot of products inside of our laboratories, and then we work with businesses to get them moved out into commercializations, the Apples in the Happy Meals at McDonald's, lactose-free milk, instant potatoes, the potatoes that are used for Pringles. All those things were developed in ARS, but once we discover it and deliver it, we work with the private industry to move it out. Sometimes that includes exclusive license, if that is necessary, but often it is just in the partnerships, and through other mechanisms.

Ms. ROCKEY. Senator, as you know, our foundation was created with that exactly in mind. For every dollar that we spend we leverage another dollar from the private sector. So it is really about finding those in the private sector or commodity groups or other potential partners who share our goals for the research. We often

times use our convening power to bring those individuals and organizations to the table so we can decide collectively which areas of research would be the most important to go through, either first or to place our funding on.

So it is important for our relationship and for our foundation to work to bring together those private-public partnerships.

Senator HOEVEN. You are finding that USDA, ARS, NIFA are all very receptive to that, right——

Ms. ROCKEY. Oh, absolutely.

Senator HOEVEN. —and you are able to work with them and do creative things——

Ms. ROCKEY. We work very, very——

Senator HOEVEN. —leverage resources.

Ms. ROCKEY. We work very, very closely with USDA. They are our closest partners. Not only that we complement their work but we have, for example, ARS scientists intimately involved in many of our projects. We work closely with NIFA through the AFRI program to see where our research programs can come in and fill gaps or white spaces that the AFRI programs may not be covering. We have great relationships with the USDA.

Senator HOEVEN. Good stuff. Thank you all.

Chairman ROBERTS. Dr. Ramaswamy, as you know there is a facility now being under construction at Kansas State called NBAF. It comes as a result of the danger of agro-terrorism. Some time back, in a city called Obolensk, which is not too far from Moscow, that is one of the secret cities during the time that Russia was much more open than it is today, there were large amounts of pathogens. I would imagine that it is still there. I hope it is still there, but under Mr. Putin it is a whole different matter. The intelligence community would let you know that it is in the top 10, top 5 things they worry about, is an attack on our food supply.

I would like to visit with you about that, and also anybody else that wants to chip in, but we are now in a voting process on the first of three votes. Senator Stabenow will return and then we will switch back and forth.

I want to thank all of you for taking time out of your valuable schedule to come. Usually when we have a hearing like this, I get to come up, shake your hand, thank you, visit with you a little bit more, but we have some time constraints. So thank you so much, and I would like to welcome our second panel of witnesses to come before the Committee.

Mr. RAMASWAMY. Thank you very much, Chairman Roberts.

Ms. JACOBS-YOUNG. Thank you.

Ms. ROCKEY. Thank you, sir.

[Pause.]

Chairman ROBERTS. We will proceed with the next panel.

First I would like to introduce Dr. Floros, Dr. John Floros, of Kansas State University. He has been the Dean of the College of Agriculture and Director of K–State Research and Extension since August of 2012, and under his leadership K–State established the Center on Wheat Genomics and successfully competed to host four Feed the Future labs on wheat, sorghum, and millet, and post-harvest loss reduction and sustainable intensification of agriculture. He was recently recognized by the Food and Drug Administration

for his distinguished service to the people of the United States, as a member of the Science Board to the FDA. Welcome. I look forward to your testimony. Doctor, it is good to see you again.

Mr. Gary McMurray, Senator Perdue is on his way to introduce you, and so we will wait until the distinguished Senator arrives.

Then we have Dr. Kerry Hartman. Doctor, I am going to give this a good go. This is a welcome that Senator Heitkamp wanted to proceed, and that Senator Stabenow then said she would read, and now she has given it to me while she is voting. So stay with me here.

I want to give a warm welcome to Dr. Kerry Hartman, Academic Dean and Sciences Chair at Nueta Hidatsa Sahnish—and the parens here on how to really do that is to say Nueta Hidatsa Sahnish College. I struggled through that. I apologize, sir.

Dr. Hartman has spent the past 25 years conducting agriculture research and teaching on the Fort Berthold Indian Reservation in North Dakota. His research has focused on land, water, the environment, and native plants and wildlife that are central to the lives of the Mandan, Arikara, and Hidatsa people.

I think that I am looking for a second page and obviously we do not need that with that introduction.

Senator Perdue.

Senator PERDUE. Thank you, Mr. Chairman, it is my honor this morning—good to see you——

Chairman ROBERTS. Thank you.

Senator PERDUE. —it is my honor to introduce Gary McMurray this morning, a fellow Georgia Tech guy, and I am pleased to introduce him as a graduate. He received his bachelor's and master's degree in mechanical engineering from Georgia Tech and is now a Principal Research Engineer and Division Chief at the Georgia Tech Research Institute's Food Processing Technology Division. He has been with the institute for over 25 years. He is also the Associate Director for Collaborative Robotics at the Institute of Robotics and Intelligent Machines at Georgia Tech.

Being from a non-land-grant college, Mr. McMurray's perspective on ag research is especially important to spur innovation beyond traditional methods of food production. Mr. McMurray's research has focused on the development of robotic technologies and solutions for the manufacturing and agribusiness communities. His focus on research that brings experts from non-agricultural fields together with ag scientists is crucial to defining new technologies that can benefit farms and ultimately the consumers they feed.

For the previous four years, Mr. McMurray led a strategic initiative on the future of agricultural sensing that involved a multidisciplinary team of engineers, computer scientists from Georgia Tech, and plant pathologists and agricultural engineers from the University of Georgia.

He is currently leading a National Robotics Initiative project in conjunction with partners from the University of Georgia, that is funded by the USDA, to develop an automated system to identify plants that are potentially suffering from soil, nutrient, and water deficiency problems.

Thank you, Gary, for being here today. We appreciate and look forward to your testimony.

Thank you, Mr. Chairman.

Chairman ROBERTS. Thank you, Senator Perdue. It is my privilege to introduce Mr. Steve Wellman from Syracuse, Nebraska, where he and his family grow soybeans, corn, winter wheat, and alfalfa, as well as manage a cow-calf herd on their fourth-generation family farm. Mr. Wellman has served in a variety of capacities through his agriculture career, as President of the American Soybean Association, an inaugural board member of the Supporters of Agriculture Research, and on the USDA/USTR Agricultural Technical Advisory Committee for Grains, Feeds, Oilseeds, and Planting Seeds.

We thank you all for coming.

We will start with Dr. Floros.

STATEMENT OF JOHN FLOROS, PH.D., DEAN AND DIRECTOR, COLLEGE OF AGRICULTURE AND K–STATE RESEARCH AND EXTENSION, KANSAS STATE UNIVERSITY, MANHATTAN, KANSAS

Mr. FLOROS. Senator Roberts, thank you, sir, for inviting me and good to see you again.

Chairman ROBERTS. Thank you. EMAW.

Mr. FLOROS. There you go.

Chairman ROBERTS. That stands for" Every Man A Wildcat". I want to explain that to the others.

[Laughter.]

Mr. FLOROS. Sir, I would like to start by apologizing for my appearance here. It took me more than 20 hours to fly here from Manhattan, and my bag did not make it, so my apologies for looking a little——

Chairman ROBERTS. I think your attire is splendid, sir. Please proceed.

[Laughter.]

Mr. FLOROS. What I would like to do today is talk a little bit about the land-grant system and its importance to our research, agriculture research, and then very briefly talk a little bit about agricultural and food research and several components of its importance, the impact, and the long-lasting value of such research, so that you and your Committee can actually continue to support the research and our efforts.

Finally, I want to talk a little bit about infrastructure, as well as workforce issues, and I am going to start by briefly saying how important the land-grant system has been, over 150 years now, for this country, and the well-being of the American citizens, particularly because we have the teaching, research, and extension components as part of that. I would like to stress that food security and political security are connected, and both of those are directly connected to food and agriculture innovation, and it is driven by agriculture and food research.

In terms of ag research, what I would like to point out is that most of the investment that comes through USDA, the land-grant system, it is actually matched 1-to-1, in some cases 7 or 8-to-1, by other investments, from state governments, local governments, and other sources as well. So we will appreciate continuing that invest-

ment because not only it is supplemented by other sources but also because its impact has been long-lasting.

You heard earlier from USDA that the return is about 20-to-1, and I am sorry that the Chairman is not here, but that return in the state of Kansas is actually 33.6-to-1. So the return of agricultural research is very, very high, and you will be pressed to find anything higher than that. I also would like to say that AFRI should be really brought up to its appropriations of $700 million, because we have a lot of challenges coming up, as you all know.

One of the points I wanted to stress has to do with food science and technology-related research. We put some emphasis on agriculture but we are not putting as much emphasis on food science and food processing and manufacturing. Food manufacturing per se, it is almost 15 percent of American manufacturing, and we are not really emphasizing much of that in our portfolio of investments. It used to be that half of every dollar goes to the farmer from the consumer, but today only probably one out of seven dollars goes to the farmer from the consumer. The rest, $6, are actually added value, and that is what we need to capture. We have divested from this area, and as a result, I think the American manufacturing segment of food and agriculture has suffered, and innovation is now coming from elsewhere in the world because of that.

I also would like to say a few words about international research in food and agriculture. USAID invests a lot of money in that. We do a lot of work in that. Much of what we do benefits other countries out there in the world, but most of the information we generate comes back to the U.S., to help our own farmers, our own ranchers, our own industry, to improve and get better.

A couple of things about infrastructure. There was a study that has been done very recently. Throughout the country, food and agricultural research infrastructure is suffering from really negligence in terms of our buildings and their maintenance. There was a study that shows that about $8.4 billion are needed to just bring the infrastructure to today. Just at K–State alone, we just did a study and it shows $550 million worth of needs right now to our own infrastructure.

Finally, I want to put a couple of comments about capacity funding and you all know what that is, and USDA talked a little bit about that. Just in the last 50 or so years, the improvement of the U.S. agriculture has been about 2.5 times, when you look at productivity, compared to where we were 50 years ago. Capacity funding had a lot to do with that. Everybody talks about the green revolution. We are going to have to actually have a second green revolution if we are to meet the needs of a growing world. It is not just the growth in population. It is also the growth in middle class. It is the diversity of the population. The food system, the global food system, needs to respond to all of those, and for that I think we need to continue to invest in capacity funding as well as NIFA and AFRI.

The final point I wanted to make is training the next generation, and it is critical that we find ways to train more people in agriculture and in food. A USDA study shows that we only provide maybe a little more than half of the workforce that we need today, and we will need more tomorrow.

So with that, I have overstated my time. I would like to assure the Committee that every dollar we invest in food and agricultural research, it will be worthwhile spent and we will see very long-term return and huge impact because of that.

Thank you so much for giving me the opportunity.

[The prepared statement of Mr. Floros can be found on page 61 in the appendix.]

Senator STABENOW. [Presiding.] Thank you, Dr. Floros, and let me just indicate that we are in the midst of three votes and Chairman Roberts and I are playing tag-team back and forth, and we apologize that members are being pulled in a number of directions.

Dr. Floros, I want to just underscore what you said about food manufacturing, as a state that does a lot of food manufacturing, how important that is.

Mr. McMurray.

STATEMENT OF GARY MCMURRAY, DIVISION CHIEF, FOOD PROCESSING TECHNOLOGY DIVISION, GEORGIA TECH RESEARCH INSTITUTE, ATLANTA, GEORGIA

Mr. MCMURRAY. Thank you very much, Chairman Roberts, Ranking Committee Member Stabenow, and other Committee members. It is really an honor to be here today and to represent Georgia Tech, which is a non-land-grant institution, and the work that we are doing in agriculture. I, myself, am honored to lead a team of 28 research faculty members, 14 academic faculty members, and over 40 students, working in the area of agribusiness and food manufacturing. So we have over 45 years' experience working in this through a state-funded program called the Agricultural Technology Research Program. So we have a lot of experience in this area, working in sensors, robotics, and sustainability.

Georgia Tech is one of the leading engineering schools within the nation. It has outstanding reputation from NSF, DARPA, DoD, and Department of Energy. One of the things we are trying to do is leverage that expertise, which is funded from other government agencies, bring that to the world of agriculture.

But one of the things which is very critical to us is that we are very much involved in the multidisciplinary approach. All of our projects have partners—at University of Georgia, University of Florida, and other land-grant institutes—because we really recognize the synergy that comes about when you bring the engineers together with the scientists. They really come up with groundbreaking and new ideas, and this is something that we really want to see continue.

I would like to talk about several projects that we are focused on. We are mainly focused on yield improvements, because that is a critical issue to feeding the global population. We have two projects right now we are focused on: presymptomatic disease detection and field scouting for abiotic stress. These issues are very important for a number of different reasons. Currently we still lose over 12 percent of our crops to disease and approximately 16 percent of our crops to pests. So addressing these issues will go a long way to addressing some of the issues, which are of major concern.

We do this through a couple of different areas. We focus on novel sensors as well as robotic systems. In the novel sensors, we have

been working on a micro gas chromatograph, which takes a traditional gas chromatograph, which works in a laboratory environment, we have reduced it down to something the size of a 9-volt battery size, which can now be field deployed and can actually, in real time, take air samples and process that.

Why is that important? Because plants emit volatile organic compounds, and those compounds will give you tremendous insight into the health of the plant. Not only can we recognize stress in plants but can actually target and actually identify specific pathogens and diseases that are attacking the plants. That is very important.

We are also looking at root sensors to be able to actually look at the root mass, and this has tremendous value in agriculture. This, actually, this type of multidisciplinary work is something that we feel would really be better served through the creation of something we call ARPA AG. These types of programs have been very successful in a number of government agencies, and it is the opportunity to do high-risk, high-reward, but really bring the scientists and the engineers together to work on critical issues in agriculture.

So, in conclusion, the land-grant institutes are very interested in working in agriculture, because it is a major problem that we face in the world. We think that we can bring expertise, from NSF, DoD, and other agencies, to bear on this problem in a very unique way, and this is something that we at Georgia Tech are very excited about and really look forward to contributing as the process goes.

So I thank you very much for the opportunity to be here, and I look forward to answering your questions.

[The prepared statement of Mr. McMurray can be found on page 81 in the appendix.]

Senator STABENOW. Thank you very much. Dr. Hartman, welcome.

STATEMENT OF KERRY HARTMAN, PH.D., ACADEMIC DEAN AND SCIENCES CHAIR, ENVIRONMENTAL SCIENCES, NUETA HIDATSA SAHNISH COLLEGE, NEW TOWN, NORTH DAKOTA

Mr. HARTMAN. Thank you very much, Ranking Member Stabenow, and I wish Chairman Roberts was here. I would like EMAW to him also. My daughter graduated from our college and is now attending vet school at Kansas State.

On behalf of the nation's 34 tribal college land-grant institutions known as the 1994s, thank you very much for this opportunity to talk about our place-based research. Indian country includes some of the most isolated and economically challenged regions in the United States, but our lands are rich in natural resources and our people are among the most resilient in the world. Within this context, tribal colleges are working to strengthen our tribal community economies, to revitalize our cultures and languages, and to protect, restore, and sustainably use our lands, waters, and traditional foods.

Since 2001, my undergraduate students and I have been conducting culturally and economically relevant research under the USDA/TCU programs. The goal of my current NIFA research project, conducted with tribal game and fish biologists and South Dakota State University, Mr. Thune, Senator Thune, is to figure

out how to develop and maintain an environment that will support the native pollinators of Amelanchier cultivars, or juneberries, as well as other native fruits. Juneberries are an ancient plant. There are high levels of protein, calcium, antioxidants, sustained generations of native people throughout the northern plains and woodlands, until native pollinators and juneberry stands fell victim to Western expansion.

Ranking Member Stabenow, a juneberry is very, very, very similar to a blueberry. If they were sitting here together, you cannot tell them apart. Down the road I hope to do research on the genetics. I do not know whether it was convergent evolution or divergent evolution or just the luck of the draw, but these two berries are very, very similar.

Back to my written statement now.

If we can restore the juneberry native habit we can sustainably cultivate crops for local use and small farm commercial production, helping to grow our reservation's economy and improve the health standards of our people.

We are also helping to restore the identity and cultural pride of the Mandan, Hidatsa, and Arikara people. This project would not happen without USDA support for our specialty crop research. The need for research into emerging technologies for small farmers, invasive species management, sustainable growth, and security, is essential in Indian country, as the juneberry research attests to.

As you work to reauthorize the farm bill, I have three quick recommendations. We need to acknowledge the value of undergraduate place-based research and education. The Farm Bill's research provisions should specifically acknowledge that diversity matters. Students and faculty at 1994s and the minorities and the small institutions can enhance the call to competency and research capacity of the next generation of agricultural scientists and practitioners. This is extremely important in expanding our U.S. workforce as well as the global economy.

Second would be to resist efforts to consolidate Federal STEM research programs. We will lose research opportunities under the President's budget proposal to consolidate Federal STEM programs. History demonstrates it is small and poor institutions, like all of the 1994s, cannot compete against Research I and the large land-grant institutions.

Thirdly, to establish McIntire Stennis eligibility for the 1994s. This is a matter of equity. In 2008, the McIntire Stennis Act was amended to include tribal lands and a formula for state forestry programs but tribal land-grant institutions were excluded. Please amend the McIntire Stennis formula to include 1994s with the forestry programs.

Mr. Chairman and Ranking Member, the modest Federal investment in the 1994 institutions has already paid great interest in terms of increased employment, access to higher education, and research opportunities and economic development. Continuation and growth in this investment makes sound moral and fiscal sense.

Thank you.

[The prepared statement of Mr. Hartman can be found on page 68 in the appendix.]

Senator STABENOW. Thank you so much for your testimony. Mr. Wellman, welcome.

STATEMENT OF STEVE WELLMAN, FARMER, WELLMAN FARMS, SYRACUSE, NEBRASKA

Mr. WELLMAN. Yeah. Thank you, Ranking Member Stabenow, and also I appreciate the invitation from Chairman Roberts and you and the rest of the Committee to appear here today, to really discuss the science and innovation which is the very essence of farming. My perspective is, as a third-generation farmer, farming the same fields that my father and grandfather did, plus a few more.

We need three things to get American agriculture growing: sun, rain, and research. There is not much I can do about the first two, but when it comes to research, I can lend my name, my time, and my voice, to policymakers, encouraging you to renew American leadership in agricultural science.

Sufficient Federal investment and wise policies are essential if the United States is to continue to be a global leader in agriculture. As SoAR founder, Bill Danforth, has remarked, "Food is too important to the human race to be a research afterthought. It needs to be a high priority for the nation's entire scientific community," and I would add, for the entire nation.

Traditionally, we have thought of agriculture science in terms of improving yields, preventing soil erosion, and adapting crops to a variety of growing conditions. Today, agriculture stands to realize significant gains through interdisciplinary research across numerous scientific fields, including data science, nanotechnology, biotechnology, and genomics. To capitalize on these relatively modern fields of science we need to ensure we have a modern Federal research enterprise, and that is why I am urging you to give the entire USDA research, education, and economics mission area your full attention.

Public agriculture research spending peaked in 1994, and has since declined 20 percent. The 2008 Farm Bill authorized AFRI at $700 million annually, yet funding has reached only the halfway point of that level. As a percentage of total Federal research investment, USDA has fallen to less than 3 percent of the annual Federal investment. Put another way, research funding for other Federal agencies is nearly $60 billion. Research funding at the USDA research mission area tops out at just over $2 billion, an amount that has remained virtually unchanged for decades.

On our non-irrigated farm, conservation of natural resources is a constant focus. Farming practices such as contour terraces, no till, drought and insect-tolerant seeds and cover crops are all implemented. Field scripts prescribing varieties to plant managing nutrients to maximize yield while controlling inputs, are also used. Thanks to modern science, these are all effective and productive practices. Will they be in the future, and will new research demonstrate ways to improve?

What we do today is based on years of research and learning. Where will the knowledge to improve U.S. production practices come from in the future without public research leading the way?

American agriculture is a marvel of the world but that does not mean the world is standing by. As you mentioned earlier, China has increased their investment at a double-digit pace and are actually outspending the United States on ag R&D at this point. Funding rates in the European Union has increased and their grant proposals are nearly a 40 percent success rate. In the U.S., AFRI grant applications are between 10 and 15 percent, and only around 25 percent of the projects they rate highly receive support.

For fiscal year 2015, the most recent research AFRI analysis shows a total of 2,694 competitive grant applications, requesting just under $1.8 billion. They were received and reviewed through the competitive peer review process. An additional 884 proposal were recommended for funding by review panels and could have been supported provided an additional $690 million was available for the program. A modernized system, supported with additional investment, is the plea I make to you today.

In closing, I leave you with a question. How certain are we that we can provide food security for 10 billion people by the middle of the century? The U.S. has been the world leader in agricultural production and innovation for decades. This is a role the U.S. needs to retain. I believe it will not happen without a strong commitment to public research, from Congress and our Administration.

Thank you.

[The prepared statement of Mr. Wellman can be found on page 105 in the appendix.]

Senator STABENOW. Well, thank you very much to each of you, and I could not agree more, Mr. Wellman, about the importance of agricultural research and what this means to the future of the country, and to farmers, and to all of us.

Mr. Hartman—Dr. Hartman, I wanted to ask you first if you might just expand a bit on the important benefits of partnerships with the tribal communities and other land-grant universities and so on. I know we, in Michigan, have some terrific examples of that with Michigan State University and our tribal colleges. But these have been very important partnership and I wondered if you might expand a bit on that.

Mr. HARTMAN. Thank you for that question very much. They enable us—partnerships with other land-grant institutions under the NIFA 1994 program, partnerships are required with land-grant institutions and state institutions or agricultural research stations. These partnerships assist us in carrying out the grant's primary emphasis, which is on training students in sciences.

Through the collaborations and cooperative projects, I personally have grown significantly in my education philosophy, research capabilities, professional contacts, and, most importantly, in terms of educational research. Scientists, researchers, professors, career professionals from multiple institutions are now readily available to me. I have contacts at NDSU. I graduated. My PhD was from South Dakota State University. I have done my pollinator research and most of my cultivator research was with South Dakota State and North Dakota State.

Our initial—well, I think one of the first NIFA land-grant collaborative was a huge one, with Iowa State. There was four—forgive me—I think they are the 1864s, the original land-grants, the

ones that were started under the Morrill Act. There was four Morrill Act and four tribal colleges—North Dakota, South Dakota, Nebraska Community College, and Sinte Gleska. That grant was a huge grant and we still have connections. I was able to achieve my PhD through a collaboration of that grant. We did lots of partnerships. We like to say that we help educate the 1884s also, to extend their understanding of the tribal communities, and to bring their scientific expertise out to our communities, and to take some of our students over there.

As I mentioned, here is—the Chairman is back. As I mentioned, my daughter graduated from our tribal college and she is now attending veterinary college at Kansas State University. EMAW there, sir. We have lots of students that have transferred to the institutions after these collaborations were begun.

So I hope I addressed your question. They offer us research capabilities and scientific—laboratories that we, of course, are not capable of maintaining, and research expertise, also, from their professors. We like to say we offer them a very different ecosystem also. For instance, North Dakota State is in the Red River Valley, and we are on high, arid, western North Dakota, so we have very, very different ecosystem climate characteristics, et cetera.

Chairman ROBERTS. [Presiding.] I apologize to this panel. You are caught in those merry-go-round moments that we have on occasion, where we have had three votes, and the distinguished Ranking Member was helpful to—she is voting. I just voted. We have another vote, so time is of the essence, and I apologize because we have, or I have quite a few questions for you, as would every member of this Committee.

Dr. Floros, you mentioned that the price and availability of food directly impacts the political stability of our country. But we are currently experiencing low commodity prices. Food insecurity around the world certainly remains of serious concern, especially South Sudan, Yemen, Somalia, Northern Nigeria. How can we better leverage USDA domestic and international research efforts to help support the goal of producing enough food supply for the incredible 10 billion people that we may experience in the next several decades?

Mr. FLOROS. Chairman, thank you. That is a great question. Not necessarily an easy answer, but definitely we need to invest more in looking at the system that helps our farmers and our ranchers plan better, and plan ahead, versus from year to year.

There is no question that what happens in one part of the country affects what happens all around the world, but our system is not quite designed to figure that out ahead of time. So I think we need to be able to project forward a little better than we are today.

The other thing that I think we need to work on is developing a system that is much more robust, in terms of the varieties that we use, in terms of the genetics we use for animal production, in terms of how much we lose from the farm to the table, to reduce food waste. All of that will impact not only prices but also the availability of food and the final prices of the food around the world.

Today, in this country, we have the least expensive food supply in our history, and in the world, for that matter. That is a result

of investing heavily in food and agricultural research, and I think if we continue to do that, it will help both our farmers and our ranchers in the long term, as well as our citizens.

Chairman ROBERTS. Thank you. Mr. McMurray, as the representative of the non-land-grant institution on our witness panel, you bring a unique perspective. Your testimony mentioned that overhead issues matching requirements from the USDA may present engineering universities like Georgia Tech from participating in agriculture research. Do not let Sonny Perdue know that.

In spite of the tough budgetary environments that many states are facing, are non-land-grant institutions or other significant food and agricultural programs still able to find a way to effectively leverage resources to match Federal grant dollars and do more with less? If you can, please explain how the overhead issue is negatively impacting the ability of Georgia Tech to utilize the USDA grant programs.

Mr. MCMURRAY. Thank you, Chairman, for the question. It is an excellent question, and I think it is one that is complex in some sense. We do see engineering as a critical component to agriculture, and we do want to play a role in this area. But when it comes to things with cost-matching and overhead rates, it becomes very difficult for us. My organization, at GTRI, we do not receive discretionary funding from the state, that we could use as leverage for cost-sharing or the cost match.

So it becomes a serious impediment for many of the non-land-grant institutes to participate in programs from USDA. I think that is unfortunate because I think there is much to be offered from these institutions. Many of these institutions have played major roles in some of the innovations in many of the industries throughout the United States, and they want to contribute in ag, but so far these issues have limited their ability to participate.

Chairman ROBERTS. I appreciate that. Mr. Wellman, you mentioned research advances including drought-tolerant plant varieties and plant input management to help you reduce costs and maximize yields. Research on conservation practices like contour terraces, no-till farming, cover crops have some support but they have yet to be broadly adopted.

Beyond seed technology and precise fertilizer application, what research opportunities in agriculture would most directly impact our producers on the ground?

Mr. WELLMAN. Chairman Roberts, I just want to say to you thank you for the invitation to appear here today. To your question, agriculture is so diverse across the United States, and there really is a variety of needs for, depending upon what area the farmer is and the crops they want to produce, or that are needed to be produced.

Maybe that is the question, the overarching question. Are we producing the right products? Are we producing the products that the world will need in the future, that was mentioned earlier, looking ahead as to what is needed. How do we transition? If that is the case, if there are other products that maybe are more nutritional in a smaller quantity, how do we transition from where we are now to something like that in the future?

What we have recognized, up to this point, is from the technology side of it, with the biotechnology and then also the equipment that we use today, and the advancements that we have seen there. It is just amazing the progress that we have made, and the ability to produce more with less labor, which is another—I think, a future problem for us, as we move forward, is where is the labor force going to come from?

The long-term aspect, the long-term view of where research money needs to be spent to really get a response that is beneficial to the farmer, the person that is going to use it and be implementing this research, and then, in turn, beneficial to the consumer.

Chairman ROBERTS. Thank you, sir. Senator Hoeven.

Senator HOEVEN. Thank you, Mr. Chairman. Thank you to our witnesses. Dr. Hartman, it is great to have you here, representing Nueta Hidatsa Sahnish College in New Town, North Dakota, and the American Indian Higher Education Consortium.

NIFA administers four programs for 1994 institutions, an ag equity program, a research program. The 1994 institutions often serve as the primary institutions of scientific inquiry, knowledge, and learning for tribal communities. The two other programs that I should mention, the competitive extension program and also research programs. So four different programs.

In your testimony, you state all of these grant programs are critically important, to your college and the other 1994 institutions. I guess my question would be, can you tell us a little bit more about the impacts that these programs and funding have on students, the colleges, and the communities?

Mr. HARTMAN. Good to see you, Senator. I do not need this but I will use it anyway. Thank you for the question, sir.

I will have to qualify my answer just a little bit. I am primarily involved with the research grants, the Tribal College Research Grants Programs, and I can talk about them for hours. I will address the extension. We are the extension agent on the reservation. So the previous panel was addressing the importance of extension, and at our land-grant institution, and many of the tribal colleges, we have an agriculture department, and our ag department administers the extension and the equity, and the one other grant, cooperative or collaborative. I do not remember what the other grant is, sir. My knowledge of them is somewhat limited.

I know extension, we do a lot of activity with the Boys and Girls Clubs. We do Young Farmers program. We have—previously we had emphasis on young farmers, where we introduced everybody from grades—I think it was 4 through 6, up through 12. They were eligible for sheep and hogs program that we ran. We have a gardening program that we run, between those. Of course we do education. We have our small farmers and ranchers program that provides workshops and trainings.

We work close—I should not say "we"—they work closely with the tribe in administering some of the tribal activities and assisting with the bison project. Again, the tribal gardening and reinforcing the gardening, the elders' foods program. Just to briefly address those that I am least familiar with.

The Tribal College Research Grants, we have been doing those since 2002, and we basically have three, I guess, three chair legs that we like to stress in our research. The first one, of course, is the educational component of implementing research in our undergraduate experience. We have a bachelor's degree in environmental science and our students plan—they choose, they plan, with my help and from the 1860s also, of course, we have a design component where we design our research projects. We conduct our own research. We have done everything from aquaculture, invasive species. We did a research project on leafy spurge, when leafy spurge was such a major issue out in western North Dakota. My juneberry research has been focused on small fruits and small crops. We have got the best cultivars we are trying to select out.

But all throughout that we try to implement the concept of doing quality scientific research to our students, and validating the results, and repetition trials, et cetera.

We also like to strengthen and reinforce the culture. Of course, the tribal culture is important, and that is one of the missions of all tribal colleges is to help perpetuate the cultures. Juneberries, for instance, they were harvested for centuries, and we have got elders in telling stories. We talk about the traditional use of the juneberry. Our nutritional research was conducted with South Dakota State University. So our students learned how to do nutritional analysis, in our lab and in the lab at South Dakota State, and, of course, we stress that with community members, in collaboration back with our extension people, of the results. Juneberries are extremely nutritious in antioxidants.

Right now we—my current research is involving pollinators, and that would be native pollinators, primarily, and we are trying to understand the interactions with the environment, of course, and with the berries, and maximizing the pollinator habitat, and maximizing the pollinator food plots. That will hopefully improve not only the juneberry quality and quantity but also the plums and the chokecherries and the buffaloberries and the crabapples that are all there.

But throughout all the processes, we like to stress introducing research to our undergraduates, as well as reinforcing the culture and the educational opportunities.

Senator HOEVEN. Well, again, I want to thank you for your outstanding work there for many years, in making a real difference, and then, I had asked the earlier panel, but anything we can do to help leverage funding from other sources to join with the NIFA money that you receive, we want to try and help do that.

Mr. HARTMAN. Thank you, sir.

Senator HOEVEN. Thank you. Thanks for being here today, too, to all the witnesses.

Thank you, Mr. Chairman.

Chairman ROBERTS. Thank you, Senator. Dr. Floros, you mentioned that for every $7 spent on food, about $1 goes to the primary agricultural production, with the remaining $6 spent on handling, processing, packaging, transportation, and distribution. Then, in the meantime, it is estimated that we waste 30 to 40 percent of the food produced in the United States.

My question is, which research authorities might be most useful in considering efforts to reduce waste along the entire food supply chain, and subsequently, help cut costs related to food production?

Mr. FLOROS. Senator, thank you for the question. The answer is not easy and it is not simple. I think there are a lot of things we need to do. We need to start by some of the comments that were heard earlier. We need to probably redesign our food system so that we are actually producing what it is that we need to produce, rather than producing what we are producing and push it down the chain.

I think we need to really understand better what are the needs of the consumer, what are the global needs of the food system, so that we can come back and really redesign the whole thing. If we did that, I think prices will be a lot better off for our farmers and our ranchers.

A quick example about sorghum, which is so important in Kansas. If we were to figure out ways to create products that consumers want, that are sorghum-based, I think we will be doing a big favor to our farmers back home. Similar things we can do across the board, throughout the food system.

The other part that has to do with waste is how do we really take the raw material, how we handle the raw material, how it gets to the consumer, because in this country, most of that loss happens at the very end of that chain. It happens at restaurants. It happens at grocery stores. It happens at consumers' houses. A lot of it has to do with how we label the food. A lot of it has to do with policies that we have in place. But it also has to do with the technology and the science we have behind that very complex system, which we have not really paid much attention to in recent decades.

So I would say that there are a lot of things that we need to do to reduce waste in this country, and to really stabilize the system, make it more robust, so that the producer wins, the manufacturer wins, the citizen, the consumer wins, as well.

To look at a little broader aspects, however, most of the loss that happens worldwide, it actually happens between the farm and the plate, not at the very end, like it happens in this country and in developed countries. So the developing world still needs help with really figuring out how to protect the food supply very early on in that chain.

If we did that, I think we will also gain because of that, we being the American farmer and the American consumer as well, because it is a global system.

There are also other things that I believe will contribute to the complexity of the system, and that has to do with diseases for plants, diseases for animals, and the safety and security of our food supply globally, that if we were to really do a better job of designing the system, we will actually do a better job of having a safer, more secure food supply overall.

Chairman ROBERTS. I appreciate that very much. I am reminded of the—one of the first calls I got from the Secretary, Secretary Perdue, was to be with him at Leesburg. We were trying to get at the problem of wasting one-third of the food that is served in our school lunch program, and the angst that we have on the regu-

latory side with school nutritionists. The decision was made by the Secretary to issue proclamations. Quite frankly, I did not know that he could do it to that extent, but I am happy to learn that. I have a whole list of proclamations that I wish he would issue.

But there were three, and it was to provide one percent milk to mix with chocolate and/or strawberry so the kids would actually drink it, or would want to drink it, and then there was the whole grains issue, and then there was the salt issue. I just talked to a nutritionist, I think it was yesterday. I asked her, "Did this make a difference?" She said, "Oh, yes, especially keeping that salt situation right where it is."

So there are things that you can try to mandate, from the United States Government, that simply do not work given the circumstances, and still have something that is certainly nutritious.

I have been advised that the third vote just started, and so, let us see if I can get to the conclusion here.

I am sorry for the disruption we have had, and virtually every member of this Committee has been running back and forth between their other committee assignments and voting.

So this will conclude our hearing today. As we heard during this Committee's recent hearing addressing the state of the agriculture economy there are macroeconomic forces that have created these current difficult times for American farmers and ranchers. Research is an integral tool that can help combat these larger trends. Research that results in better efficiencies and productivity becomes a significant risk management tool against weather, pests, and disease.

Thank you to each of our witnesses on both panels for taking the time to share your view on agricultural research. The testimonies provided today are valuable for the Committee to hear first-hand and also be on the record. For those in the audience who want to provide additional thoughts on the farm bill, we have set up an e-mail address on the Senate Ag Committee's website, to collect your input. Please go to ag.senate.gov and click on the farm bill Hearing box on the left-hand side of the screen. That link will be open for five business days following today's hearing.

To my fellow members, I would ask any additional questions you may have for the record be submitted to the Committee Clerk five business days from today, or by 5:00 p.m. next Thursday, June 22nd.

With that, the Committee stands adjourned.

[Whereupon, at 12:03 p.m., the committee was adjourned.]

APPENDIX

JUNE 15, 2017

Statement by Senator Thad Cochran
Senate Committee on Agriculture, Nutrition, and Forestry
Agriculture Research Hearing
Thursday, June 15, 2017

Mr. Chairman, thank you for convening this hearing to review the research programs administered by the U.S. Department of Agriculture. As this Committee prepares to write the 2018 Farm Bill, it is important to identify the research programs that are working well and those that need improvement.

Agricultural research has a significant impact on our nation's economy and the world. American farmers and ranchers play the leading role in feeding and clothing the world. The United States would be hard pressed to fulfill this mission without significant investment in agricultural research.

I am pleased that this Committee continues to support the expansion of academic knowledge about agriculture in order to help our farmers be more efficient and effective.

The Land Grant System is an important resource for promoting research. Formula grants distributed by the Department of Agriculture provide a stable source of funding for universities to conduct innovative agricultural, forestry, and extension activities which encourage U.S. food and fiber production.

I also commend the USDA Agricultural Research Service for working with universities to increase research productivity. There is no better example of this than in my state. Agriculture production in Mississippi contributes roughly $8 billion annually to the state economy. Much of this success can be tied to recent and ongoing advances in agricultural research.

Finally, I am pleased that the Committee established the Foundation for Food and Agriculture Research in the 2014 Farm Bill. This innovative model is enabling the best and brightest scientists to focus on research to enhance the economic and environmental resilience of our food supply.

Statement by
Dr. Ann Bartuska

Acting USDA Chief Scientist and Under Secretary for
Research, Education, and Economics
June 15, 2017

Chairman Roberts, Ranking Member Stabenow, and distinguished members of the Senate Agriculture, Nutrition, and Forestry Committee, I am pleased to appear before you to provide an overview of the activities of the Research, Education, and Economics (REE) mission area of the United States Department of Agriculture (USDA), highlight some of our recent successes, and share information on the priorities and challenges facing the future of agricultural research.

I am Dr. Ann Bartuska, the Acting Under Secretary for the REE mission area. I am a career Senior Executive Service employee of USDA and have served as the Deputy Under Secretary for REE since 2010. I previously worked in the U.S. Forest Service as the Deputy Chief for Research and Development and also served as the Acting Under Secretary for the Natural Resources and Environment mission area in 2009.

The REE mission area has four agencies: the Agricultural Research Service, the Economics Research Service, the National Agricultural Statistics Service, and the National Institute of Food and Agriculture. I am accompanied by the leaders from two of the four agencies in the Research, Education and Economics Mission Area: Dr. Chavonda Jacobs-Young, Administrator of the Agricultural Research Service (ARS), and Dr. Sonny Ramaswamy, Director of the National Institute of Food and Agriculture (NIFA). The other two agencies in the mission area are the Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS). I also serve as the Acting Chief Scientist for USDA and oversee the Office of the Chief Scientist, which was mandated in the 2008 Farm Bill. The Office of the Chief Scientist provides strategic coordination of the science that informs USDA's and the Federal government's

decisions, policies and regulations that impact all aspects of U.S. food and agriculture and related landscapes and communities.

The United States and the world are facing critical problems and opportunities. Global population is expected to reach 9.7 billion people by 2050, almost two and half billion more people than today. At the same time, we are seeing the impacts of extreme weather conditions, impacts that will likely only get worse. These are among the challenges that all of us face. Investments in research are a critical factor in meeting these and other challenges and opportunities, and it is the REE mission area agencies that support the critical research our country needs to ensure farm profitability and strengthen our communities; improve nutrition and food safety for lifelong health; and safeguard sustainable use of natural resources, including an abundant and safe water supply. For instance, ARS' network of 2,000 Ph.D. scientists at nearly 90 laboratories across the country work to enhance and protect agriculture as well as transfer research results to the marketplace where they serve the needs of a wide range of users. By funding research at land-grant universities, as well as other universities and organizations, NIFA integrates research, education, and extension to ensure that groundbreaking discoveries go beyond the laboratory and make their way to the farms, ranches, classrooms, and communities where Americans can put this knowledge into practice and improve lives. The research and analytical work of ERS provides vital statistical information to policymakers, consumers, other researchers, and the marketplace. NASS conducts numerous surveys and issues over 400 reports that provide accurate, timely, and useful official statistical data on national, state, and county agricultural estimates covering production, supply, price, and other aspects of the U.S. agricultural economy. Farmers and ranchers, governments, commodity markets, businesses, and researchers are among those who depend on these statistics to make informed decisions.

We have a rich history of the agricultural sciences in the United States and I would like to provide you some context for the ongoing work within the mission area.

The agricultural research and education system of the United States started in 1862 with President Abraham Lincoln signing into law the creation of a new Department of Agriculture with the mission to promote scientific agriculture and the propagation and distribution of seeds. The passage of the Morrill Act in 1862 established the Land Grant University (LGU) system. In creating the Land Grant system, a whole new generation was allowed to gain access to post-secondary education in the United States, ensuring that higher education would forevermore be accessible to everyone. Congress expanded this family of Land Grants in 1890 through the Morrill Act of 1890 to serve the educational needs of the African American communities and, in 1994, to serve Native Americans in welcoming Tribal universities and colleges through The Equity in Educational Land-Grant Status Act of 1994.

Congress passed the Hatch Act of 1887, which created the State Agricultural Experiment Stations. These experiment stations contributed many key discoveries in agricultural science. In 1914, the Smith-Lever Act was signed into law, which created the Cooperative Extension Service as a unique federal, state, and local partnership to translate knowledge into innovations and solutions that advanced economic and social progress in American agriculture and rural America.

REE's work in the food and agricultural sciences is based on the premise that the federal government has a role in advancing scientific knowledge to promote our Nation's social and economic well-being. REE does this by investing in areas in which for-profit industry does not invest, such as basic research. It also collaborates with the public sector, academia, and the private sector to amplify research outcomes and impacts. We know that the return on investment

in agricultural research is $20 for every $1 spent. Underinvestment or the absence of investments in food and agricultural sciences diminishes the needed foundational knowledge-base and impacts our Nation's global preeminence and economic well-being. It is with these goals in mind, that the REE mission area agencies establish their priorities and conduct their work.

These priorities are determined through a rigorous and extensive process that incorporates the direction provided by this Committee, and the House of Representatives counterpart, through five-year authorizing farm bills, the annual appropriations bills, and related governance statutes set in place by Congress and guidance provided by the President. REE agencies have five year strategic plans, which are aligned with the Department's plans. Input is also solicited from many different types of stakeholders throughout the planning process. These stakeholders conduct or use agricultural research, education, and economics services provided by or for the agencies and include representatives from commodity groups, industry, interagency federal working groups, scientific societies, and university partners. Stakeholders also include the Congressionally-established REE external advisory committee, the National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB).

Additionally, Congress, in the 2008 Farm Bill, directed the REE mission area to prepare a roadmap for USDA agricultural research, education, and extension. The *Roadmap* stated that solutions to many of modern society's most intractable problems demanded change that USDA would bring about by, for example, (1) better coordinating its science planning among and between REE science agencies and with other Federal science agencies; (2) listening to the needs of stakeholders; and (3) institutionalizing outcome-driven scientific program planning and implementation. Building upon this, REE developed an Action Plan organized around the leading priority areas for USDA science that contains long-term goals and short and immediate

steps to: enhance crop and animal health and production; develop positive responses to changes in weather and climate; develop new energy resources; develop knowledge about sustainability of our natural resources; develop more knowledge about childhood obesity and nutritional needs; enhance food safety as new challenges emerge; and increase science literacy and education.

REE ensures the highest level of integrity in all aspects of the Department's engagement in these scientific and technological activities and through the use of scientific information in policymaking. REE has developed and provided continuous improvements to a Department-wide scientific integrity policy intended to provide guidance to leadership and employees to ensure public policy is informed by science that is unbiased and unaltered as well as developed under stringent scientific standards. This policy also is intended to instill public confidence in USDA research and science-based policy.

You will hear more on the work and accomplishments of ARS and NIFA in their respective remarks. I would like to take a moment to highlight the important work of our statistical agencies – ERS and NASS. ERS shapes its research program and statistical products to serve those who routinely make or influence public policy and program decisions and their work reaches far beyond the borders of USDA. The mission of ERS is to inform and enhance public and private decision making on economic and policy issues related to agriculture, food, the environment, and rural development. Although ERS statistical research is aimed at the information needs of policymakers, its statistical products are also used by the media, trade associations, public interest groups, and the general public. ERS statistical products are widely recognized in the research community for its credibility, timeliness, and use of cutting edge data, models, and methods.

Rather than make recommendations, ERS designs its statistical research to examine alternative programmatic or policy pathways. In fact, in recognition of this 'arms-length' role, along with NASS, ERS is one of the 13 OMB officially designated Federal statistical agencies. As principal Federal statistical agencies, both NASS and ERS provide data that are relevant to policy issues, maintain credibility among data users, maintain the trust and confidentiality of data providers, and the independence from political and other external influence.

As I mentioned earlier, NASS's mission is to provide timely, accurate, and useful official statistics in service to U.S. agriculture. NASS achieves this through two separate appropriated program areas: the Agricultural Estimates program, and the Census of Agriculture and its follow-on studies. The Agricultural Estimates program provides critical supply, production, and price data that is the foundation of the commodities market and critical to the coordination of damage and loss assessment of the crop insurance program and disaster assistance. The Agricultural Estimates program issues over 400 reports annually, providing U.S., regional and State estimates on a wide range of crop and livestock commodities, in addition to estimates of environmental issues, economics, and demographics. The Census of Agriculture serves as the benchmark of the structure of agriculture in the U.S and is critical to formulation of agriculture policy. The quinquennial census, which is being done this year, provides very detailed statistics at the county, watershed, and Congressional district level. Additionally under this program, NASS conducts in-depth studies on topics like irrigation, horticulture, organic farming, and aquaculture.

In keeping with the efforts to break down silos, REE agencies are actively encouraged to seek efficiencies, collaborations, and partnerships with other agencies in the REE mission area and the Department. For example, ERS relies on NASS data for its Farm Income Estimate research; ERS provides ARS with social science research and analysis that guides some aspects

of ARS' priority setting; and ARS and NIFA routinely work together on research projects that have both intramural and extramural components. The REE mission area works broadly across the Department and with other Federal agencies on agricultural literacy, food safety, pests and diseases, bioenergy, natural resources, and nutrition programs in order to ensure REE programs provide the science backbone to support budget and program policy decision makers.

Mr. Chairman, up to this point, I have presented some information on the mission of REE agencies and provided some background on how priorities are coordinated in the mission area. I would like to look forward at agricultural science in coming years and the unique challenges we face.

Expected gains in agricultural yield and production are unlikely to sustainably provide feed, fiber, and fuel to the burgeoning population projected to be 9.7 billion people worldwide by 2050 without additional resources for research. The U.S. is losing its global scientific dominance and research leadership to emerging countries in addressing agricultural productivity and profitability challenges. China has surpassed the United States and continues to increase their investment in agricultural research.

New discoveries, new technologies, and new skill sets (e.g. precision agriculture, artificial intelligence, machine learning, robotics, photonics, remote sensing, computational biology, etc.) applied to agriculture and forestry, are needed to greatly increase agricultural productivity and profitability sustainably in order to provide for a population expected to expand to 9.7 billion people worldwide by 2050. U.S. agricultural research currently has limited flexibility and resources to apply to these high-risk opportunities, and perhaps an even bigger recurring challenge is attracting the brightest minds to sustainably increase food and fiber production and to solve tough problems. Despite these challenges, REE is looking towards the

future to meet the demands of providing feed, fiber, and fuel to an exponentially growing population. This will require focus on the growth and development of the physical infrastructure, human capital, and big science capabilities within USDA and the agricultural research enterprise.

As I mentioned earlier, ARS operates an extensive network of over 90 research facilities for which adequate, up-to-date and safe structures, as well as laboratories, are critical to produce research results that will help the U.S. continue to lead the world in agricultural innovation.

Concurrently, infrastructure for agricultural research at land grant (including 1862's, 1890's, 1994's, and HSI's) and non-land grant universities includes deteriorating 19th and 20th century facilities unsuitable and unsafe for quality modern research. A recent Association of Public and Land-Grant Universities audit estimated $8.9 billion in deferred maintenance of mission-critical buildings, including classrooms and laboratories, animal and plants research houses/farms, greenhouses, and pilot facilities with a $29 billion replacement value. Investments in academic research infrastructure would immediately create local jobs, conserve energy, and realize savings over time, in addition to improving research and education outcomes. Most universities already have documented capital infrastructure 'shovel-ready' projects.

Agriculture will need to produce more food, fiber, and fuel in the next 30 years in order to provide for a population expected to expand to 9.7 billion people worldwide in that time – more than mankind has produced over its entire history; yet land area available for cultivation decreases, so production increases must be made through efficiency. Recent discoveries, new technologies, new sources of data, and holistic approaches allow breakthrough technologies and management practices to meet the production challenges facing U.S. agriculture. Transformative innovations to ensure nutritional security and safety will require substantial additional investments, which can be leveraged by significant private sector investments and, often more

critically, create new industries and technological efficiencies for the U.S. private sector to market. This would significantly boost U.S. agricultural production, increase farm incomes and profitability, benefiting the entire agricultural sector, consumers, and their rural communities. Both development as well as effective monitoring of these systems regionally are needed, for example, as provided by the USDA-ARS Long Term Agroecosystem Research (LTAR) network, which addresses water resource issues through holistic approaches such as drought tolerant germplasm and non-traditional water management research.

Decisions and products for U.S. agricultural and nutritional security and global competitiveness will continue to dramatically improve if cyberinfrastructure enables the necessary big data to be readily accessible and the information to be properly analyzed, validated, used, and disseminated. USDA and other federal research organizations generate enormous quantities of valuable big data, as well as integrated models, on agricultural production and markets, natural resource utilization, agricultural production systems, genetics of agricultural species, and field data on crops, soils, climate, and water. Data collected on-farm is rapidly growing from tractors and other machines, Unmanned Aerial Systems (UAS or drones), and the Internet of Things. New software, algorithms, and analytical models using this wealth of digital untapped information would reduce burdens, decrease operational cost and time, increase efficiency, and provide new products for the private sector. Underserved needs for big data infrastructure by USDA uniquely encompass all aspects of the REE mission area – ARS, ERS, NASS, and NIFA. A few data-enabled science goals would include more accurate and timely crop forecasts, accelerated breeding of crops and animals, enabling robotics and smart systems, improved market and supply chain efficiencies, and gaining better health outcomes to sustainably provide food, fiber, and fuel to 9.7 billion people worldwide by 2050. Investments in

our future must also include trained staff, data storage, high performance state-of-the-art computing clusters, partnerships with university researchers, a high-speed network backbone to link locations, agricultural data hubs, digital data spokes, and modern cybersecurity mechanisms. USDA needs to expand its big data platform, Ag Data Commons, to handle USDA-funded scientific data in open computable forms. USDA also needs a virtual research support core to provide the advanced informatics, statistical, data management, programming, modeling, and other analytical capabilities.

A highly focused, but nimble, effort that can support high-risk opportunities and attract expert researchers from within and outside of agriculture to work on applied problems in agriculture and forestry is also urgently needed. A research effort focused on data and technology advancement would provide this novel approach, yielding the ability to bridge the innovation "valley of death," attract new talent in agriculture, and improve data-driven decisions. Such an effort would expand USDA's ability to accelerate cutting edge technology adoption to provide solutions to U.S. producers, consumers and other end users.

Agriculture critically needs a steady supply of individuals with modern agricultural and scientific knowledge and training to support the agricultural industry and R&D enterprise. This requires an ability to translate complex technical knowledge to end-users, particularly farmers and livestock producers, while recognizing local needs and constraints. A Purdue University study suggests an acute shortage and immediate need for significantly more agricultural graduates than currently being produced; this is an emerging threat to our food and national security, especially in the context to provide for an expanding population. A USDA-NIFA "systems approach," including development of transformative models in agricultural education, spanning the "K through 20" pipeline, would result in students competent in leadership, critical

thinking, problem solving, communication skills, digital competencies, professionalism and ethics. This would create the workforce needed for future U.S. agriculture. A specific training need for national security is modernizing the workforce at the USDA-ARS Plum Island Foreign Animal Disease facility in New York in advance of the move to the $1.2 billion National Bio- and Agro-defense Facility, known as NBAF, in Kansas in 2021.

In addition to the infrastructure needs of USDA, the future of farming extends beyond our rural communities and into our urban spaces. Small community gardens, urban farms that span several city blocks, and intensive indoor aquaponics facilities are all examples of urban agriculture. The fast-growing phenomenon has the potential to nourish the health and social fabric of communities and create economic opportunities for farmers and neighborhoods. Urban agriculture can provide many benefits to a community, including closer neighborhood ties, reduced crime, education and job training opportunities, and healthy food access for low-income residents. USDA's urban agriculture research provides leading science and decision tools to inform urban natural resources stewardship and improve environmental health and community well-being in urban areas. Our research helps communities transition to a more sustainable future. Key urban research areas include: forestry inventory and management; ecosystem services; human health and well-being; urban sustainability; green infrastructure; water and watersheds; and urban long-term research, which works across and within disciplines to identify a holistic approaches to sustaining urban agriculture and improving the communities served.

Mr. Chairman, despite significant efforts by recent Farm Bills and annual spending bills to enhance agricultural science in the United States, we are at a crossroads. Although REE has made significant strides, there is still much to be accomplished. Our storied legacy of discovery, innovation, and international leadership in agricultural research, education, and economics is in

jeopardy by insufficient investments in both money and minds. This is a challenge we must all rise to meet and REE looks forward to rising to the challenge. Thank you.

STATEMENT FOR THE RECORD

By

DR. JOHN FLOROS
DEAN OF AGRICULTURE
DIRECTOR OF THE AGRICULTURAL EXPERIMENT STATION AND
COOPERATIVE EXTENSION SERVICE
KANSAS STATE UNIVERSITY

Before the

SENATE COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY

UNITED STATES SENATE

"AGRICULTURAL RESEARCH: PERSPECTIVES ON PAST AND FUTURE SUCCESSES FOR THE 2018 FARM BILL"

JUNE 15, 2017

Food and Agriculture Research and Innovation Depends on the Land-Grant University System

The year 2012 marked the sesquicentennial celebration of the signing of the Morrill Act and the establishment of the land-grant university system. At the time that President Lincoln signed federal legislation, little could he or the authors of the bill have imagined the far-reaching implications of the enactment of that landmark legislation. The partnership that was developed between the states and the federal government with the Morrill Act, and subsequently the Hatch and Smith-Lever Acts, provided broader access to higher education and application of agricultural research findings on and off campus. One of the results was the development of an agricultural economy and a food system that is unmatched across the globe. Efficiencies achieved through knowledge generated by research and communicated to producers and industry through Extension programming have been a solid investment of public resources. The U.S. is fortunate to have abundant natural resources within its borders, and those resources have been critical in contributing to the food security enjoyed by her citizens. The public land-grant system has been critical in leveraging that investment into a safe and abundant supply of food.

Globally, much of the social and political unrest and riots that swept the planet in recent years have been connected to a single factor—the price of food. Studies, including data gathered by the United Nations, show strong correlations among the price of food against time, the so-called food price index of the Food and Agriculture Organization of the UN, and the dates of riots around the world, whatever their cause.. This seems to indicate that food price indices rising above a certain threshold results in trouble around the world[1]. Many recent events in the Middle East, North and Eastern

[1] M. Lagi, K.Z. Bertrand, Y. Bar-Yam (August 10, 2011). The Food Crises and Political Instability in North Africa and the Middle East. https://arcfiles.ucdavis.edu/uploads/filer_public/2014/03/27/bellemarefoodpricesaugust2011.pdf and Lagi et al. 2011, http://necsi.edu/research/social/food_crises.pdf

Africa, Southeast Asia, Latin America and elsewhere around the world underscore the tragic consequences that can accompany regional food insecurity and food shortages, regardless of the root cause. In the words of the late Jamaican musician Bob Marley, "...a hungry mob is an angry mob." Food security is truly central to security and political stability, not just in the United States, but throughout the world. **Food security and political stability can be linked directly to agricultural and food-system innovation driven by investment in food and agricultural research.**

Agricultural Research Has an Impressive Impact and a Long-Lasting Value

The second piece of federal legislation that was important in transitioning and broadening the teaching mission of land-grant universities was the Hatch Act of 1887. That piece of federal legislation, celebrating its 130th anniversary this year, established the so-called Agricultural Experiment Stations that inaugurated the food and agriculture research function at land-grant universities. That legislation provided a framework for federal support of the research mission at land-grant institutions to be matched at least 1:1 (and in other cases 7 or 8:1) by state dollars through what are now referred to as federal capacity funds. This mix of federal and state funds is now further leveraged many-fold by federal competitive grants, grants from private industry, and other types of unrestricted gifts and awards to faculty conducting research at the nation's land-grant universities. That activity is further leveraged by integration with the research and economic arms of U.S. Department of Agriculture, the Agriculture Research Service and the Economic Research Service, to round out the nation's food and agriculture research enterprise. That enterprise has, for 13 decades, advanced scientific knowledge in all aspects of food production, and together with Cooperative Extension, has advanced production capacity, profitability, and safety of the nation's food system. Agricultural trade, in turn, engages the nation's food system with the larger global food system, extending the value of public and private investments in research and development worldwide.

What do experts say about the value of public investment in agricultural research? That question is central to the published, peer-reviewed research of agricultural economists at multiple land-grant institutions. These scientists essentially conduct research on the impact of agricultural research. The work of these economists, notably Dr. Wallace Huffman, Iowa State University; Dr. Phillip Pardey, University of Minnesota; and Dr. Julian Alston, University of California-Davis; all points to the value of public investment in research and further warns of the downstream consequences of public divestment from agriculture research. **In general, the published benefit-cost ratios vary by state but are always double digits, averaging 21:1 and corresponding to annual rates of return between 9-10%.** For example, in Kansas, the estimated benefit-cost ratio was **33.6:1** with an annual rate of return of about 10%[2]. An important nuance of these otherwise very impressive rates of return is that, especially considering research related to production agriculture, the payoff for investment is realized only after considerable lag time, in some cases multiple decades. **Thus, the reality is that failure to continue to invest in food and agriculture research would be expected to have negative consequences for decades to come, and that will take significant time to reverse.**

Even though the United States remains a world leader in agricultural science as measured by publications, citations, and patents, the U.S. lost its number one ranking in the world to China for

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[2] Julian M. Alston, Matthew A. Andersen, Jennifer S. James, Philip G. Pardey; The Economic Returns to U.S. Public Agricultural Research. *Am J Agric Econ* 2011; 93 (5): 1257-1277. doi: 10.1093/ajae/aar044

public investment in food and agriculture research in 2009[3]. To fill the void, the private sector has become a key funder of research at land-grant universities. In general, this trend is in part a result of a very small funding base in USDA NIFA's flagship grant program AFRI. With the private sector funding food and agriculture research, essential "high risk-high consequence" questions to advance the science and solve fundamental problems relevant to agriculture and food (plants, animals, pests, diseases, safety, sustainability, etc.) are more likely to remain unexplored. Although progress is being made to incrementally increase appropriations to the AFRI program, it remains funded at considerably less than the $700 million authorized in the previous two Farm Bills. Although it is understood that budget management and fiscal accountability are shared responsibilities across federal agencies, the AFRI program simply does not have the level of base funding (as compared to NIH or NSF) to shoulder continued reductions. In fact, we support the goal of achieving appropriations in AFRI equal to that authorized in the last Farm Bill by 2020.

Food Science and Technology Research Adds Safety, Security, Quality, and Value to Agricultural Commodities and Our Food Supply

Studies of many ancient civilizations indicate that, throughout history, humans overcame hunger and disease not only by harvesting food from a cultivated land, but also by preserving and processing it. Today, our modern food system is complex, and our food supply is largely safe, nutritious, tasty, abundant, diverse, convenient, and less costly and more readily accessible than ever before. Contemporary food science and technology contributed greatly to the success of this modern food system by integrating science, engineering, and many other disciplines to solve difficult problems, such as enhancing food safety, improving availability, and resolving nutritional deficiencies, while adding tremendous value to raw agricultural commodities[4]. However, research funding for food science and technology within USDA has declined substantially over the years, with the possible exception of food safety research.

The impact of modern food preservation, processing, and manufacturing methods is evident in today's food supply. Food quality can be maintained or even improved, and food safety can be enhanced. Sensitive nutrients can be preserved, important vitamins and minerals can be added, toxins and anti-nutrients can be removed, and foods can be designed to optimize health and reduce the risk of disease. Similarly, processing and manufacturing can improve the overall efficiency of the food system, minimize waste or product loss, facilitate distribution of foods around the world to increase availability, and contribute significantly to increased trade and economic growth[5]. Research funding for food post-harvest handling, preservation, processing, packaging, and other manufacturing methods is now almost non-existent within USDA, with only some private investments in the broader area of food processing innovation.

Food manufacturing transforms raw agricultural materials into products for intermediate or final consumption by applying technology, labor, machinery, energy, and scientific knowledge. In 2011, food manufacturing accounted for 14.7% of the value of all shipments from U.S. manufacturing[6]. Also, according to USDA Economic Research Service, the farmer's share of the consumer's food

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[3] USDA ERS Amber Waves at https://www.ers.usda.gov/amber-waves/2016/november/us-agricultural-rd-in-an-era-of-falling-public-funding/.

[4] Floros et al. 2010, Feeding the World Today and Tomorrow: The Importance of Food Science and Technology, Comprehensive Reviews in Food Science and Food Safety, Vol. 9, 2010, pp: 572-599.

[5] Floros et al. 2010, Comprehensive Reviews in Food Science and Food Safety, Vol. 9, 2010, pp: 572-599.

[6] USDA Economic Research Service, https://www.ers.usda.gov/topics/food-markets-prices/processing-marketing/manufacturing.aspx.

shopping dollar has decreased from 46% in 1913 to less than 20% in 2006[7]. Overall, today, only about $1 out of every $7 spent on food goes to primary agricultural production. The remaining value of approximately $6 is added by handling, processing, packaging, transportation, distribution, and other modern food manufacturing techniques. If we were to look at wheat, for example, an important agricultural commodity for Kansas, wheat represents less than 9% of the retail value of a typical loaf of bread. Milling, baking, and related manufacturing activities represent almost 65% of the final value, and the remaining 26% is due to transportation and retail mark-up[8]. However, drastically reduced research funding over several decades has considerably decreased innovation and competitiveness in the U.S. food manufacturing sector.

Many individual research studies and several comprehensive scientific reviews concluded that: (1) major advances in sustainable food production and availability can be achieved with the concerted application of current technologies; and (2) in order to enable the food system to cope with both known and unknown challenges in the coming decades, it is important to invest in research sooner rather than later[9].

International Research is a Key Component of America's Agriculture Research Portfolio
The United States Agency for International Development (USAID) is the lead federal agency working to end extreme poverty and enable success in resilient democratic societies[10]. The Feed the Future Innovation Labs, funded by USAID, draw upon faculty expertise of top U.S. universities and in-country research institutions that tackle the most difficult challenges in agriculture and food security[11]. As one inspects the list of U.S. universities leading these efforts, it is obvious that land-grant universities are generally best suited to provide key expertise and leadership fundamental to the success of each laboratory. At my home institution, Kansas State University, we went from not leading any labs in 2012 to now leading four Feed the Future laboratories. What has become obvious to us is that, although the target of the work is international in nature, the knowledge, relationships, and products of the work (e.g. sources of plant genetic diversity) become available to researchers as Kansas State University as a natural outcome of the labs, and, in turn, they help our farmers, ranchers, and industry to advance.

A Major Infrastructure Challenge
Since the last presidential election, major challenges associated with the current state of America's airports, roads, bridges, and ports have been in the news. It is apparent that our infrastructure, so important to the U.S. economy and national security, is aging and in need of upgrade and repair. Similarly, the country's land-grant universities, a network so vital to the nation's economy and national security, also have an aging infrastructure, and they are in desperate need for repair and rebuilding.

America's colleges of agriculture ***educate*** the next generation of leaders in this most important of industries; conduct the ***research*** that will allow us to provide food, feed, fiber, and fuel for a growing world population; and take ***science-based education*** to every county in the U.S. The physical infrastructure that supports these activities is the foundation of our national

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[7] Value-Added Products and Enterprises, University of Maryland Extension, https://extension.umd.edu/agmarketing/value-added-products.
[8] Robert M. Kerr Food & Agricultural Products Center, Oklahoma State University, http://fapc.biz/valueadded.
[9] Godfray et al. 2010, The Future of the Global Food System, Phil. Trans. R. Soc. B, 365, 2769–2777.
[10] United States Agency for International Development. https://www.usaid.gov/who-we-are.
[11] Feed the Future Innovation Labs. https://feedthefuture.gov/lp/feed-future-innovation-labs.

competitiveness in food, agriculture, and natural resources. The infrastructure in most land-grant universities is aging, inadequate, and, in many cases, obsolete. A national study of capital facilities and deferred maintenance recently documented the magnitude of the infrastructure problem that threatens to further erode the United States' preeminent role in global food and agriculture. Building level data supplied by 91 colleges of agriculture (1862, 1890, and 1994 land-grant universities and colleges, and some non-land-grant universities) documented the existence of more than 15,000 facilities with 87 million gross square feet of space valued at over **$29 billion** in this largest and most comprehensive study in the U.S. Summary findings: 54% of facilities were constructed during 1951-1990, accounting for 68% of deferred maintenance needs; more than $5 billion of the deferred maintenance pertains to science research ($3.2 billion) and classroom/teaching ($2.0 billion), while the remaining $3.2 billion was marked as farm/animal, support, greenhouses and Extension buildings; only 20% of colleges of agriculture invest at levels that would at least stabilize, if not decrease, the backlog of deferred maintenance; 80% of the campuses are investing capital at such a low level that they will continue to add to the backlog of deferred maintenance every year. The conclusions from this *Sightlines LLC Study*[12] on the age of the buildings, the lack of capital investment over time, and the levels of deferred maintenance needs are sobering — **the total deferred maintenance cost is at least $8.4 billion. In order for the United States to remain the world leader in food and agricultural research, the aging infrastructure problem must be addressed.**

Pressure on NIFA Capacity Funding

The U.S. agriculture industry is the envy of the world and a true American success story. Since the 1940s, the U.S. food, agriculture, forestry, fishery, and natural resource industries' productivity and output have increased by more than 2.5 times, while using fewer total acres. However, this track-record of success has not occurred by chance. Rather, it is a result of the intense and deliberate application of scientific research and development and technological development—with the involvement of the federal government and state and local (county) governments. A key component of this federal funding has been Capacity Funding (Hatch, Smith-Lever, Evans-Allen, 1890 Extension) specifically dedicated to supporting research and Cooperative Extension programs at America's land-grant universities. With roots in legislation passed in 1862, NIFA has asked the question of "**whether Capacity Funding remains a productive model for supporting academic institution-based research and Extension in the 21st century**?" *TEConomy Partners* conducted a national survey and synthesized the results for NIFA.

The findings are strong and unequivocal in their impact: financial leveraging through matching state and local funds of at least $1.86 per $1 federal sustains the specialized personnel and scientific facilities and instruments, research station infrastructure, and Extension operations needed for complex agricultural and associated research programs; generates significantly higher volumes of publications; provides flexibility to fund rapid response to emergencies or emerging issues; allows long-term research, leading to improved crop and livestock management; and provides a base of support to successfully vie for competitive grants across all sizes of institutions and federal, state, and local agencies. Capacity funds align with 9 out of 10 2014 Farm Bill priority areas (as well as a majority of NIFA Challenge Areas); research programming thrust is evident across applied, translational, and basic sciences; patenting output is more wide-ranging and influences up to one in

[12] A National Study of Capital Infrastructure & Deferred Maintenance at Schools of Agriculture. Sightlines, LLC. http://www.aplu.org/projects-and-initiatives/agriculture-human-sciences-and-natural-resources/DeferredMaintenance_SchoolsofAg.pdf

every six patents; this funding model should be increased and maintained into the future. Comparative Levels of Funding to Federal R&D Supporting/Performing Non-Defense Agencies from 1997 to 2016[13] illustrates a very challenging narrative: NIH $588 B, NASA $251 B, DOE $221 B, NSF $101 B, USDA $52 B and all other $169 B.

The core finding is that Capacity Funding carries substantial and ongoing advantages as an agricultural research and Extension base funding model, and it should be considered by other federal funding agencies.

Training the Next Generation Food System Workforce

Recent revisions from the Population Division of the United Nations Department of Economic and Social Affairs of the United Nations Secretariat predict world population growth to 9.7 billion by 2050[14]. Awareness of the population growth, the need for action to prepare for the predicted growth, and the desire of that population for a higher standard of living was highlighted prominently in the publication[15], "A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution." This National Research Council publication became the roadmap for the organization of AFRI requests for applications. One of the grand societal challenges highlighted in those requests was global food security. Feeding a world of more than 9 billion people is a complex and multifaceted problem that will require significant advances in plant and animal genetics, soil fertility, water and nitrogen use efficiency, animal nutrition, tillage and irrigation practices, and other areas. These advances must occur in a world with a potentially more variable climate and must include major improvements in food distribution, breakthroughs in food processing and stored food preservation, and substantial progress toward reducing food waste and food loss. The grand challenge to feed the growing world population points to the need for AFRI to be re-authorized in the 2018 Farm Bill at no less than $700 M, and grown quickly to that level of appropriated funding.

Since its inception, the land-grant university system has played an important role in continually providing new knowledge that advances the science and application of new technology. These advances allowed production agriculture and agribusiness to meet and defeat agricultural production challenges, and have ensured food security for the United States. Undoubtedly, the land-grant university system played a major role in global food security, and until now, it has helped meet the ever-increasing population challenges. But who will continue the education, discovery, and outreach in the coming decades?

Replacing faculty positions vacated by retirements and lost to budget cuts at land-grant universities over the coming decade is going to be a major challenge, if not a crisis. However, awareness of this looming challenge is increasing. As an example, the Coalition for a Sustainable Agricultural Workforce formed a partnership aimed at increasing the workforce pipeline by generating greater numbers of bachelor to doctoral degree recipients in an array of disciplines within food and

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[13] National Evaluation of Capacity of Programs. Quantitative and Qualitative Review of NIFA Capacity Funding. *TEConomy Partners, LLC.*
https://nifa.usda.gov/sites/default/files/resource/NIFA%20Capacity%20Funding%20Review%20-%20TEConomy%20Final%20Report.pdf

[14] World population projected to reach 9.7 billion by 2050. UN Department of Economic and Social Affairs, 2015. http://www.un.org/en/development/desa/news/population/2015-report.html.

[15] National Research Council. 2009. A New Biology for the 21st Century. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/12764.

agriculture[16]. The coalition, a collection of prominent, agriculturally related scientific societies, agribusinesses, and industry leaders, has proposed federal partnerships with leading agribusinesses to help fund this effort. This and other similar efforts are examples of initiatives needed to address a looming crisis. We support initiatives to enhance the number of students selecting agriculture and related disciplines for their university training. We encourage the Committee to explore avenues so that the next Farm Bill can raise national awareness of and authorization to begin to tackle this challenge of worldwide food security.

Related to the issue of the workforce pipeline, we additionally would encourage the committee to consider another problem. Like many STEM (Science, Technology, Engineering and Mathematics) disciplines, graduate programs in food and agriculture attract bright and very capable international applicants into their doctoral programs. If these doctoral recipients are not placed in faculty or research associate positions in land-grant universities in the United States, they return home. Home often means returning to the growing economies of India, China, Brazil, etc. It would seem prudent to consider ways to "reinvest" these doctoral recipients in the land-grant university system, and to nurture and diversify the system.

Finally, it must be pointed out that the agricultural research workforce dilemma has at the root of its solution the continued USDA investment in land-grant universities. Capacity funding via the Smith-Lever act provides base support for the 4-H program. This important youth development activity is the beginning of a pipeline directing both rural and urban youth to engage with greater probability in higher education with the potential for careers in the food and agriculture sectors. A percentage of those youth would be expected to choose graduate degrees that will credential them for careers in agricultural and food research, either at land-grant universities or in the private industry. **An important takeaway is that capacity funding through USDA supports ongoing programs through Extension that are interconnected to the workforce pipeline needs for the food system, including food and agricultural research.**

Conclusion

It is my hope that this testimony captures the enduring optimism that has been a common thread connecting more than 150 years of history of the land-grant university system. That thread is one of valued service to the farmers, ranchers, food and agricultural industries, and all the citizens of this great nation. Faculty and staff at land-grant universities across the nation recognize that their work takes place on behalf of a greater good, a broader goal, and a common vision that is much bigger than their individual achievements. Members of this United States Senate Committee on Agriculture, Nutrition, and Forestry can be confident that every dollar of federal investment authorized by the 2018 Farm Bill and expended at land-grant universities will be a wise investment. That investment is guaranteed to be leveraged further, and to spawn innovation and discovery that will be translated into solutions to improve the lives of U.S. citizens. I thank you for this opportunity to provide testimony.

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[16] Coalition for a Sustainable Agricultural Workforce. http://www.apsnet.org/members/outreach/Pages/CSAW.aspx.

AMERICAN INDIAN HIGHER EDUCATION CONSORTIUM

STATEMENT OF KERRY E. HARTMAN, PH.D.
ACADEMIC DEAN & SCIENCE CHAIR
NUETA HIDATSA SAHNISH COLLEGE AND
THE AMERICAN INDIAN HIGHER EDUCATION CONSORTIUM
NEW TOWN, NORTH DAKOTA

BEFORE THE
COMMITTEE ON AGRICULTURE -- UNITED STATES SENATE
JUNE 15, 2017

Chairman Roberts, Ranking Member Stabenow, and Members of the Committee, thank you for the opportunity to testify this morning on behalf of my institution, Nueta Hidatsa Sahnish College, and the American Indian Higher Education Consortium, which is the nation's 37 Tribal Colleges and Universities, on the topic of Agricultural Research: our past experiences and potential opportunities for the 2018 Farm Bill.

I am Dr. Kerry Hartman, Academic Dean and Sciences Chair, and for the past 25 years, I have been a full-time faculty member and teacher on the Fort Berthold Indian reservation in North Dakota. Throughout that time, I have been engaged – most often with my undergraduate students -- in research on the land, water, environment, and native plants and wildlife that are at the center of life for the Mandan, Arikara, and Hidatsa people.

BACKGROUND ON TRIBAL COLLEGES:
American Indian Tribal Colleges, including Nueta Hidatsa Sahnish College (NHSC), are public institutions of higher education that are young and geographically isolated – primarily located on federal trust land. Chartered by the Three Affiliated Tribes, NHSC, like all Tribal Colleges that followed, was established for two reasons: (1) the near complete failure of the U.S. higher education system to address the needs of – or even include – American Indians; and (2) the need to preserve our culture, our language, our lands, and our sovereignty.

Collectively, Tribal Colleges have grown from one institution in 1968 to 37 TCUs today, operating 75 sites in 16 states and serving approximately 160,000 American Indians, Alaska Natives, and other rural residents each year in academic and community-based programs. We are located in some of the most economically impoverished regions of the country, yet our homelands are rich in natural resources and our people are among the most resilient in the world. Within this context, Tribal Colleges are planting seeds of hope for the future; nurturing languages, cultures, and traditions; helping to strengthen tribal economies and governments, and sustaining and revitalizing our lands, waters, environments, and traditional foods.

NHSC's values are represented by the earth lodge, the common home to the Nueta/Mandan, Hidatsa, and Sahnish/Arikara people. The earth lodge symbolizes the universe and all elements necessary to exist in the world. Unity, being the key value, is located in the center (fire pit), around which the rest of the values build and is depicted through the Earth. Spirituality, People, Culture, and Future are the four domains represented by the four main posts. The outer twelve posts represent values within each of the four domains and follow these guiding principles: Our Livelihood, Teachings, Leadership, Community,

Industrious, Determination, Growth, Respect, Land, Language, Balance, and Humility. All of the research at our college, like our education programs, grows out of these values and is intended to sustain them. At the same time, we are part of the nation's higher education system and research infrastructure.

TCUs AS LAND-GRANT INSTITUTIONS

In 1994, the Tribal Colleges took a significant step toward greater participation in the American higher education system when American Indian reservations became the last lands under the American flag to receive federal land-grant status and funding under the U.S. Department of Agriculture (USDA). This historic -- and long overdue -- recognition occurred with the passage of the Equity in Educational Land Grant Status Act of 1994.

As place-based institutions of higher education whose collective mission is to meet the needs of our tribes and tribal communities -- and most important, to preserve, strengthen and sustain our tribal lands, languages, and cultures -- Tribal Colleges are proud to be part of this nation's land-grant family. I think it is important to remember that over 155 years ago, the first Morrill Act was enacted specifically to bring education to the people. Today, the 1994 institutions -- more so than many other institutions of higher education -- epitomize the original intent of the first land grant legislation: we are truly place- and community-based institutions. All of the 1994 institutions offer place-based natural resource management programs and train a significant number of our tribal natural resource research and management professionals. Of 37 Tribal Colleges, 34 currently are 1994 land-grants, and another will join our ranks as a 1994 land-grants when the Farm Bill is next reauthorized.

Being part of the land-grant system is important to us because, as I mentioned earlier, we are people of a Place. Place defines who we are. Our stories, songs, and language come from the land, waters, mountains, and wind. Most of our land -- the remaining tribal land in North America -- is forest or agricultural land. In fact, of the 55.7 million acres that compose American Indians reservations, more than 75 percent are agricultural and forestry holdings.

The National Institute of Food and Nutrition (NIFA) administers four modest programs for the 1994 institutions: a $3.4 million (formula) agriculture education equity program, which has enabled the thirty-four 1994 institutions to develop and offer small foundational agriculture or natural resource education programs; an endowment program, from which the 1994 institutions share annual interest payments of approximately $5 million (total) each year; a $4.4 million competitive extension program, which supports 1994 outreach activities such as community gardening, summer science and nature camps for youth, agriculture technical assistance, and financial literacy programs; and a $1.8 million competitive research program, which began in FY2000 at $500,000. As the NIFA website states, our institutions often serve as the primary institution of scientific inquiry, knowledge and learning for our tribal communities. This modest funding assists us in our efforts to protect our reservation's forests, woodland, and monitoring water quality and other environmental factors. Projects range from studying bison herd productivity to efforts such as mine, which focus on the connection between traditional plants and their role in managing diabetes, controlling invasive species, or revitalizing Native species.

Under the NIFA-1994 program, partnerships are required with other federal and land-grant institutions or state institutions or Agriculture Research Service stations. These partnerships assist us in carrying out the grant's primary emphasis, which is on training students in science.

Three types of funding are available through the program: "New Discovery" supports basic and applied scientific inquiry that could be published in a peer-reviewed journal. "Capacity level" grants support local, applied research. "Student Inquiry" funding allows a Tribal College student to build a research project and present the results under the guidance of a 1994 Land-Grant faculty member. 1994 faculty may also receive a grant to study optimal ways to teach Native American students in sciences as they relate to health, conservation and agriculture, and there is a special funding initiative that allows the 1994s to develop scientific capacity throughout the entire 1994 Land-Grant system.

All of these grant programs, though small, are critically important to NHSC and the other 1994 institutions. My years as a member of the NHSC faculty have instilled in me a keen understanding of the need to write and administer grants to support our extremely under-funded institution. In my 15 years as a full-time faculty member, I have written, co-authored, or been a collaborator in approximately two dozen grants, and I have served as Principal Investigator, Project Director, researcher, faculty member, and student mentor, usually at the same time. These grant programs have had a lasting impact on my students, our science department, and the community. They have allowed us to purchase equipment and supplies, conduct research, obtain training/professional development, financially support and employ student researchers, participate in national and regional conferences, and more. My college simply would not be able to offer the science and agriculture education and opportunities to our students and community that we offer today without these programs. The same is true for all of the 1994 institutions.

A key additional benefit of the USDA-NIFA Tribal College Research Grant Program is the collaboration the grants build other institutions faculty, agencies, tribal organizations, and researchers. Through these collaborations and cooperative projects, I personally have grown significantly in my educational philosophy, research capabilities, professional contacts, and most important, in terms of educational resources available to my students and me. Scientists, researchers, professors and career professionals from multiple institutions, agencies, and businesses are now readily available to me for support, to respond to questions, suggest methodologies and inform me of other resources. Likewise, I serve as a resource to others. These communities of practice are similar to learning communities – through and within them, we find camaraderie, communication networks, and resources that strengthen our individual research and education projects and serve as laboratories for innovation, technology transfer, and ongoing regional (and national) economic and community development.

1994 Research

NHSC along with the other Tribal Colleges in North Dakota are engaged in research directly related to sustainably managing the traditional resources of our tribes' homeland, now known as the Northern Great Plains. While mapping and exploring the region, Lewis and Clark were struck by the "immence [sic] herds of Buffaloe [sic] deer Elk and Antelopes which we saw in every direction feeding on the hills and plains." The wildlife that wandered this vast grassland and the plants on which they found nourishment were the traditional foods and medicines of the Mandan, Hidatsa, and Arikara people. Using Native knowledge and practices, tribal ancestors researched the plants, wildlife, and insects of their homeland and made remarkable discoveries that helped improve health, create crop rotation and irrigation cycles, and sustainably co-exist with the natural world. Today, the wildlife and plants are not entirely gone, but they are far less abundant.

I am proud to say that NHSC has been a beneficiary of the competitive USDA-NIFA TCU research program almost since the program's inception. I personally have been involved in NIFA-funded research grants since 2001. Common threads in all four of these grants is a research focus that is culturally and

economically relevant to the people of the Fort Berthold reservation, and most important, that the research involves and engages students. Locally- and community-relevant research enhances the education experience and, I believe, sparks an interest in my students to continue their education for the benefit of their tribe and community.

Primarily through our grant collaborations, NHSC students and I have been involved with multiple individual and collaborative research projects on a wide range of issues, including water quality monitoring, selenium in bison meat, diabetes monitoring, and aquaculture. Previously funded NIFA-TCU research grants include a multi-TCU/state institution of higher education grant to build and enhance TCU natural resources education programs; aquaculture research aimed at creating local small farmer economic development opportunities; and a series of grants related to juneberries (environment, production and propagation, nutritional implications, Native/traditional habitat), a traditional plant and food of our region. With all of these projects, the search for solutions and the excitement of conducting valid and reliable research that will benefit our community and tribe in terms of culture and identity, health status, and economic impact continues excites my students and me. Importantly, as my research has evolved, I have become more aware of the need to incorporate qualitative research into my methodologies and to ensure that Native science is incorporated within the research paradigm.

The goal of my current NIFA-TCU program research is to develop and sustain the environment needed to support *native* pollinators, which – through improved pollination – will help us restore and sustain one of our native plants/foods, *Amerlanchier Cultivars*, or juneberries. Juneberries are important to us for their nutritional value and newly discovered anti-cancer properties. NHSC is doing this research in partnership with Tribal Game and Fish biologists and South Dakota State University.

It is important to note that SDSU as well as the Tribal Game and Fish Department have been key partners in all of our *Amerlanchier Cultivars* research. Equally important is that fact that research such as this would not be possible without a focus at USDA on specialty crop research. In rural America and Indian Country, specialty crop research is critically important to building and sustaining a local economy: locally grown, locally produced, locally packaged, and locally consumed. Whether through a separate specialty crop program or the NIFA-TCU research program, we believe this type of research is the most relevant and will yield the largest return in many of our communities. The need for more an ongoing research into new and emerging technology uses and impacts; pest and invasive species management; sustainable growth; and food safety/security are essential in Indian Country, as NHSC's series of juneberry research grants attests.

Other TCUs are also doing important research. Salish Kootenai College, in Pablo, Montana, conducts extensive research and offers an accredited bachelor's degree program in the Science of Hydrology to address a dearth of American Indian water management scientists. This is particularly relevant to people of the Flathead Indian Reservation because their primary body of water, Flathead Lake, is the nation's largest freshwater lake west of the Mississippi and it is fed by several rivers and streams flowing from the glaciers of northern Montana and Canada.

Ilisagvik College in Barrow, Alaska, is located on the northern-most point of the United States where "the sea is the way of life." Ilisagvik offers a unique Marine Mammal Observer Stewardship degree that combines Inupiaq traditional knowledge, Western science research, and industry standards into a program that is recognized by the Alaska Federation of Natives as "*the* training center for Alaska Natives on Marine Mammal Observation."

These examples demonstrate our fundamental connection to the 1994 legislation: We are people of a Place. Tragically, due to misuse, exploitation and lack of expertise and training, millions of tribal acres are fallow, under-used, or are being developed through methods that could render resources non-renewable. For this reason, in particular, agriculture and forestry research is critically important to the 1994 institutions and our tribal communities.

THE NEED TO GROW TCU (1994) AGRICULTURE & FORESTRY RESEARCH PROGRAMS:

THE PRODUCTION CHALLENGE

The agriculture challenges we face as a nation and world today are well established: constantly and rapidly changing technologies; population growth and predicted food shortages; environmental changes and competition over water and land access and use; obesity and health status; and more. A common thread adding another layer of complexity to each of these challenges is the aging agriculture workforce in the U.S. The average age of farmers and producers in the U.S. is 60 years of age and continues to rise each year. Among Native American farm operators, more than 30 percent are 65 years or older. But for American Indians and Alaska Natives (AI/AN), the issue goes far beyond age. The 2012 Agricultural Census reports less than 38,000 Native American-operated farms, representing only 1.8 percent of the approximately 2.1 million farms in the U.S. Of these Native farms, only 8 percent had a market value of $50,000 or more, while 25 percent of all U.S. farms were worth $50,000 or more. In North Dakota, the statistics are even more grim: in 2012, only 348 principal farm operators were AI/AN, representing only 1.1 percent of all farm operators in the state. The state lost nearly 20 Native farmers between 2007 and 2012. The bottom line is that Native farmers and ranchers are already under-represented in the U.S., and their numbers will likely decline even further as today's farmers and ranchers retire.

As a nation, we must do more to increase the number of young people seeking careers in the food and agricultural sciences, including agriculture research, agribusiness, food production, energy and renewable fuels, and farming marketing, innovation, and distribution. The need is particularly acute in Indian Country, as the numbers I have cited attest. For Native farmers and ranchers, access to land is not the primary issue, as it is for most potential farmers in the country. (As I mentioned earlier, 75 percent of the remaining lands in Indian Country are forested or agriculture lands.) Access to capital, agriculture education and research, and technical assistance are the major barriers for most Native farmers and ranchers. Outreach, technical assistance and innovative research opportunities through traditional Cooperative Extension and education programs are limited in many tribal communities, often due to the rural settings and funding limitations. Tribal Colleges often lack the funding they need, as well as critical support from the mainstream land-grant system, to develop and deliver appropriate agricultural programming and research opportunities. Yet, with adequate funding, TCUs can provide relevant, locally- and place-based higher and technical/career education that is innovative and which includes important tribally-driven experiential learning and community-based research opportunities to aspiring and beginning farmers, ranchers, and agriculture/forestry researchers and students throughout Indian Country.

RECOMMENDATIONS FOR CONSIDERATION DURING THE FARM BILL REAUTHORIZATION

The 1994 institutions are confident that we have the potential of becoming significant contributors to the agricultural base of the nation and the world once again. More and more AI/AN tribes and 1994 institutions are beginning to re-assert sovereignty over our food, agriculture, livestock and fisheries systems. Working with key partners, we are defining policies that are ecologically, socially, and culturally appropriate to our unique circumstances.

Due in large part to our land-grant activities, leveraged with other federally funded STEM programs, our students are involved to some degree in cutting-edge and community-relevant research, particularly research related to the preservation of our natural resources and the exploration of the linkages between nutritional patterns and disease. Much of this research is conducted with other land-grand institutions, resulting in both good science and solid partnerships.

1. Acknowledge the Value of Place-based, Traditional Research and Education

The 1994 Institutions, along with other Minority-Serving Institutions (MSIs), are uniquely positioned to provide the next generation of technically and culturally competent agricultural scientists and researchers. We believe that our Native American students represent a unique competitive advantage in an increasingly culturally diverse global agriculture science world. Our Tribal College students can succeed in cross-cultural contexts better than anyone, and these types of people will be successful as agriculture scientists working in places that are culturally different from the U.S., such as the Middle East, South America, and Africa. American Indians and Alaska Natives are a unique and important component of any student pipeline that leads to a new generation of agriculture scientists.

The research provision of the Farm Bill should specifically acknowledge that students and faculty of the 1994 institutions and other MSIs can enhance the cultural competency of the next generation of agricultural scientists, researchers, and practitioners. The cultural competency needed to meet global agricultural challenges will often be as important as scientific and technical competency. Agricultural scientists and researchers working in cross-cultural, international settings will need to be sensitive and respectful of cultural and social norms and values. In many countries, cultural competency facilitates the initial access to local populations before technical and scientific activities can proceed. Indigenous peoples are especially vulnerable to exploitation of cultural and natural assets, such as traditional ecological knowledge and natural resources.

More broadly, research and education provisions of the Farm Bill must specifically include underserved students at the undergraduate level. The vast majority of the USDA current "education" and research funding supports graduate-level research. More resources need to be devoted to student success, faculty development, curriculum innovation, international development, facilities development, and infrastructure support at the community college and early undergraduate level.

2. Resist Efforts to Consolidate STEM Research Programs

As you know, the President's Fiscal Year 2018 budget request proposes the consolidation of many federal STEM higher education and research programs. We expect that other proposals along these lines will be put forth in the months ahead. We believe that the research programs supported by NIFA are important and unique. Consolidation of these programs with other federal STEM research and education programs is simply a bad idea, particularly for Indian Country. Not only would the agriculture and natural resource focus become lost – which is so important to us for the reasons noted earlier – but also to be lost will be the multi-cultural, diversity of thought focus of America's education programs. Under proposals to consolidate and homogenize programs, we stand to lose some important USDA programs, and history clearly demonstrates that small and under-resourced institutions, such as the 1994 land-grant institutions, would fair very poorly in competitions with well-resourced major Research I institutions.

3. McIntire Stennis amendment to establish participation eligibility for 1994 Institutions with baccalaureate degree programs in forestry

The McIntire Stennis Act of 1962 (16 U.S.C. 582a, et seq. Public Law 87-788) should be amended to allow Tribal Colleges (1994 institutions) that offer a bachelor's degree in forestry to receive a share of McIntire Stennis Act formula funding that flows to a state in which a relevant 1994 institution is located.

Justification: In 2008, the McIntire Stennis Act was amended to include Tribal lands in the formula calculation for funding of *state* forestry programs, which are centered around forestry research and management. However, the 1994 institutions were not included in the funding formula, nor were states required to include them in funding distributions. This oversight is significant because, as noted earlier, 75 percent of Tribal land in the U.S. is either forest or agriculture holding. In response to the severe under-representation of American Indian professionals in the forestry workforce to conduct research on the AI/AN forestry holdings in Montana and across the United States, Salish Kootenai College (SKC) launched a Forestry baccalaureate degree program in 2005.

In 2013, SKC became the first tribal college land-grant to join the National Association of University Forest Resource Programs, a consortium of 85 forestry schools, the vast majority of which receive McIntire Stennis funding. However, when SKC recently sought specialty accreditation for its program, the college was told that it was "one forestry researcher short" of the optimum number needed. Participation in the McIntire Stennis program, even with the required 1-1 match, would help SKC secure the researcher it needs to gain accreditation. Yet, it cannot participate in the program. Once again, TCU land-grants are prohibited from participating as full-partners in the land-grant system. And although currently, only SKC has a baccalaureate degree in forestry, considering the wealth of forested land on American Indian reservations, others such programs could arise at the nation's other Tribal land-grant institutions, to further the effort to grow Native researchers in this essential area.

Conclusion

In closing, Mr. Chairman and Madam Ranking Member, I want to reiterate that the 1994 Institutions have proven to be efficient and effective vehicles for bringing education and research opportunities to American Indians/Alaska Natives and the promise of self-sufficiency to some of this nation's poorest and most underserved regions. The extremely small federal investment in the 1994 Institutions has already paid great dividends in terms of increased employment, access to higher education and research opportunities, and economic development. Continuation of and significant growth in this investment makes sound moral and fiscal sense. As stated earlier, no institutions better exemplify the original intent of Senator Morrill's land grant concept than the 1994 Institutions. We are proud to be part of the nation's great land-grant system, and I am honored to have this opportunity to share our story and a few recommendations with the Committee today. Thank you.

Statement by
Dr. Chavonda Jacobs-Young
Administrator
USDA Agricultural Research Service

Before the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate
June 15, 2017

Good morning, Chairman Roberts, Ranking Member Stabenow, and Members of the Committee, I am honored to have this opportunity to speak about USDA's Agricultural Research Service.

The Agricultural Research Service (ARS) in partnership with the National Institute of Food and Agriculture exemplify the mandate expressed in President Abraham Lincoln's 1862 executive order establishing the USDA, in which the Department was charged with conducting "practical and scientific experiments" to improve the quality and security of agriculture in the United States.

As U.S. Department of Agriculture's chief scientific in-house research agency for the past 64 years, the Agricultural Research Service, with its 1,800 scientists at 90 laboratories throughout the United States, carries on that mission today and represents an important component of USDA's science infrastructure. ARS has world-class research units from Maine to Hawaii, and we maintain research facilities in France, China, Argentina, and Australia that serve as bases for our insect pest and weed biocontrol collection efforts. We manage tens of thousands of acres of pasture, rangeland, and crop land for our research; more than 3,000 buildings housing our laboratories; and 8,000 employees developing cutting-edge science at our locations. They provide us with the infrastructure to pursue the science to make American agriculture stronger and more resilient to environmental changes and the demands of feeding a growing world population.

We have 19 genebanks that manage the U.S. National Plant Germplasm System's collections and provide scientists all over the world with the genetic materials to develop new varieties that improve the quantity, quality, and production efficiency of our food, feed, bioenergy, fiber, and ornamental crops. The genebanks hold 578,000 accessions representing more than 15,000 plant species, making it the largest collection of plant germplasm in the world.

This resource is very much in demand by scientists everywhere. In the most recent fiscal year, these genebanks facilitated the distribution of more than 240,000 plant germplasm samples domestically and internationally. The GRIN-Global database of the details about the accessions held in our genebanks [https://npgsweb.ars-grin.gov/gringlobal/search.aspx?] received more than 1.5 million page visits during that time. ARS also maintains genebanks for animal and bee germplasm for research and breeding purposes, and collections of insects, microbes, nematodes, and plant pathogens that are used for reference by USDA action and regulatory agencies and as resources for researchers.

We have organized 18 of our experimental watersheds, ranges, and research farms into a coordinated national information-gathering network for creating an infrastructure for research on agricultural processes at a variety of scales. These locations have been collecting data on agricultural production, natural resources, and conservation in their specific areas – some for as long as 100 years – but had not shared that information amongst themselves.

The concept of the Long-Term Agro-Ecosystem Research Network, or LTAR, is to put data into a format that will provide the capacity to address large-scale environmental questions through shared research protocols across locations, and even to a continent gradient. Our scientists are using the data to develop more refined and accurate modeling systems for estimating the effects of climate variability on agricultural production. Recent LTAR findings include a 10-year study identifying a link between extreme precipitation patterns and decreased vegetation productivity across 11 sites in the continental United States; validation of satellite-based rainfall estimates made by NASA's Tropical Rainfall Measurement Mission satellite; a global analysis of plant community water demand; and publication of 50+ years of data records for watersheds in Oklahoma and Missouri.

I would also like to highlight ARS support for the National Agricultural Library that is located in Beltsville, Maryland, just outside Washington, D.C. While not a research facility per se, it is the world's largest agricultural library, and one of four congressional national libraries. The Library is an important component of the ARS research infrastructure, and we are rapidly increasing the ways in which the information in this repository can be shared with our scientific colleagues. As a public institution, ARS maintains an open access policy for the data and research results our scientists generate, and the National Agricultural Library is instrumental in assisting ARS in meeting that demand. The Library now provides access to nearly 50,000 peer-

reviewed journal articles authored by USDA researchers through the PubAg public archive system, and is adding more publications every year. It has turned out to be a very popular and active resource. In 2016 alone, the Library reported its uscrs had downloaded more than 13.5 million full-text items. This free flow of information is an important stimulus for the entrepreneurs who will be developing valuable decision support options for farmers based on site-specific crop, soil, and weather data.

ARS is also looking to the future, and developing two state-of-the-art animal disease research facilities — one in Athens, Georgia and another in Manhattan, Kansas.

In Athens, ARS is modernizing the biocontainment facilities and expanding the capabilities of the Southeast Poultry Research Laboratory, ARS' preeminent location for poultry related disease, toxicology, and food safety research.

The new National Bio- and Agro-Defense Facility (NBAF) in Manhattan will allow ARS and the USDA Animal and Plant Health Inspection Service to safely study foreign animal and zoonotic diseases, such as foot-and-mouth disease of cattle, classical swine fever, and African swine fever, that are not yet in the United States. When completed in 2023, NBAF will replace an aging facility at Plum Island, New York, which is currently the primary USDA laboratory responsible for research on high-consequence foreign zoonotic diseases, but which lacks the infrastructure to work with the highest level BSL-4 biosafety agents.

The most irreplaceable component of our infrastructure, however, is our employees. ARS has internationally recognized scientists working on every issue affecting American agriculture today. ARS scientists arc engaged in the agricultural, biological, chemical, engineering, veterinary medicine, human nutrition, food technology, and physical science disciplines on 690 research projects that fall under four broad research areas:

- Nutrition, Food Safety, and Quality;
- Animal Production and Protection;
- Natural Resources and Sustainable Agricultural Systems; and
- Crop Production and Protection.

It is this science that provides help in controlling plant and animal diseases; finding ways to ease the effects of drought and soil depletion; increasing yields and sustainablc production of plant crops; determining nutritious dietary food choices; and developing new products from our Nation's agricultural production.

The key to our success has been our strong partnerships and collaborations. We work closely with Land-Grant university researchers; scientists from other Federal agencies; international organizations; and many industry scientists and producers. As an example of that cooperation, the development of ARS' LTAR network involves the collaborative efforts of 60 universities, 15 Federal agencies, 29 international organizations, 25 non-governmental organizations (NGOs), 19 private industry firms, and 12 State government agencies.

ARS scientists also continue to play an important role in providing the objective science that action and regulatory agencies in USDA and other Federal departments need and use as the basis for developing their policies. For instance, under the IR-4 program, ARS scientists evaluate the safety and residue of pesticides on specialty crops grown in fields using established application protocols. The data generated is used by the U.S. Environmental Protection Agency to inform its decision on pesticide labeling and use.

ARS scientists also provide critical support to the USDA Animal and Plant Health Inspection Service (APHIS) on numerous fronts, such as during the 2015 outbreak of highly pathogenic avian influenza that started in Washington State and soon spread across the Midwest, resulting in the loss of 49 million chickens and turkeys from approximately 200 farms. ARS scientists quickly implemented a rapid response research program to determine the virulence, host range, and transmission capabilities of the emerging viruses. Within weeks, ARS scientists had developed a rapid molecular test to detect the H5N8 and H5N2 viruses causing the disease. They then transferred the test to the APHIS National Veterinary Services Laboratory to help APHIS track and react to the spread of the viruses.

ARS' institutional capacity, wide-ranging expertise, and geographic reach allows it to conduct coordinated and integrated research targeting national and regional agricultural priorities of importance to our many stakeholders. One such example is the national coordination involving ARS, APHIS, and NIFA to focus efforts to control and eradicate Huanglongbing, or citrus greening, which also involved private industry from Florida, California, and Texas, State departments of agriculture, and university researchers. The collaboration was essential to identifying research gaps, establishing priorities, and developing a coordinated research plan to manage the citrus greening disease and its insect vector across a variety of interests. ARS' in-house expertise and NIFA's financial support for increased research were brought to bear on this

most serious threat the U.S. citrus industry has ever encountered. While the disease continues to impact the production of citrus in Florida, it has only been found in limited instances in other citrus-producing states to date.

Meanwhile, ARS and its collaborators have made significant strides in preparing industry to better cope with its presence. We have developed new citrus tree rootstocks more resilient to the disease; techniques for preventing or mitigating the disease from infecting trees; and strategies to reduce the population of the insect vector.

Recently, ARS' decades-long expertise was also called upon to address an outbreak of New World screwworms in Florida Key deer on Big Pine Key, the first U.S. infestation reported in 30 years. The screwworm is devastating for cattle ranchers and caused tens of millions of dollars in loses each year before it was eradicated from the United States in 1966 using a technique developed by ARS scientists. ARS researchers in the 1950s developed the sterile fly technique that involved releasing sterilized (infertile) screwworms into infested areas, where they would mate with wild screwworms without producing any progeny. ARS and APHIS continue to collaborate on a sterile fly rearing facility in Panama that is supplying flies today to create a barrier in Central America to prevent the spread north of screwworm populations still persistent in South America. In Florida, ARS scientists, working with APHIS and the Florida Department of Agriculture and Consumer Services, brought in nearly 154 million sterile flies from the Panama facility and released them in the Keys and southern Florida. By April 2017, 5 months after the infestation was discovered, APHIS announced the screwworm had been successfully eradicated from Florida.

Since its inception, USDA has recognized the importance of maintaining a research infrastructure of both intramural and extramural research. This includes NIFA, which as USDA's extramural agricultural research agency provides research funding to scientists who work at universities and other public organizations, including Federal agencies. To avoid duplication of effort and enhance coordinated research goals, ARS and NIFA have established agency mechanisms for identifying overlap/duplication of research projects in related topic areas.

This involves checking the CRIS database for duplicative current research projects; vetting proposed projects through an external peer-review process; joint agency meetings with stakeholders; and active communication between national program leaders at both agencies and

with other members of the scientific community. However, the strength of having intramural programs provides ARS and USDA with unique capabilities, capacities, and responsibilities:

- Conduct inherently governmental, or for "the public good", research;
- Support action and regulatory agencies, such as APHIS, FSIS, and the EPA;
- Maintain essential germplasm collections;
- Conduct long-term nutritional studies and maintain databases;
- Operate long-term experimental watershed facilities;
- Respond to emergent national priorities; and
- Engage in long-term research to meet national goals;

This infrastructure, expertise, and nationwide network of partnerships is needed to respond quickly to a national agricultural emergency like the H1N1 swine flu virus or soybean rust, and to prepare for those emerging diseases – such as the Ug99 stem rust disease of wheat or the foot-and-mouth disease of cattle – that are not yet in our country.

In a 2011 study on returns to investment from USDA intramural agricultural research, the USDA Economic Research Service estimated that for every dollar spent on research, the country received approximately $17 in economic benefit. These returns include benefits not only to the farm sector, but also to the food industry and consumers. Over the years, our public investment, and the cooperation in agricultural research among the private sector, universities, and government, has given Americans the safest, most nutritious, and most abundant food supply anywhere.

Agriculture has formed the foundation of our national economy for the past 200-plus years, and agricultural research has given strength to that foundation. And that is the mandate President Lincoln gave the USDA at its founding. As we face the challenges to U.S. agriculture in the coming decades, ARS will continue to place a premium on expanding our scientific cooperation where we can and with whom we can, and on sharing our information and technology as freely as possible to help the American farmer.

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Georgia Tech Research Institute

Written Remarks by Gary McMurray
Division Chief, Food Processing Technology Division, Georgia Tech Research Institute
Associate Director, Institute for Robotics and Intelligent Machines, Georgia Institute of Technology
Member of Advisory Council for Foundation for Food and Agriculture Research
Atlanta, Georgia

Senate Committee on Agriculture, Nutrition, and Forestry

June 15, 2017

Good morning Chairman Roberts, Ranking Member Debbie Stabenow, and members of the committee. My name is Gary McMurray and I am the Division Chief for the Food Processing Technology Division of the Georgia Tech Research Institute (GTRI) in Atlanta, Georgia. I am honored to lead a team of 28 full-time research professionals, 14 academic professors, and 40 students working in the areas of perception and sensing (food quality and food safety), robotics and automation, energy, and environmental engineering in support of the agriculture and food processing industries. I am also the Associate Director for the Institute for Robotics and Intelligent Machines (IRIM) at Georgia Tech. IRIM serves as an umbrella organization that brings together over 75 roboticists to create new and exciting opportunities for faculty collaboration; educate the next generation of robotics experts, entrepreneurs, and academic leaders; and partner with industry and government to pursue truly transformative robotics research. In addition, I am a member of the Advisory Council for Food Waste and Loss for the Foundation for Food and Agriculture Research. Thank you for the invitation to discuss the importance of agricultural research and innovation as you prepare the next Farm Bill.

Investing in agricultural research is critical and necessary to address the future food production needs of the United States and the world. The need for an additional 75 percent more food by 2050 is well documented and the focus of a great deal of research. The USDA has made significant investments that have produced incredible improvements in yield per acre and reduced the inputs required to achieve that yield. However, to make even greater strides in this area, transformative innovation is needed. Transformative innovation moves beyond just improving existing methods and processes to totally re-thinking systems development by creating entirely new systems.

At Georgia Tech, we are very focused on the technology required to make the next quantum leap in food production systems. Georgia Tech is consistently ranked in the top 5 engineering schools in the United States and has received significant research dollars from other federal agencies such as National Science Foundation, Department of Energy, Defense Advanced Research Projects Agency, and the Department of Defense. GTRI has been a leading research institute for more than 80 years and prides itself with developing technologies that help industry and government solve complex problems. Robotics and sensors, in conjunction with machine learning, have been the key technologies behind our agricultural research endeavors. In conjunction with our colleagues at the University of Georgia (UGA), we are currently focused on two main areas that we believe can benefit from new technology.

Crop monitoring for biotic yield-reducing factors (pest organisms such as insects, plant pathogens, and weeds) and abiotic stresses (such as inadequate moisture and nutrient levels) are pivotal components of integrated crop and pest management systems, but manual crop scouting by growers or crop consultants is often time- and cost-prohibitive. In the state of Georgia alone, yield losses due to these factors exceed a billion dollars a year. Multi- and hyper-spectral satellite imagery has been studied for years as a method to monitor crop health, and unmanned aerial vehicles (UAVs) are currently garnering considerable attention as a method of remote crop monitoring. Although such systems can detect plant stresses, they are not capable of autonomously collecting samples for identification and verification of the cause of the stress symptom. In this area, we are working on autonomous systems for improved field scouting and sampling for peanuts. These systems are instrumental in providing earlier detection of pests as well as abiotic yield-reducing factors, thereby preventing crop loss and improving the efficacy of agrichemical applications.

We are also developing advanced sensing capabilities for unmanned ground vehicles (UGVs) that work in conjunction with unmanned aerial vehicles (UAVs) to autonomously map presymptomatic (plants that show no visible symptoms of disease) and infected plants using real-time volatile organic compounds (VOC) emissions data and ground images of leaves, fruits, and the stem. This technology will enable earlier detection of infected bell pepper plants or peach trees and identify the source of plant stress for timelier and more targeted intervention spraying, thereby preventing crop losses and improving the efficacy of agrichemical applications. This is a significant problem on the farm as growers currently lose over 12 percent of their crops to disease. This work integrates collaboration between aerial and ground robotic systems, advanced perception to build 4D models of individual plants, novel micro-electromechanical sensors for measurement of volatile organic compounds from plants, and sensors to measure root mass in the soil. We are using advanced machine learning techniques to synthesize the different sensor data into a decision. This is especially important in forestry, orchards, and groves as trees can be presymptomatic for up to 10 years with some diseases while they are producing the bacteria to infect other trees the entire time.

What is important about these problems is they were not something that Georgia Tech or UGA was even aware of as being problems. It was only through intentional and consistent interaction with UGA plant scientists and extension experts that the problems were identified as critical and ones that Georgia Tech had technologies and experts that could contribute to a solution. This type of interdisciplinary work involving engineers, computer scientists, plant scientists, and extension personnel is critical to making the next leap in innovating food production systems. Much like the biomedical revolution, it is the integration of multiple disciplines into a single project that allows for the transformative innovation that provides improved products for the consumer and builds new industries in the United States. The amazing new biomedical devices ranging from robotic surgery, new sensing systems, and disease diagnosis using artificial intelligence never would have occurred without significant investment by NSF and NIH in multidisciplinary projects.

There are many examples of federally funded large, multidisciplinary projects that often result in transformative innovations. Examples include the NSF Engineering Research Centers and Science and Technology Centers and the National Network Manufacturing Innovation (supported by various federal agencies). The Department of Defense's DARPA and the Department of Energy Advanced Research Projects Agency – Energy fund high risk, high reward projects that drive transformative innovation. A recent example is DARPA's Insect Allies program that is focused on using targeted gene therapy and viral manipulation to spread disease-resistant genes to plants via insects so that mature plants are protected

from disease in a single growing season. The current structure of USDA is well suited for funding the basic science work that has had a tremendous impact on all of our lives, but it is not suited to funding this type of multidisciplinary research.

I would respectfully propose that the next Farm Bill include the creation of an Advanced Research Projects Agency – Ag (ARPA-AG) to create the next generation of transformative research in agriculture by bringing together multidisciplinary university-based research teams. The agency would bring together experts in nutrition, soil sciences, plant pathology, plant physiology, and other fields of sciences with technology experts in robotics, sensors, artificial intelligence, materials, supply chain logistics, and energy systems to solve the most complex problems in agriculture. Examples of these large, multidisciplinary projects include areas such as efficient, high-throughput phenotyping; individual plant management to optimize yield; and efficient, dynamic supply chains to minimize food waste and loss. These are examples of the types of projects that are necessary to take the next leap in innovation, but they do not fit within USDA's current research structure. Only through the creation of an ARPA-AG can we provide the necessary resources required for multidisciplinary teams to solve these complex problems.

Finally, the next Farm Bill must address the issue of overhead restrictions. Today's leading engineering universities are major partners in driving innovation in every economic sector other than agriculture. These universities will be deterred from participating in USDA opportunities until the overhead issue and cost-matching requirements are revisited because most of them are not land-grant universities. The overhead rate at USDA must be on par to what other federal agencies like NSF and NIH pay to attract the best minds to solve these critical problems. A partnership between engineering universities with their systems approach and technology focus and land-grant universities with their agriculture expertise would be a powerful team to bring the types of transformative innovation that the agricultural community needs to keep our growers profitable and the world fed.

The entire Georgia Tech community looks forward to working with USDA and NIFA to solve the problems that face our agricultural community. We know that these problems are critical to maintaining one of the most important industries to our nation and our world. The challenges are large, but I am confident that through a systems approach coupled with integrated, multidisciplinary teams, we can begin to solve these problems in a cost-effective manner that will maintain the public's confidence in our ability to produce safe and affordable food while allowing the growers and the affiliated industries a profit. I look forward to working with the USDA, the academic community, and the industry to achieve these goals.

I would be happy to respond to any questions that the members may have.

Statement by
Dr. Sonny Ramaswamy
Director of the National Institute of Food and Agriculture
Before the Senate Committee on Agriculture, Nutrition, & Forestry
June 15, 2017

Chairman Roberts, Ranking Member Stabenow, and Members of the Committee, I am honored to have this opportunity to speak about the National Institute of Food and Agriculture (NIFA), whose mission is to catalyze transformative research, education, and extension to address 21st century agricultural challenges. At the outset, I would like to thank you and the Committee for your dedication to America's farmers and livestock producers. Your support of U.S. Department of Agriculture (USDA) agencies such as NIFA promotes the productivity and profitability of our farmers and the health and safety of all Americans.

I have had the privilege of traveling across America and experienced first-hand the impact of our data-driven, research and extension investments. For example, wheat blast, a crop disease caused by the fungus *Magnaporthe oryzae triticum* (MoT), can result in 30-100 percent crop loss. In spring 2016, work undertaken by Kansas State University scientist Barbara Valent and her colleagues helped prevent the devastating impact of this disease in the United States. With support from two NIFA Agriculture and Food Research Initiative (AFRI) grants totaling $5.4 million, Dr. Valent and her colleagues from the University of Kentucky and USDA-Agricultural Research Service created a sensitive new method to detect the fungus. In tests, it accurately distinguished all known strains of MoT from more than 280 specimens of *M. oryzae* collected around the world. The method yields results in less than 24 hours and is sensitive enough to detect even trace amounts, and will protect our wheat production systems and enhance profitability.

Similarly, Michigan State University (MSU) Extension, with partial Smith-Lever extension funding from NIFA, deployed a rapid response to the crisis of lead contamination of water in Flint, Michigan. MSU specialists offered educational workshops and wrote several articles and fact sheets on lead poisoning; they facilitated the distribution of 12,000 gallons of milk to the Food Bank of Eastern Michigan. Milk can be used to mitigate the effects of lead

absorption, as it is rich in iron, vitamin C, and calcium. Additionally, MSU Extension worked with partner organizations to fund and distribute water filters and soil tests. MSU coordinated with Edible Flint, an informal cooperative of food producers, to focus new programs on lead in soils and educating people who grow their own food. Such grassroots work by Extension is crucial to the vitality of our communities in rural and urban America.

NIFA was established by the Food Conservation and Energy Act of 2008 (the 2008 Farm Bill) to find innovative solutions to issues related to agriculture, food, the environment, and communities. NIFA's investments are driven by the six priorities articulated in the 2014 Agricultural Act: Plant Health, Production, and Products; Animal Health, Production, and Products; Bioenergy, Natural Resources, and the Environment; Food Safety, Nutrition, and Health; Agriculture Systems and Technology; and Agricultural Economics and Rural Communities. NIFA supports user-inspired discoveries that transform lives: in the classroom, on farms, in communities across our great nation, and in other countries where often the need is greatest. My six-year term appointment as director expires in May 2018, with the position subject to an additional six-year term, as mandated in the 2008 Farm Bill.

NIFA is one of four agencies within USDA's Research, Education, and Economics (REE) mission area, and is authorized to direct federal funding through approximately 60 capacity, or formula based, and competitive grant programs that address key national and global challenges. NIFA invests in and advances agricultural research, education, and extension to solve societal challenges, thus ensuring nutritional security in the context of diminishing land and water resources, changing climate and extreme weather events, while promoting the health and well-being of all Americans and creating economic opportunities in rural communities. The agency promotes the education and training of our nation's workforce through programs offered to support K-12 education, along with undergraduate and graduate education. NIFA supports technology transfer and knowledge sharing through Cooperative Extension; additionally, the agency manages the Small Business Innovation Research (SBIR) grant program for USDA. The agency has approximately 350 employees and was funded at approximately $1.53 billion in Fiscal Year 2017 through discretionary and mandatory lines; the agency also generates approximately $50 million per year in interagency collaborations and reimbursable agreements with other federal agencies.

Organizationally, NIFA is divided into two units: programs and operations. The Civil Rights Office and Congressional Affairs Office report to the agency director.

Associate director Meryl Broussard oversees NIFA programs deployed through four institutes (Food Production and Sustainability; Food Safety and Nutrition; Bioenergy, Climate, and Environment; and Youth, Family, and Community), the Center for International Programs, and Planning, Accountability, and Reporting. Staff in the programs unit help develop science priorities based on congressionally mandated Farm Bill priorities, those of the White House and Secretary of Agriculture, and seek input from the vast array of stakeholders across America. They also deploy funding opportunities through Requests for Application (RFAs), work with external peer reviewers to select the best ideas for funding, undertake pre- and post-award management, and evidence based analysis of achievement of goals.

Associate director Robert Holland oversees the agency's operations through the Office of Grants and Financial Management, the Office of Information Technology, Budget, and Communications. A key role for the operations unit is implementing NIFA's grants modernization initiative to streamline the agency's grant application and award process. This business transformation initiative will result in increased efficiency and reduced costs (in system maintenance and staff time) for NIFA grantees and staff. NIFA is now using ezFedGrants, a new web-based grants and financial management system used by several USDA agencies, to support this initiative. Additionally, the information technology staff manages NIFA's Data Gateway, an online portal that allows users to find funding data, metrics, and information about research, education, and extension projects that have received grant awards from NIFA. The user can render and visualize data using various tools, including by State, Congressional District, and Science/Knowledge Area. NIFA is committed to increasing transparency and making technical advancements to ensure that data are easily accessible.

NIFA has been in existence for eight years, but its history goes as far back as the creation of the People's Department and land-grant Colleges in 1862. Landmark farm bills and other significant legislation passed by Congress have shaped the history of NIFA and its predecessor agencies. The Morrill Act of 1862 created land-grant institutions (LGUs) to enable children of the working class to have access to higher education with a focus on agricultural and mechanical skills. The Morrill Act of 1890 established the 1890 land-grant institutions to promote

educational opportunities for African Americans. The Equity in Educational Land-Grant Status Act of 1994 established the 1994 land-grant institutions to promote educational opportunities for Native Americans.

The Hatch Act of 1887 authorized strengthening the capacity of land-grant colleges to research agricultural problems faced by rural citizens by providing funds to create a series of agricultural experiment stations across America. The Cooperative Extension System was created through the 1914 Smith-Lever Act, as a partnership between the federal, state, and local (county/county equivalents) governments.

NIFA is committed to supporting the research, education, and extension efforts of its 112 land-grant partners through legislatively authorized capacity funds, comprising 49 percent of NIFA's annual appropriations. Several types of capacity funds for supporting research, Extension, and 4-H are available annually on a non-competitive basis and require a match at the state and local levels. The amounts allocated to each state depend on variables such as rural population, farm population, forest acreage, and poverty rates, as authorized by Congress.

Key capacity funding programs include Hatch capacity funding, which supports research and training of students at state agricultural experiment stations (SAES). McIntire-Stennis capacity funding supports forestry research and training at SAES, forestry schools, and land-grant forestry research programs. Renewable Resources Extension Act capacity funding supports forest and rangeland education programs that benefit landowners and managers, communities, and the environment. Animal Health and Disease Research capacity funding enhances the capacity of veterinary schools and SAES to conduct research to improve the health of poultry, livestock, aquaculture, and other income-producing animals. Expanded Food and Nutrition Program (EFNEP) capacity funding provides nutrition education programming to low-income families to help them develop healthy habits in eating, physical activity, food handling, and food storage.

Cooperative Extension is funded through Sections 3(b) and 3(c) of the Smith-Lever Act. Extension provides non-formal education and learning activities to people throughout the country – to farmers and other residents of rural communities, as well as to people living in urban areas. By translating knowledge into solutions and delivering to end users, NIFA helps improve and transform people's lives. 4-H, our nation's preeminent positive youth development

program, is funded through Extension with NIFA-supported 4-H programs positively influencing over 6 million children across the country every year.

With Hatch funding, South Dakota State University collaborated with Agrisoma Biosciences, Inc., and the SD Oilseeds Council to develop an oilseed crop, Carinata, to be used for production of bio-based jet fuel and diesel for the U.S. Navy. Carinata, which has the potential to be used as a 100 percent petroleum substitute in biodiesel, bio-jet fuel, oil additives, and specialty lubricants, can reduce dependence on petroleum-based products.

NIFA's 1890 land-grant institutions programs are intended to strengthen research, extension and teaching in the food and agricultural sciences by building the institutional capacities of the 19 institutions with the LGU designation. 1890 programs include 1890s Extension that provides primary support for extension programs at 1890 LGUs, while Evans-Allen capacity funding supports research and training of students at 1890 land-grant institutions.

NIFA-funded researchers at the University of Maryland Eastern Shore studied factors that affect antibiotic resistance and virulence of *Salmonella* during poultry processing. Their analysis showed that chilling can lead to *Salmonella* contamination and cross-contamination among poultry carcasses but has no effect on the prevalence of antibiotic-resistant genes. This knowledge is being used to develop tools to help poultry inspectors improve *Salmonella* detection, helping to improve food safety and prevent future food recalls.

At Georgia's Fort Valley State University (FVSU), new leaders in agricultural and life sciences are coming face-to-face with technology that will help them solve the toughest agricultural challenges of the future. A $150,000 grant from NIFA's 1890 Capacity Building program helped FVSU create a bioinformatics curriculum where students learn to transform biological research into informational science. In the program, science, technology, engineering, and mathematics (STEM) majors join with computer science majors to become competent bioinformatics programmers and gain hands-on experiences in writing algorithms and coding for biological problems. Bioinformaticians use computers to store, organize, and analyze the vast amounts of data generated by scientific research.

The Equity in Educational Land-Grant Status Act, within the Improving America's Schools Act of 1994, established 29 tribal colleges and universities as 1994 tribal land-grant institutions. There are currently 36 LGUs with 1994 tribal land-grant institution status. NIFA

funds five programs that promote learning, opportunity, and health in Indian Country. These programs give them access to federal government resources that improves the lives of Native students through higher education and help propel American Indians toward self-sufficiency. These resources also support innovative research, education, and extension programs that positively impact agriculture and food production. These programs include the Tribal College Equity program, which supports formal education at these schools. The Tribal College Extension program supports informal, community-based learning such as farmer education, youth development, and rural entrepreneurship. The Tribal College Research program helps the 1994 LGUs build scientific capacity and provide a strong foundation in research knowledge for students. The Tribal College Endowment program receives annual appropriations from Congress, and the institutions receive money from the interest earned during the previous year. The amount each school receives is based in part on the number of Native students attending the school, and is determined annually through the Indian Student Count. The Federally Recognized Tribes Extension Program (FRTEP) allows 1890 and 1862 LGUs to provide informal learning to support youth development and agricultural productivity. They complement Extension efforts of the 1994 LGUs, often serving in states that do not have a 1994 land-grant institution.

According to the Department of Health and Human Services' Indian Health Service, American Indians are 2.2 times more likely to have diabetes compared to non-Hispanic whites. The United Tribes Technical College (UTTC), in Bismarck, North Dakota, is doing its part to lower that number by mentoring nearly 450 people at five diabetes-related events. UTTC also produces three publications that were delivered to more than 11,000 local households. In 2017, UTTC plans to host three 6-week training sessions for 10-15 people each, covering topics such as understanding and monitoring the human body, nutrition, and physical activity.

A recent TEConomy report (page 3, https://nifa.usda.gov/resource/nifa-capacity-funding-review-teconomy-final-report) states that capacity funding generates an additional $1.86 in non-federal funding for every $1 in federal funds, considerably expanding the utility of federal funding dollars. Between 2000 and 2015, there were 19,971 projects supported by capacity fund; 1 in 6 patents in agriculture across the U.S. are based on innovations resulting from these capacity funds. In 2014, about 31,500 full-time equivalent jobs were supported by capacity funds.

NIFA deploys almost $700 million in competitive grants, funding for which are derived through annual discretionary appropriations and mandatory programs. The Agriculture and Food Research Initiative (AFRI) is America's flagship competitive grants program for agricultural sciences. AFRI was created in the 2008 Farm Bill and authorized at $700 million annually. The Fiscal Year 2017 Omnibus Appropriations Act provides $375 million to AFRI. AFRI competitive funds support research, education, and extension grants to promote productivity and profitability of farming systems, improve rural economies, combat childhood obesity, promote the bioeconomy, mitigate the impacts of climate variability, address water availability issues, ensure food safety and security, and train the next generation of agricultural workforce.

Other key competitive grant programs include the following mandatory programs: Organic Agriculture Research and Extension Initiative (OREI), Biomass Research and Development Initiative (BRDI), Specialty Crop Research Initiative (SCRI), Emergency Citrus Research and Extension Program (CDRE), Food Insecurity Nutrition Incentive Program (FINI), Biodiesel Fuel Education Program, Agriculture Risk Management Education Program, and the Community Food Projects Competitive Grants Program.

A deadly bacterial disease—Citrus Greening or Huanglongbin—has infected up to 80 percent of Florida's citrus trees and cost billions in lost revenue. U.S. citrus growers have a critical need for grove-deployable management practices that keep healthy citrus from becoming infected. With a $6 million SCRI grant, Dr. Susan Brown, Kansas State University, and colleagues from other institutions are collaborating to combat the disease by developing innovative approaches to stop the pathogen from developing in and being transmitted by the vectoring insect.

NIFA administers USDA's Small Business Innovation Research Program (SBIR), which offers competitive grants to support small businesses undertaking research on the feasibility of starting viable small businesses to address agricultural challenges. The program stimulates technological innovations in the private sector, strengthens the role of federal research and development in support of small businesses, and also fosters and encourages participation by women-owned and socially or economically disadvantaged small businesses.

In 2014, the porcine epidemic diarrhea (PED) virus was responsible for the death of eight million piglets in the United States. Developing a vaccine took many months, making it hard to rescue the declining swine community. Harrisvaccines, in Ames, Iowa, with funding from NIFA

through the SBIR program, used its patented SirraVaxSM technology to analyze PED gene sequences to commercialize a vaccine in just four months, and gained conditional licensure from USDA. The vaccine, called iPED, is administered to sows right before they give birth to a litter, protecting the piglets. Recently, Harrisvaccines has been acquired by Merck Animal Health, which will deploy this vaccine to protect piglets.

NIFA reviews all proposals through the external peer review process for individual competitive programs. Evaluation criteria are described in the Requests for Application (RFAs). The total time for this entire peer review process is about six to nine months. Prior to the RFA or soon after its release, the respective NIFA National Program Leader (NPL) selects a Panel Manager (PM) with the appropriate expertise to lead the panel review process alongside the NPL. The PM is not a NIFA employee and is hired as a temporary Federal Employee. Proposals are accepted for panel review if the proposal addresses the program priorities and is submitted to NIFA before the RFA deadline date. The PM works closely with NPLs to ensure a diverse panel with the appropriate expertise is constituted to review proposals submitted to the program, assign proposals to panelists based on panelist expertise, and lead the panel review meeting.

Panelists develop their individual reviews for each proposal assigned to them prior to the review panel. Once the peer review panel meets (in person or virtually), the entire panel discusses each proposal and reaches a consensus rank within each peer review category. Those in Outstanding, High Priority, and (extremely rarely) Medium Priority categories are respectively funded until no appropriated funds are left. Peer Review Panel Ranking Categories are Outstanding, High Priority, Medium Priority, Low Priority, and Do Not Fund. Following the funding decisions, applicants receive copies of the written reviews of their proposal (with reviewer name removed to maintain reviewer confidentiality), the panel summary, and information on the relative ranking of their proposal.

Funding rates in NIFA's competitive grants programs range from approximately 13 percent in AFRI to approximately 19 percent in SCRI; because of the significant competition for funding in AFRI, many worthy ideas addressing agricultural challenges go unfunded. NIFA is attempting to develop multiple approaches to enhance the funding rate, including administrative policy changes to address unobligated funding from prior years.

NIFA collaborates with other federal agencies within and outside of USDA, including the National Science Foundation, National Institutes of Health, Agricultural Research Service, United States Agency for International Development, Department of Energy, Environmental Protection Agency, Centers for Disease Control and Prevention, Health and Human Services, Department of Veterans Affairs (VA), and Department of Defense (DOD), to accelerate progress on the discovery and application of solutions to high priority agricultural and societal challenges. By partnering with agencies with complementary missions, we are able to leverage funding and bring a wider range of capabilities, expertise, and experience to our programs.

NIFA, DOD, and VA collaborate to support those who protect America: active duty military and their families, along with veterans. Research suggests that children of deployed parents experience more stress than their peers. NIFA, DOD, and VA collaborations have helped thousands of military families gain access to the high-quality educational programs in early childhood education, youth development, and related fields that land-grant university cooperative extension systems provide. In nearly every state, 4-H Military Partnerships offer programs for children from military families. NIFA also engages military veterans through the Beginning Farmer and Rancher Development Program (BFRDP), which funds organizations that train beginning farmers and ranchers through workshops, educational teams, training, and technical assistance. Nearly 10 percent of BFRDP funding went to projects that serve military veterans in 2016.

Collaboration with our stakeholders ensures that NIFA responds to their needs and the needs of the end-user. Our staff interacts with LGUs on a continual basis through respective national program leaders and our state liaisons. NIFA also keeps keep open lines of communication with other stakeholders. Additionally, NIFA periodically holds formal listening sessions to garner feedback from all stakeholders and stakeholders are encouraged to provide feedback on our RFAs via a web portal. NIFA is undertaking a series of "Calls to Conversation" meetings aimed at continuing to work with stakeholders to seek a shared vision to enhance the effectiveness, efficacy, and efficiency of agency programs.

Colorado State University, the University of Wyoming, and NIFA hosted the first such Calls to Conversation in September 2016. The meeting, themed "*Engagement and Success of Land-Grant Universities and Colleges – Respecting Sovereignty, Serving the People and the*

Land," was held for the purpose of promoting a candid and productive conversation between the 1994s and 1862s, to discuss ways to strengthen their relationship, and chart a course for a more collaborative and productive future.

In February 2017, the University of Maryland and NIFA hosted a conversation on the topic of Tactical Sciences: a complementary set of programs offering the tools to protect the integrity, reliability, sustainability, and profits of the U.S. food and agriculture system against threats from pests, diseases, contaminants, and disasters. The biosecurity of America's food and agricultural system is of utmost priority, and we are committed to supplying a toolkit of science-based tactics readily available to help prevent, prepare for, detect, respond to, and recover from known and potential pests, diseases, and other natural disasters.

In August 2017, the University of Georgia, Fort Valley State University, and NIFA will undertake a Call to Conversation on Positive Youth Development (PYD). 4-H, the youth outreach program of Cooperative Extension, reaches six million children and translates the sciences of engagement, learning, and change with youth and adults who collaborate to create sustainable community change. 4-H National Headquarters at NIFA provides leadership on positive youth development in the areas of citizenship, healthy living, and science.

The narrative provided above gives you an overview of the vast and complex programs and impacts NIFA has with funding from Congress. Through your continued support, NIFA can continue to spark innovation through funding of extramural research, extension, and education to address the significant agricultural and societal challenges facing humanity as a result of the burgeoning population. With your help, and the help of our stakeholders, we can meet those challenges head on. Thank you for this opportunity to highlight NIFA, our employees, our grant programs, and successes of those programs.

Written Statement for the Record of

Dr. Sally Rockey
Executive Director
Foundation for Food and Agriculture Research

Before the

U.S. Senate Committee on Agriculture, Nutrition, and Forestry

Hearing on

Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill

June 15, 2017

Foundation for Food and Agriculture Research

401 9th St NW, Suite 630 | Washington, DC 20001

www.foundationfar.org

Introduction

Chairman Roberts, Ranking Member Stabenow, and Members of the Committee, I am Dr. Sally Rockey, Executive Director of the Foundation for Food and Agriculture Research, and I am honored at the opportunity to testify as you continue discussions for the next Farm Bill. The Foundation for Food and Agriculture Research is an independent 501 (c) (3) nonprofit organization established with bipartisan Congressional support in the 2014 Farm Bill to serve as a new model in our nation's mission to be the global leader in food and agricultural sciences. Rather than repeat what others do, FFAR makes progress in seven strategic areas by finding critical gaps in research and accelerating problem solving using a new model in partnership and program design and delivery.

Much like President Abraham Lincoln referred to the U.S. Department of Agriculture (USDA) as the People's Department upon its founding in 1862, I believe FFAR is the People's Foundation. The Foundation belongs to everyone in the food and agriculture community, especially to our farmers and ranchers.

To the members of this committee who were so instrumental in establishing FFAR, I thank you on behalf of the entire food, agriculture and scientific communities. I look forward to the opportunity today to provide an update on FFAR's progress, give an overview of what lies ahead for the Foundation, and to demonstrate that FFAR remains worthy of this Committee's full support in the next Farm Bill.

FFAR is a New Model in U.S. Agriculture Science and Research

At FFAR, we envision a world in which ever-innovating and collaborative science provides every person access to affordable, nutritious food grown on thriving farms. FFAR's aim is to fund innovative and applied sciences that help to increase access to food, support producers and the agricultural economy, and foster environmental resilience. Additionally, FFAR builds unique partnerships that can address the most pressing challenges in food and agriculture. From the lab, to the farm, to the boardroom, the Foundation delivers solutions-based science that empowers and safeguards our nation's economic and national security while providing a significant return on the taxpayers' investment.

We are not a government agency, although USDA is our closest partner. Instead, the work we do complements scientific programming carried out by the USDA. Nor is FFAR a completely private entity, although we partner frequently with the private sector to respond rapidly to emerging challenges that can be addressed through research.

Thanks to this Committee's forethought, FFAR is something brand new for the agricultural arena. Designed to foster public-private partnerships meant to deliver bigger bang for the taxpayer's buck, FFAR is perfectly positioned to put America back on top as a global leader in agriculture R&D by accelerating problem solving on behalf of U.S. agriculture.

FFAR matches every program dollar with outside funding, delivering huge value for American taxpayers. Every $1 contributed by FFAR has been more than doubled by our funding partners. In other words, the U.S. government's $200 million investment in FFAR will eventually deliver more than $400 million in programming.

We have also formed a diverse and esteemed Board of Directors led first by Dan Glickman, former Agriculture Secretary, and now by Dr. Mark Keenum, president of Mississippi State University. In 2016, we expanded the Board by adding six new positions. Today, the Board of Directors includes 19 voting members and five ex-officio members designated by Congress, none of whom receive compensation for their positions.

FFAR's non-voting ex officio members, including Agriculture Secretary Sonny Perdue, are the stewards of the Foundation's close partnerships with the National Science Foundation and the USDA. Specifically, these members provide insight into the federal research enterprise and ensure that FFAR's work complements USDA and NSF research.

The Foundation has also established six Advisory Councils to provide guidance on program development and implementation, potential partnerships, and other matters of significance across our research portfolio. Advisory Council members are leaders in their respective fields with expertise and experience spanning the food and agriculture industry from both a scientific and business perspective. We are grateful for their contributions.

FFAR Brings Together New Kinds of Partners

Owing to its unique public-private partnership model, FFAR is able to convene diverse groups that might not otherwise collaborate around common challenges of national and international significance. We have formed partnerships with farmer and commodity groups, retail, IT companies, the public health sector, and other foundations.

Since I came on board in 2015, FFAR has joined with 41 funding partners to carry out the Foundation's cutting-edge research agenda, including the Bill & Melinda Gates Foundation, the Laura and John Arnold Foundation, the Fair Food Network, the Indiana Soybean Alliance, the Iowa Corn Promotion Board, Kaiser Permanente Center for Total Health, Cargill and many others. Besides providing good stewardship of taxpayer dollars, FFAR's dollar-to-dollar match ensures our partners are equally invested in delivering value and seeing measurable outcomes, similar to other critical public private partnerships in the food and agriculture space, such as the federal crop insurance program.

By uniting researchers with groups like venture capitalists, partner governments and global philanthropies, FFAR can quickly bring research to scale and more than double the taxpayer's investment.

The Foundation also puts significant emphasis on convening external events and other information sessions with experts to identify critical research needs facing agriculture and food.

To that end, FFAR has reached more than 12,000 individuals in the food and agriculture research community through conference presentations and organized six large-scale convening events that have attracted leaders from science, farming, government, business, and the non-profit sector.

Additionally, FFAR staff have personally met with more than 400 groups in food, agriculture and research to hear their different perspectives on the most pressing issues. We continue to welcome insight from all facets of our vibrant food system: from scientists conducting food and agricultural research, to farmers in the field, to members of the public deciding what to feed their families each day. We seek researchable issues with the potential to yield pivotal pieces of knowledge that propel the food and agriculture field forward. This approach then translates to program implementation. For each project, we survey the food and agriculture field to ensure we are focusing on research questions that are not being answered elsewhere. We then look at the landscape and decide, project-by-project, how to convene the right partners to address a given issue.

To catalyze innovation, we believe we need not only brilliant minds, but also diverse perspectives tackling today's challenges in food and agriculture. It takes outside-the-box, interdisciplinary thinking to solve the food system's most pressing challenges. When soliciting research proposals or building a team, we strive to include experts with diverse backgrounds and in different fields, and perspectives from different sides and stages of an issue.

Many of the events and convenings mentioned above deliver immediate results. For instance, FFAR and Purdue University co-hosted an event to unite the field of plant phenomics by facilitating opportunities for collaborative research. Attendees from 11 countries, 34 companies, 30 academic institutions and a variety of commodity groups, nonprofit organizations and government agencies joined the discussion. Because of this event, FFAR will announce a collaborative project at the end of this month called Crops of the Future. This project will form a collaborative between several companies and organizations to identify genes that give rise to specific traits in plants that will be necessary in the future, including drought resistance, heat tolerance, and increased nutritional value. Companies will pool resources in a pre-competitive space so that results come more quickly and data can be shared.

Just recently, we held a convening event in Lincoln, Nebraska as part of our Overcoming Water Scarcity Challenge Area to determine potential research opportunities to improve irrigation systems.

FFAR is also seeking engagement on virtual platforms. To remain open to emerging innovation potential and facilitate public engagement in research opportunities, FFAR opened the online Concept Portal for public input on research concepts. To submit a research concept to the Foundation, you simply visit our website, foundationfar.org, and give an overview of the idea. Our staff will respond promptly and the idea may help to inform a FFAR research program or project.

FFAR is Delivering on its Promise

Since I joined FFAR as Executive Director in 2015, we have focused on building the foundation into an institution that will support U.S. food and agriculture long into the future. Over the past year-and-a-half, we have established critical resources and processes to support the Foundation's ability to solicit and review grant applications, build partnerships and issue research funding. Now, in 2017, we are seeing the fruits of this monumental effort.

I want to thank the members of this Committee for demonstrating patience as the Foundation was established. I believe, and I know you all agree, that FFAR was created to be an institution, rather than a short-term experiment, to contribute to the long-term competitiveness of our nation. With your support, we have built an efficient, nimble organization able to meet the most pressing challenges in food and agriculture.

To date, FFAR has delivered $32.4 million in 22 grants with more than 41 funding partners. By the end of the year, we will have obligated about half of our funding and identified more than $100 million in matching funds.

In addition to building awareness, educating the food and agriculture community on FFAR, establishing long-term partnerships and building the Foundation's systems and structures, we have focused primarily on garnering matching funds. Generating matching funds for any startup organization is a challenge.

What we have discovered over the past two years is that we have two distinct advantages over other government-established research foundations. First is our public funding, which gives FFAR the flexibility to seek out diverse partnerships, especially with the private sector. Rather than raising money for a government agency, which is the model for most government established research foundations, FFAR leverages public funding—more than doubling that funding—for the public good and, in the process, develops a new community of partners. Second is our independence, which allows us to focus almost exclusively on results. When partners are focused just on the science and equally invested in seeing measurable outcomes as soon as possible, new partnerships may develop.

I firmly believe the current FFAR model is working effectively. As a long-term safeguard, we continue to look at ways to take investment income earned by the Foundation and create a long-term fund that will support FFAR. Building a self-sustaining organization is part of the Foundation's five-year strategic plan, but that effort will take time. We will continue to lay the groundwork for future fundraising and partnerships, prioritizing projects that help to attract private sector investment.

Our goal today is to continue to demonstrate our value to this Committee and to the food and agriculture community as a highly effective organization that supports innovative work and collective research priorities.

FFAR Research Success Stories

FFAR now has the systems in place to design programs, assess requests, match funds, and award grants quickly and efficiently. For example, no grant cycle is longer than six months. Because of the expert staff and vetting in place, the Foundation can award grants in as little as one week, acting nimbly to mobilize resources to confront emerging pest, disease and climatic threats before it's too late. Grants can be awarded competitively, directly, or through challenges or prizes.

Taken together, the Foundation has a variety of tools in its toolbox. Of the $100 million in matching funds identified by FFAR to date, roughly 80 percent will come from non-academic entities, including industry, associations, retail, and foundations. These unique partnerships have allowed FFAR to achieve important results in a short period.

For example, this past March, FFAR announced a National Cover Crop Initiative in partnership with the Samuel Roberts Noble Foundation. The $6.6 million research initiative was made possible by a $2.2 million grant from FFAR—a two-to-one match—to promote soil health through the development and adoption of new cover crops across the United States. The National Cover Crop Initiative unites the resources of the two foundations with scientific expertise from several universities and USDA.

Two months later, FFAR responded to an emerging issue in egg production, announcing it had matched a grant to reduce bone fractures in cage-free, egg-laying hens. The research has the potential to improve the health and productivity of approximately 100 million hens by 2025 and garnered support from the United Egg Producers and the American Veterinary Medical Association (AVMA).

The work we are doing to reduce bone fractures in cage-free hens is just one program within our Protein Challenge, a suite of research programs that will support producers' efforts to improve plant and animal production efficiency to meet the growing global protein demand while conserving natural resources. In total, FFAR has seven Challenge Areas ranging from protein to urban food systems. The seven Challenge Areas were developed with direct input from farmers, consumers, industry, and other stakeholders.

Another innovative FFAR program is our Rapid Outcomes from Agricultural Research, or ROAR program. Through ROAR, FFAR makes available up to $150,000 in matching funds in one-year grants to combat or prevent new or emerging pest and pathogen outbreaks that threaten U.S. food and agriculture systems. ROAR enhances the nation's capacity to mitigate and prevent outbreaks by ensuring rapid review of grant applications and rapidly disbursing funding for research and extension. In this way, ROAR serves as a bridge to traditional, longer-term funding sources while supporting critical short-term research that will help farmers in the field.

For example, when an invasive pest decimated 21 percent of Michigan's 2016 cherry crop, FFAR formed a partnership with the Cherry Marketing Institute to fund scientists at Michigan State University to combat the pest, spotted wing drosophila (SWD). This ROAR grant will benefit the fruit industry in California, Idaho, Michigan, Montana, New York, Oregon, Pennsylvania, and Washington.

Just a few days ago, FFAR announced a new, incredibly innovative program with the University of Illinois that brings together computer scientists, plant scientists, mathematicians and breeders to develop realistic models that mimic plant response to their environment. The Crops *in silico* project, while very theoretical, has the potential to create virtual plant models that could speed up the time it takes to develop new plant varieties by replacing what are often times long term field trials.

As additional projects, events and grants are announced in the months ahead, we look forward to continuing our work with the Committee to streamline FFAR's operations and administration, and we look forward to your suggestions.

How FFAR Designs Programs

There are seven Challenge Areas that guide FFAR's work. Developed in consultation with farmers, consumers, industry, and other stakeholders, the Challenge Areas are:

1. **Protein Challenge** helps to sustainably increase the production of high quality protein to meet current and future demands.
2. **Overcoming Water Scarcity** aims to increase the efficiency of water use in agriculture, reduce agricultural water pollution, and develop water reuse technologies.
3. **Forging the Innovation Pathway to Sustainability** helps break down barriers to the adoption of technology and research results into sustainable practices.
4. **Healthy Soils, Thriving Farms** aims to increase soil health by building knowledge, fueling innovation, and enabling adoption of existing or new innovative practices that improve soil health.
5. **Food Waste and Loss** seeks to mitigate social, economic, and environmental impacts from food waste and food loss.
6. **Urban Food Systems** enhance our ability to feed urban populations through urban and peri-urban agriculture, augmenting the capabilities of our current food system.
7. **Making "My Plate," Your Plate** focuses on research that includes, but is not limited to, increasing the production and accessibility of fruits and vegetables with optimal nutritional quality and taste desirability, and reviewing system constraints that not only impede the incorporation of more fruits and vegetables into the supply chain, but also decrease farmer profitability and consumer affordability.

In addition to these seven Challenge Areas, FFAR addresses pressing issues in food and agriculture that cut across multiple areas, such as pollinator health and emerging pest and disease threats.

FFAR is Building the Bench

By championing the next generation of food and agriculture scientists, the Foundation is also taking an important step in making agriculture an attractive field for aspiring scientists through the New Innovator in Food and Agriculture Research Award. As a scientist, I am particularly proud of the New Innovator program.

It was an honor last year for FFAR to award its first grants to nine talented early career researchers, or New Innovators, in partnership with their respective universities. FFAR invests in faculty members within the first three years of their careers to allow our best and brightest to pursue innovative and transformational ideas uninhibited by the pressure of identifying their next grant. Our goal is to train, encourage, and inspire future generations of agricultural and food scientists. FFAR announced nine New Innovator awards in 2016, including Dr. Kisekka of Kansas State University. Dr. Kisekka's research will integrate data to develop methods and tools for optimizing water use in agriculture. Another researcher from Purdue University seeks to improve plant disease mitigation by investigating which genes are communicating through plant root systems. The 2017 awardees will be announced this summer, and we look forward to sharing their names with this Committee.

In that same vein, FFAR has partnered with the National Academies of Sciences, Engineering, and Medicine and the Supporters of Agricultural Research (SoAR) Foundation to launch Breakthroughs 2030, an innovative effort to determine the greatest scientific opportunities in the next decade within the fields of food and agriculture. Breakthroughs 2030 will respond to the numerous reports issued by government and non-governmental organizations on the relationship of the food and agricultural system to public health, food security, national security, trade, economic development, and the environment. Most of these reports emphasize the need to dramatically increase food production worldwide to feed a growing global population. Tapping the ingenuity and knowledge of the American research community, Breakthroughs 2030 will produce a blueprint for how research can solve these major issues. FFAR is proud to support this effort on behalf of U.S. food and agriculture.

Evolving Our Institutions to Meet New Challenges

A few years ago, a seismic shift occurred in global leadership when China overtook the United States in public agricultural R&D. By 2013, according to the USDA, they had a 2-to-1 advantage over the United States. But the members of this Committee did not take that news lightly. Instead, you took a bold step by establishing FFAR with bipartisan support.

In my lifetime, total agricultural output in the United States has grown nearly 170 percent with less land and labor due to the adoption of technologies in crop and livestock breeding, farm

equipment, fertilizer use, pest management, and farming practices. Advances in food, agricultural, and environmental sciences depend upon this research. And to put a finer point on these achievements—over that same period, the United States has established itself as the most consistently food secure nation on the planet. With food security come economic and national security. And when you have all three of these together, you have prosperity.

Let us not overlook just how important agricultural research is to our nation's prosperity. Like medical sciences, modern advances in agriculture depend upon research advances from public and non-governmental organizations alike.

Certainly, the return on investment must be recognized. Ours is a technology and knowledge-based economy, and we firmly believe that food and agriculture science conducted by our organization and by our colleagues in the research funding community, is a critical economic engine. Agricultural science and research from public and private institutions is a boon to our nation's economy, generating roughly $20 in economic activity for each $1 invested.

Yet, as we all know, federal funding for agricultural research has been stagnant over the past decade, and has declined in real terms according to USDA.

With 9.7 billion people projected to populate the world by 2050, we have new challenges to face with far-reaching implications. Global hunger is still unacceptably high. Pests and disease have decimated American crops like citrus while stagnant yields for staples like wheat make it tougher to compete in trade.

If America wants to continue to feed the world, our farmers and ranchers must be given every opportunity to apply cutting-edge research and technology into their fields. With an ever-increasing number of mouths to feed and threats mounting, it's imperative that our food system keep pace by supporting innovation and technology.

I also believe there is no better time to be engaged in food and agricultural science and research. The pace of technology is absolutely breathtaking, and FFAR is uniquely positioned to bring together all aspects of our food system in an inspiring, unified manner to solve the biggest challenges ahead.

FFAR Opportunities Ahead

In the 2014 Farm Bill, this Committee took a bold step by establishing the Foundation for Food and Agriculture Research with bipartisan support. Designed with a public-private partnership model, FFAR's emergence as a cutting-edge research institution is well timed considering the many challenges we face.

FFAR matches every one of its public dollars with outside funding, delivering huge value for American taxpayers. By 2019, the U.S. government's $200 million investment in FFAR will deliver more than $400 million in programming.

Building a foundation from scratch is not easy, but since 2014, FFAR has worked to hire staff, develop reliable systems and structures including robust scientific review processes, and raise funding from diverse partners. Today, the Foundation has invested more than $32 million in food and agricultural science with 41 partners, and has done so nimbly and efficiently, with the ability to award grants in as little as one week to confront emerging pests, diseases and climatic threats before it's too late. Moreover, by uniting researchers with groups like venture capitalists, the private sector and global philanthropies, FFAR can quickly bring research to scale and more than double the taxpayer's investment while, at the same time, expanding the tent for U.S. agriculture.

Now that the Foundation is fully staffed and has developed the systems and structures to contribute toward its long-term sustainability, the value and volume of award announcements will continue to pick up throughout 2017 and 2018. In the following months, FFAR will further distinguish itself as a cutting-edge institution with the announcement of three significant research projects.

1. **A new soil health initiative** will help catalyze the adoption of soil health promoting practices across a large percentage of our farmland.
2. **Research to improve photosynthetic efficiency** has the potential to significantly increase the yield of staple food crops.
3. **Advancing and applying new irrigation technologies** will make irrigation more efficient for producers.

Over the next five years, FFAR will become a pivotal player in the food and agriculture research community. In order to fulfill our Congressional mandate, FFAR is uniquely positioned to carry out its three core strategic priorities:

1. Evaluate potential gaps and emerging issues in food and agriculture.
2. Facilitate public private partnerships to fund research that addresses the most pressing issues in food and agriculture.
3. Grow the scientific talent pool to address critical food and agriculture issues.

In keeping with the Foundation's strategic plan, we anticipate awarding the balance of FFAR's funding by early 2019, matched dollar for dollar by diverse partners in support of scientific solutions to critical issues facing food and agriculture.

We are grateful for the opportunity to continue work with Congress to ensure FFAR is reauthorized and fully funded in the next Farm Bill, consistent with our bipartisan legacy as an institution contributing to the long-term competitiveness of our nation's food and agriculture sector.

I know we will look back on the past two years as an important, formative time spent planting the seeds of innovation and I also know that the best is yet to come for FFAR. The relationships,

scientific ideas, and organizational framework in which we have invested so much energy are just now beginning to prosper.

Written Remarks by Steve Wellman, Farmer

Wellman Farms Inc.

Senate Committee on Agriculture, Nutrition and Forestry

"Agricultural Research: Perspectives on Past and Future Success for the 2018 Farm Bill."

June 15, 2017

Chairman Roberts, Ranking Member Stabenow, and distinguished Senators of the Committee, thank you for the invitation to appear today before the Committee to discuss science and innovation which is the very essence of farming -today and especially into the future.

My name is Steve Wellman. I am a past President of the American Soybean Association and an inaugural board member of the Supporters of Agricultural Research (SoAR). Most importantly, I am a third-generation farmer from Syracuse, Nebraska farming the same fields my father and grandfather did. Today, we raise soybeans, corn, alfalfa, winter wheat and a cow-calf herd.

On behalf of SoAR and the American Soybean Association I am here today advocating for additional agricultural research support, including full funding of the Agriculture and Food Research Initiative, USDA's flagship competitive grants program.

As I like to say, we need three things to get American agriculture growing: sun, rain and research. There's not much I can do about the first two but when it comes to research I can lend my name, my time and most importantly my voice to policymakers encouraging them to renew American leadership in agricultural science.

Sufficient federal investment and wise policies are essential if the United States is to continue to be a global leader in agriculture. More aptly, as SoAR Founder Bill Danforth has remarked, "Food is too important to the human race to be a research after-thought; it needs to be a high priority for the nation's entire scientific community."

And I would add for the entire nation.

Today's hearing is a welcomed review of the state of farm science and the investment in federal agriculture research. Farmers like me are rightfully concerned about trade policy, commodity risk management, crop insurance and conservation. But the ancestry of virtually every topic discussed in the Farm Bill can be traced to research. And for that matter, the future of each rests on the shoulders of our collective ability to modernize USDA agriculture research so that we don't miss opportunities awaiting discovery.

Traditionally, we have thought of agriculture science in terms of improving yields, preventing soil erosion, and adapting crops to a variety of growing conditions. Today, agriculture stands to realize significant gains through interdisciplinary research across numerous scientific fields including data science, nanotechnology, biotechnology, biologicals and genomics. To capitalize on these relatively modern fields of science we need to ensure we have a modern federal research enterprise. That is why today I am urging Senators during this Farm Bill debate to give research and the entire USDA Research, Education and Economics mission area your full attention.

Public agricultural research spending peaked in 1994 and since has declined 20 percent. The 2008 Farm Bill authorized AFRI at $700 million dollars annually yet today funding has reached only the halfway point of that level. As a percentage of total federal research investment, USDA has fallen to less than 3% of the annual federal investment. Put another way, research funding for federal agencies not including USDA is nearly $60 billion dollars. Research funding at the USDA Research mission area tops out at just over $2 billion which is an amount that has remained virtually unchanged for decades.

On our farm in eastern Nebraska thanks to modern science I plant varieties that can adapt to dry weather. Since we don't have irrigation, there isn't much I can do about long stretches of dry weather, so fortunately, I can use varieties that are drought tolerant.

With data and analytics available to purchase today, I can manage effectively and more affordably my input costs. Farmers today can receive a field script prescribing which varieties to plant, at what time on which field and more precisely measure the right type of inputs to apply to fields to maximize yields. All made possible with science.

On our farm, conservation of natural resources is a constant focus. Farming practices such as contour terraces, no till farming, cover crops and nutrient management such as grid sampling plus variable rate application of nutrients and seed are implemented. These are effective and productive practices today. Will they be in the future? Or will research demonstrate ways to improve? What we do today is based on years of research and learning. Where will the knowledge to improve U.S. production practices come from in the future without public research leading the way?

We can always use more science to improve growing season forecasts, produce hardier plants, and examine how to manage too much water or not enough.

American agriculture is a marvel of the world but that doesn't mean the world is standing by. China, Brazil and increasingly Europe are investing at a double-digit pace. Now, funding rates for agriculture research grant proposals in many EU countries are nearing 40 percent. In the U.S. those funding rates for grants that score highly have fallen from 20-25 percent to 5-10 percent. The success rate for AFRI grant applications is between 10 and 15%. How can we improve this success rate? Let's look at the numbers.

For fiscal year 2015, the most recent AFRI analysis shows that a total of 2,694 competitive grant applications, requesting $1,793,235,471, were received and reviewed through a competitive peer review process. An additional 884 proposals were recommended for funding by review panels and could have been supported, provided an additional $689,574,878 was available to the program.

A modernized system supported with additional investment is the plea I make to you today.

In 1945, the final year of World War II, the number of tractors overtook the number of working horses on the farm. Today, the American farmer feeds 155 other people, but for that number to continue to grow, science must remain imbedded in modern farms. To accomplish this the scientific pipeline and the research powering American agriculture must be renewed with modern programs and robust funding.

In closing, I'd leave you with a question I ask myself on the farm frequently. How certain are we, and you as policymakers, that we can provide food security for 10 billion people by the middle of this century?

The U.S. has been the world leader in agricultural production and innovation for decades. This is a role the U.S. needs to retain. It won't happen without a strong commitment to public research from Congress and our administration.

Thank you. I am pleased to answer any questions you may have.

DOCUMENTS SUBMITTED FOR THE RECORD

JUNE 15, 2017

Testimony of

Walter A. Hill, Ph.D.
Director, Center of Innovative and Sustainable Small Farms, Ranches and Forest Lands (CISFRL)

Vice-Provost and Dean & Director, Land-Grant Programs
Tuskegee University

Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
Senate Committee on Agriculture

June 15, 2017

Mr. Chairman, and members of the Committee, on behalf of Dr. Kent J. Smith, Jr., President-Langston University and chair of the 1890 Council of Presidents; Moses A. Kairo, Chairperson of the Association of 1890 Research Directors (ARD) and Dr. Carolyn Williams, Chairperson of the Association of 1890 Extension Administrators (AEA) and the entire 1890 Land-Grant Community, I would like to thank you for this opportunity to submit this testimony. I am Dr. Walter A. Hill, Vice Provost and Dean, College of Agriculture, Environment and Nutrition Sciences at Tuskegee University. I also served as Principle Investigator for the 1890 Land Grant University 125th Anniversary Center for Innovative and Sustainable Small Farms, Ranches and Forest Lands during 2015 - 2016.

The 1890 Land Grant Universities are members of the Board on Agriculture Assembly of the Association of Public and Land Grant Universities (APLU) and we have played an active role in the development of the Board's proposed farm bill recommendations. We endorse APLU's budget priorities regarding funding needs and the need to better integrate science and education programs into all of the action and policy activities of the Department. Building on the testimony of the first panel, together with the information and data provided in this panel, I will focus on some additional issues of concern specific to the 1890s in the new Farm Bill rewrite legislation.

Key Issues for the 1890s

There are three key issues that I would like to address:

1. The critical need for increased investments; and
2. Appropriate funding mechanisms.
3. Success/Impacts of 1890 work on specialty crops and organics

The Critical Need for Increased Investments

I am heartened by the recent calls to increase significantly the investment in agricultural research, extension and education. It is remarkable that so many diverse interests are coming together with an understanding of an urgent need to reinvest in the science and education base serving our farmers and our communities. It is important to note that over the last several decades, according to USDA/Economic Research Service, the U.S. agricultural sector has sustained impressive productivity growth. The Nation's agricultural research system, including Federal-State public research as well as private-sector research, has been the key driver of this growth. Economic analysis finds strong and consistent evidence that investment in agricultural research has yield high returns per dollar spent. These returns included benefits not only to the farm sector, but also to the food industry and consumers in the form of more abundant commodities at lower prices. There is

consensus that the payoff from government's investment in agricultural research is high. **The data show that the rate of return to U.S. public agricultural research range from 20 percent to 60 percent with an average of 53 percent.** The average rate of return for private agricultural research is 45 percent.

The 1890 universities look forward to working with all of the farm and interest groups who are working to enhance our abilities to serve their needs. As we support critically needed investments in agricultural research, extension and teaching, it is essential that the specific funding needs facing the 1890 community also be addressed. At this time, I would like to convey some of our specific recommendations to meet the unique needs of the 1890s and the communities that we serve.

The 1890 Cooperative Extension programs are comprised of a broad range of science based educational efforts, which have been proven to:

1. Strengthen the food and agricultural industry, particularly small and limited resource farmers, by developing agricultural production systems that are efficient, sustainable and highly competitive in the global economy.
2. Enhance the health of families through diet and nutrition and food safety education and their economic well-being through practical financial education.
3. Enhance youth skills in science, technology, math, citizenship and leadership.
4. Foster strong, stable communities through leadership development efforts and encouraging entrepreneurship.

Cooperative Extension has developed transformation programs that have improved the economic viability of small-scale agriculture and reduced the decline of small minority-owned farms. Programs emphasizing agricultural diversification, marketing strategies and risk management have been of paramount importance to this client group. Many of the small farmers have diversified their operations to include vegetable production, fruits, specialty crops and animals to increase their cash flow. For example, the development of a Natural Hog Growers Association increased its membership hog-sale income by nearly a million dollars in North Carolina and they have entered into contracts with the Whole Food Market. The development of the Master Meat Goat Herdsman Program has saved producers over $16,250, annually, in Florida in veterinarian and production costs.

In Alabama, farmers participating in a comprehensive program in record keeping, financial management, production management and farm planning have become producers that are more efficient. It was reported that 13 farmers acquired USDA farm ownership loans in the amount of $2.6 million and 10 acquired operating loans for nearly $1.0 million. Without this training, the farmers would not have qualified for the loans. Programs of this nature enabled the limited-resource farmers in Kentucky to increase their net farm income by $4,500.00.

Increase the funding base of 1890 capacity funding

We support **reauthorization** of capacity programs funding for both 1862 and 1890 institutions. The amount of capacity funds available to the 1890s is smaller than the amount of these funds available to our colleagues in the 1862s. Currently, the legislation requires that the funding base of 1890 formula research funding (Section 1445) be set at an amount equivalent to not less than 30% of 1862 capacity funding (Hatch funding). The 1890 research program (Evans-Allen) currently received 22% of the 1862 capacity funding. It is our goal to receive the authorized amount of 30 percent. Similarly, 1890 Extension formula funding (Section 1444) is currently set at an amount equivalent to not less than 20% of 1862 Extension formula funding (Smith–Lever funding). It is our goal to receive the authorized amount of 20 percent.

Reauthorize the 1890 Capacity Building Grant Program

The 1890 Capacity Building Grants Program has played a critical role in helping us build our capacities in research, extension and teaching. This program has allowed us to attract new faculty, enhance our ability to conduct quality research, has enabled us to carry out needed curriculum development programs, and has enabled us to enhance the delivery of our extension and engagement programs. We also recommend that the authorized funding level for this program be continued.

Reauthorize the 1890 Facilities Grant Program

We recommend reauthorizing the 1890 Facilities Grant Program (Section 1447) at the authorized funding level. The 1890s have a clear and immediate need to improve their academic, research and extension physical facilities. There is also an urgent need to adequate equip these facilities for state-of-the art equipment. Years of limited resources have taken their toll and needed improvements cannot be delayed forever. Meanwhile, new technologies require new resources and modifications to existing facilities. Without the needed improvements and technology upgrades, it becomes more and more difficulty to recruit and train top quality scientists and other educational professionals for the future. We therefore urge your support of authorization for the 1890 Facilities Grant program

Change the Carryover Provision for 1890 Extension Funding

The 1890 land-grant universities can only carryover 20 percent of its Extension funding after one year while other capacity programs can carryover their funding at a 100 percent for one or more years. The 20 percent carry-over provision limits the flexibility needed for planning and expending the funding based on identified priorities. We are requesting that the carryover provision for 1890 Extension be changed from 20 percent to a carryover level that would be consistent with the carryover provision for other capacity programs such as Smith-Lever. This will provide the same carryover opportunity for Extension capacity funds for both 1890 and 1862 institutions.

Increase the funding base for McIntyre-Stennis (Forestry) funding

We recommend increased funding targeted to forestry issues (McIntyre-Stennis) at the authorized level. Many of our institutions abide in states where forestry is a major agricultural industry and these institutions have forestry and natural resource programs that are germane to the forestry industry and applicable to the current program eligibility guidelines

Nutrition Education Program (Expanded Food and Nutrition Education Program)

Nutrition education is important to the health and well-being of all families, but there is a tremendous need for this program for persons with limited income. EFNEP help individuals to improve their diets and change their food buying behavior. It is recommended that EFNEP be reauthorized at its current level of $90 million.

Authorize the 1890 Centers of Excellence

We recommend authorization of the 1890 Centers of Excellence at a funding level of $35 million per year. These Centers were developed and initiated in 2015 in recognition of the 125th Anniversary of the Second Morrill Act of 1890. The centers are: Center for Innovative and Sustainable Small Farms, Ranches and Landowners (CISFRL), 2) Center of Excellence for International Engagement and Development (CEIIED), and 3) Virtual Center to Motivate and Educate for Achievement (MEA).

In recognition of the 125th Anniversary of the Second Morrill Act of 1890, several USDA agencies committed $2 million to the 1890s to support the former two centers. The goals of the Anniversary Centers are to substantially increase diversity in the STEM pipeline, increase profitability and jobs in underserved farming communities and enhance talent preparation related to global food security. The 1890s are working in an integrative fashion across multi-disciplines and in partnership with the private sector, government and community-based organizations to make a difference and obtain measurable impacts on the lives of underserved youth, farmers and developing communities who hold great potential. Although the funds from these USDA agencies were used prudently to support underserved small farmers and students at our institutions, these funds were woefully inadequate.

Through the years, the 1890 universities have struggled with inadequate funding resources to meet the especially challenging needs of underserved communities. The proposed Centers of Excellence would be utilized to help address historical inequities of resources and to allow our institutions the opportunity to work collaboratively and synergistically to help our stakeholders while concurrently effectively competing for other funding resources. These Centers of Excellence would jump-start new initiatives on the 1890 campuses, particularly developing resources to provide practical solutions to improve job opportunities and the quality of life of citizens in the 1890 region and beyond.

Reauthorize the Outreach and Technical Assistance for Socially Disadvantaged Farmers

We recommend reauthorizing the Socially Disadvantaged Initiative (Section 2501) Program at a level not less than $20 million per year. This program allows the 1890 universities and other Community Based Organizations to work cooperatively directly in a sustained way with small farmers. We have had tremendous success providing training in risk management, record keeping, farm management environmental stewardship, and alternative enterprises and market development. We train small farmers to access new and alternative markets for their crops and animal commodities. This program has had a dramatic impact on increasing the economic viability and sustainability of these small and limited resource farmers. This critical program should be sustained and strengthened and other small farm programs should be established as a safety net for all such farmers in this category. Comparatively, this group of farming clientele has been vertically ignored in terms of specially targeted programs. We therefore ask the Committee to rectify this oversight by providing sufficient funding for this program to provide sustained impact.

Authorize Student Scholarships for the 1890 Land Grant Universities

We request support to authorize the Student Scholarships for the 1890 land-grant universities at a funding level of $19 million per year ($1 million to each institution) for student scholarships. This scholarship program is needed to increase the number of young African-American individuals seeking a career in the food and agricultural sciences and shall be provided with the caveat that such scholarship students shall commit to pursue a career in the food and agricultural sciences, including agribusiness, food production, distribution, and retailing, the clothing industries, energy and renewable fuels, and farming marketing, finance, and distribution. According to USDA data on the employment opportunities for college graduates in food, agriculture, renewable natural resources and the environment, the demand for these graduates exceeds the supply by 39 percent.

Appropriate Funding Mechanisms

We would like to commend the leadership of USDA/NIFA and the Land-Grant community in the development of the new AFRI competitive grants program. The Department staff and others went the extra mile to make sure that our institutions were fully aware of the new program and gave us the opportunity to compete as equal partners in the process. The 1890 Land Grant Universities achieved some success, however, with enhanced support to increase our competitiveness we will do even better in the future.

We recommend increased funding at a level of $418 million per year. While we support competitive grants; however, many of the programs that we provide need to be sustained over time. Short-term competitively awarded projects do not adequately serve the longer-term needs of the underserved populations that we work with. Capacity funding funds provide the necessary sustained funding that is required to truly build capacity. Again, we support competitive grants, but it is not the only funding tool and it is not always the most effective mechanism to meet our needs and the needs of the people we serve in rural and urban communities.

Small Farms/Specialty Crops

The researchers and extension specialists have focused their efforts of helping improve the quality of life and increasing the income/profitability levels of small and undeserved farm operators in the

1890 region about beyond, including an emphasis to increase the competitiveness of specialty crops and organic crops. Small farms make up 90 percent of the farm count and operate nearly half of the farmland, but only account for 24 percent of the production. The largest share of farm production, however, occurs on the large-scale family farms. According to the Economic Research Service and other researchers, specialty crops typically account for 30 to 40 percent of the total value of U.S. crops, not an insignificant value.

Even before the increased attention given to specialty crop issues in the 2008 Farm Bill, the 1890 universities have been assisting specialty crop producers to increase the quality of these products and to develop a market niche.

Specialty crop issue often vary depending on the type of crop involved and the type of market in which they are sold. Among the crops important to producers that the 1890 researchers and extension specialists have focused on include, but are not limited to, ethnic crops such as *Brassica rapa* cv. Bosai Chinensis (Bok choy), *Amaranthus viridis* Linn (Amaranth or Callaloo), and *Hibiscus sabdariffa* L. (Hibiscus or Jamaican Sorrel); energy beets; ginger;

carrots; kale; specialty peanuts; grapes; watermelon; blueberries: vegetable soybeans *(edamame)*; Indian, Chinese and Hispanic vegetable crops; sweet potatoes, southern peas, squash, and eggplant; mushrooms; and herbs.

Among the issues important to producers that the 1890 researchers and extension specialists have focused on include, but not limited to, sustainable production practices, planting flexibility restrictions, programs, labor, food safety, marketing and trade patterns, integrative pest management, and risk management.

Provided below are three impact vignettes illustrative of the type of innovative research that is being funded by USDA/NIFA at the 1890 land grant universities, and an impact vignette from the Center for Innovative and Sustainable Small Farms, Ranches and Forest Lands.

1. **University of Maryland Eastern Shore: "Organic Crop Management on Delmarva for Selected Specialty Crops"**

The goal is of this project to produce selected specialty crops in an environmentally responsible manner while assessing their safety and the economic viability of the practices on the Delmarva Peninsula. The project is comprised of the following objectives; (1) to compare the effects of subsurface applied poultry litter on the growth development and food safety of tomatoes produced under organic and conventional systems, (2) to evaluate overall economic impact of subsurface applied poultry litter application on the growth and development of tomatoes produced under organic and conventional systems, (3) to determine the optimum balance of non- poultry supplied nutrients on ginger development in high tunnel and field and evaluate the economic impact and (4) to assess selected produce for their varietal performance for small farmer consideration and use in their cropping system.

Field studies were conducted on conventional and organic sites at the university experiment station. Two heirloom tomato cultivars, Debarao plum and Brandywine red were tested in different poultry litter and non-poultry litter nutrients. The test nutrients sources were poultry litter, poultry litter plus nature safe, nature safe and blood meal for the organic site, and 20-0-12 fertilizer, poultry litter plus 20-0-12 fertilizer, and poultry litter at the conventional site. Data were collected for food safety and economic analyses of harvested fruits. Preliminary results indicate that growing Debarao plum heirloom tomatoes organically can be more profitable than growing them conventionally.

2. Virginia State University: Edamame to the Rescue?

Since the peanut and tobacco quota buyouts of 2002 and 2004, farmers in Southside Virginia and the southwestern part of the state have experienced loss of income and cropland. In the search for alternative crops to replace the two former mainstays of Virginia agriculture, researchers at Virginia State University (VSU) have identified vegetable soybean (edamame) as a potentially profitable option for former tobacco farmers. Unlike commodity soybean, edamame is harvested green and marketed as a specialty vegetable. Similar to tobacco in that it lends itself to intensive cultivation in small holdings, edamame can, with proper marketing, emerge as a lucrative cash crop.

For example, sales have averaged $2 per pound of fresh in-the-pod edamame, and one grower was able to sell half-pound packs of shelled edamame for $6. With support from the Virginia Tobacco Commission, VSU is working with Southside growers to commercialize three edamame varieties developed by the Soybean Breeding Program at the VSU Agriculture Research Station. So far, 25 growers have been contracted to grow and market edamame. The project has purchased harvesting and processing equipment and set up a centralized processing facility in Farmville, Va. VSU Cooperative Extension continues to provide marketing support. A consumer base for Southside-grown edamame has been established and continues to expand. Edamame is beginning to be recognized as a specialty crop in Virginia.

3. North Carolina A&T State University: Hypoallergenic Peanuts

Estimates vary as to the numbers of people who suffer from peanut allergy, but health officials agree it is one of the most severe and prevalent food allergies. A report from the National Institute of Allergy and Infectious Diseases in 2010 reported that the various studies on the issue, some based on self- reports, estimate the prevalence of peanut allergy in the United States population ranges from 0.6 percent to 1.3 percent (2-4 million people). According to the American College of Allergy, Asthma and Immunology approximately 400,000 children in the U.S. suffer from the allergy. Making matters worse for them, peanut allergy is rarely outgrown, unlike many other food allergies.

Scientists in the Food and Nutritional Sciences Program at North Carolina A&T State University have developed a safe, relatively simple technology for deactivating the allergenic proteins in whole roasted peanuts. The patented technology relies on treating whole roasted peanuts with various food-grade enzymes. Repeated laboratory trials using extracts from treated peanuts at N.C. A&T, as well as an initial clinical trial using skin- prick tests at the University of North Carolina at Chapel Hill, have shown promising results. Laboratory tests indicate allergenic proteins can be reduced by up to 98 percent. Researchers have also worked on applying the technology to wheat protein allergens.

One of the greatest advantages of this technology is its potential to produce peanut products that can reduce the severity of allergic reaction in the case of accidental exposure.

4. Center for Innovative and Sustainable Small Farms, Ranches and Forest Lands (CISFRL) - An 1890 Land Grant 125th Anniversary Center of Excellence

CISFRL was initiated in 2015 as an outcome of the 125th Anniversary of the 1890 Land Grant Universities. In its first year of operation, approximately 70 farmer clusters or cooperatives, including five or more owners, were created or operationalized in the seven states that initiated the CISFRL, based on competitive proposals. These clusters and cooperatives included hundreds of farmers, ranchers, and landowners. CISFRL has catalyzed farmers, ranchers and landowners working together with universities and the private sector and state governments to leverage their strengths and resources by working with like-minded producers. Among their successes has been to obtain new markets (including large commercial retailers), who require larger quantities of produce delivered on a consistent basis than a small farmer can supply alone. The cluster approach (farmers working together) has enhanced GAP and food safety certifications, soil testing, pest management, irrigation, other sustainability practices and improved partnering with USDA agencies. Specific achievements after the first year of operation include:

- Increased marketing of vegetables to large commercial retailers (Walmart, Kroger)
- Joint purchase of equipment for crop spraying and animal pregnancy testing
- Joint purchasing of coolers to increase the shelf life of fresh produce and refrigerated trucks for transporting fresh produce
- Increased irrigation capacity for vegetable production
- Access to modern packing and shipping facilities
- Conducted collectively over 80 workshops and conferences in partnership with USDA agencies, community based organizations for farmer training on FSA, NRCS, FS and APHIS programs and new technologies
- Trained and provided information to small and limited-resource land owners on forest health, pests, invasive species and fire and disease control, and assisted in developing management plans for 422 landowners

Investing in the Future

Again, I would like to thank the Committee for the opportunity to submit my testimony today. We look forward to working with you and our colleagues in the university community as we move through the reauthorizing of the Farm Bill. We urge you to use this moment, this opportunity, to invest in our 1890 universities and in the future of our communities and the people we serve.

Addendum to the
Opening Statement of
Sally Rockey, Ph.D
Executive Director
Foundation for Food and Agriculture Research (FFAR)
on
"Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill"
Before the Committee on Agriculture, Nutrition, and Forestry of the United States Senate on Thursday, June 15, 2017

Addendum Submitted June 30, 2017

The Rapid Outcomes from Agricultural Research (ROAR) grant awarded by FFAR in May 2017 to combat spotted wing drosophila was doubled by matching funds provided by Michigan State University, the Michigan Cherry Committee, and the Michigan State Horticulture Society.

QUESTIONS AND ANSWERS

JUNE 15, 2017

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. Ann Bartuska

Chairman Pat Roberts

1. Dr. Bartuska, there has been tremendous growth in organic agriculture, with sales hitting $47 billion in 2016. Producers that transition to organics receive a premium for their products in the market place, and USDA has created an Organic Transitions Program. In addition, USDA is progressing on the organic check off called for in the last Farm Bill, which could provide $30 million a year to spend on research. It was stated during the hearing that the sum total of competitive grant funding that goes to organic type enterprises is in the $40-50 million range, which is in addition to the $30-50 million of investments made by land grants, with USDA support. It was also stated that USDA is "actively promoting" organics through extension, and "encourage[s] applicants to submit grant proposals in support of organic" production. As a reminder, we are in an extremely tight budgetary environment, where the federal dollar must be stretched. In light of the many research needs of producers, are programs like the Organic Agriculture Research and Education Initiative and the Organic Transitions Program necessary for an agricultural sector with rapid growth, industry-driven research, and an existing market advantage? Or, could limited funds be better spent on challenges facing other areas of the agriculture sector?

   Response: The organic sector is one of the fastest growing sectors in agriculture, with sales more than tripling in the past 10 years; investments in research are critical to this growth.

   The National Institute of Food and Agriculture (NIFA) invests in and advances agricultural research, education, and extension to solve societal challenges. NIFA's programs promote the productivity and profitability of our farmers with every dollar invested in agricultural research now returning over $20 to the U.S. economy. Funding programs available for agricultural research and extension across NIFA, including Organic Agriculture Research and Education Initiative and the Organic Transitions Program, are extremely competitive, and many highly competitive proposals with great ideas to address problems go unfunded. Additional research, education, and extension is needed to help develop innovative management strategies for certified organic growers and to inform transition choices.

2. The Economic Research Service (ERS) is slated to examine conservation compliance regarding the "effectiveness" of the policy, including policy changes made in the Agricultural Act of 2014. Who at ERS will be responsible for this analysis? Will the Natural Resources Conservation Service, Farm Service Agency, and the Risk Management Agency be consulted during the research process? What data will ERS rely upon to analyze whether these changes are "effective"? What is the metric(s) used to measure "effectiveness"?
   Response: The study is being led by ERS Senior Economist Roger Claassen who works in the Rural and Resource Economics Division at ERS. The research has been informed by consultations with the Farm Service Agency, Risk Management Agency, and Natural

Resources Conservation Service. ERS staff engaged program agency staff before the research began and, as the research progressed, to discuss interim results. All three program agencies were asked to review the draft report during the peer review and clearance review phases of the project as is standard practice for all ERS research reports that describe USDA programs or policies. The report is scheduled for release later this summer.

The study will address several questions:

- How much erosion reduction can be directly attributed to Highly Erodible Land Compliance (HELC)?
- How large are compliance incentives under the 2014 Farm Act?
    - How much do incentives vary across farms?
    - How do incentives under the 2014 Act differ from incentives under the 2008 Act?
    - How would incentives change under the 2014 Act if crop insurance premium subsidies were not subject to Conservation Compliance?

To estimate the extent of erosion reduction directly attributable to HELC, the National Resources Inventory (NRI) point data was linked to FSA data on HEL field determinations. Erosion reduction on highly erodible cropland (land with an erodibility index of 8 or greater) located in fields that have been determined to be HEL was compared to similar land on fields that have been determined not to be HEL, controlling for a range of factors including soil quality, topography, the level of inherent erodibility, and eligibility for commodity programs (a binary indicator that base acreage is associated with the tract). Because a field is determined to be HEL only when it contains at least 33 percent or 50 acres of highly erodible soil, roughly 30 percent of highly erodible land is not subject to HELC. So, erosion reduction on highly erodible soil subject HELC can be compared to highly erodible soil that is not subject to HELC.

Ideally, Compliance incentives would be assessed by comparing farm program benefits subject to Compliance sanction with the cost of meeting compliance requirements. While farm-level data on farm program benefits is available, farm-level data on the cost of meeting Compliance requirements is not. So, the study uses two metrics to consider the size of compliance incentives:

- Farm program benefits per acre of land subject to HELC or Wetland Conservation (WC).
- Farm program benefits per dollar of rental value for land subject to HELC or WC.

The second metric is used because crop profits (crop rental rates are a proxy) are an upper bound on Compliance costs. For highly erodible land already in crop production in 1985, approved conservation systems were developed to ensure that HELC costs would not drive land out of crop production (that is, cost would never be larger than crop profits). For that land that is not in crop production, crop profit forgone (on land that is not cropped due to compliance) is an upper bound on Compliance costs.

Given that these metrics do not accurately account for Compliance costs, the study does not attempt to assess the effectiveness of HELC or WC under the 2014 Act. Rather, the study shows how incentives vary across farms, how incentives may differ from incentives that would have been realized under a continuation of the 2008 Act, and how incentives would change if the link between Compliance and crop insurance premium subsidies was severed.

USDA administrative data is used to estimate Compliance incentive metrics. For the 2008 Act, estimated benefits include commodity payments, disaster payments under the Supplemental Revenue Assurance Program (SURE), and conservation payments. Under the 2014 Act, estimated benefits include commodity payments, crop insurance premium subsidies, and conservation payments. While there are other programs subject to compliance, these programs account for a very large majority of payments subject to compliance sanction.

A simulation model is used to estimate commodity payments to ensure that 2008 and 2014 programs are compared under the same crop price levels. Farm-level information on base acreage, program yields, and commodity program elections (e.g., ARC/PLC) are used. Commodity payments are estimated for several crop-price scenarios. RMA data on crop insurance premium subsidy data is used directly (with adjustments for crop price scenarios), except that benefits from new products (e.g., Stacked Income Protection (STAX)) were simulated. Farm-level conservation payments, obtained from FSA and NRCS, were used without adjustment.

Cropland in highly erodible fields is estimated for individual farms using FSA crop reporting data and HEL determinations, by common land unit. Field level data on wetland is obtained (for the Prairie Pothole state only) from the National Wetlands Inventory (NWI) data maintained by the Department of the Interior. Data on land productivity and cropland rental rates are from USDA sources.

Farm-level metrics are summarized nationally by linking them to the National Resources Inventory (NRI). The NRI data is critical because it identifies highly erodible land and wetland and provides a complete survey of the land base, including land in farms that do not participate in USDA programs. Each NRI points that fall in fields that have been determined by USDA to be HEL or are identified as wetland by NRI are linked to a farm and the farm-level compliance metrics. Results will be shown as the number of HEL or wetland acres in various ranges of compliance incentive (e.g., $0, $0-$20 per acre, $20-$40 per acre, etc.).

3. The Economic Research Service Consumer Data Information Program funds data purchases and research on the U.S. food system. I appreciate the U.S. Department of Agriculture's commitment to food system data. Please detail how the program funding for FY2018 would be spent, including how ERS "will support only the highest priority research to create new and linked data."

Response: ERS's investments in consumer and food system data will focus on these high priority areas:

- The annual Food Security module to the Census Bureau's Current Population Survey that provides the Nation's estimates of Americans' food security status.

- The National Household Food Acquisition and Purchase Survey (FoodAPS), co-sponsored by ERS and Food and Nutrition Service (FNS), to conduct research that informs policymaking on key national priorities including obesity, food insecurity, and the Supplemental Nutrition Assistance Program (SNAP) and other nutrition programs. The survey captures unique and comprehensive data from a nationally representative sample about household food purchases and acquisitions, along with factors that influence household food choices. FoodAPS links to SNAP administrative records, USDA nutrition data bases, and food environment data sources to support research that could not otherwise be conducted on critical food policy issues facing the Nation.

- The Census Administrative Data Platform, a partnership with FNS and the Census Bureau that links SNAP and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) administrative records to Census Bureau's economic surveys to conduct evidence-based policy research.

- The University of Chicago's NORC Data Enclave that houses the confidential and sensitive FoodAPS and proprietary retail food scanner data secure systems to provide access to external researchers while protecting and maintaining the data confidentiality.

At a reduced funding level, ERS plans to make the following four data investments less frequently (rather than annually) and on a rotating 3 to 5 year basis. The reduced investments will result in less frequent updates of associated research and statistics.

- Proprietary consumer and retail scanner data that provide weekly grocery sales and purchase information at the item level that supports research on food prices, affordability, and nutritional quality. These data will be acquired every 3 years to support the work on CNPP's Dietary Guidelines. As a result of the reduction in frequency of acquiring these data, the latest information will no longer be available to support Department needs during unanticipated events such as food safety recalls or other food market changes.

- Proprietary data on the universe of retail food stores in the country that supports research on food access, consumer food shopping habits, and the influence of local food environments on food choices will be also be reduced, diminishing the frequency of updating the analytical information and statistics for the Food Access Research Atlas and the Food Environment Atlas.

- The Flexible Consumer Behavior Survey (FCBS)), a supplement to CDC's National Health and Nutrition Examination Survey (NHANES) that supports research on the influence consumers' dietary and nutritional knowledge, including use of nutrition labels on food choice behavior will no longer be included on a regular basis within

NHANES Additional FCBS questions would be included in NHANES every 2nd or 3rd year depending on budget levels and agency priorities.

- The Eating and Health (E&H) module to Bureau of Labor Statistics' American Time Use Survey (ATUS) that supports research on the impact of time-use constraints and secondary eating across various populations on their food behaviors will no longer be included on a regular basis within ATUS. Additional E&H questions would be included in the ATUS every 3-5 years depending on budget levels and agency priorities.

4. Please elaborate on the opportunities within the National Institute of Food and Agriculture (NIFA) regarding education grants to Alaska Native Serving Institutions, formula funding for McIntire-Stennis and other NIFA and Agricultural Research Service, research and extension regarding invasive plant species and insects applicable to Alaska producers.

Response: The Alaska Native-Serving and Native Hawaiian-Serving Institutions Education Competitive Grants (ANNH) Program promotes and strengthens the ability of eligible Alaska Native-Serving Institutions and Native Hawaiian-Serving Institutions to carry out education, applied research, and related community development programs within a broadly defined area of food and agricultural sciences and related disciplines. Recently, the University of Alaska Fairbanks (UAF) received a Consortium grant for about $1.5 Million to conduct projects at branch campuses and on the field to improve the economic, social and environment conditions in (rural) Alaskan villages.

Alaska Native Serving Institutions (ANSI) have also benefited from McIntire-Stennis formula funds and the Extension Implementation Program (EIPM) from the Crop Protection and Pest Management Competitive Grants Program. Alaska EIPM addresses invasive species through the invasive Plants Program, as a collaborator in the Committee for Noxious and Invasive Plants Management in Alaska (CNIPM), and through Extension. Western Water Weed (*Elodea nuttallii*) is an emerging issue for aquatic invasive species management in Alaska. EIPM responded by hosting community meetings, working with local cooperative weed management areas, and assisting with applying for state pesticide treatment permits for public and private waters. Additionally, Alaska Native Serving Institutions are eligible for NIFA competitive grants programs, including the Agriculture and Food Research Initiative.

Alaska currently has quarantined some very invasive aquatic weeds of great concern, particularly elodea, Brazilian waterweed, hydrilla, and Eurasian watermilfoil. ARS has two main aquatic weed research laboratories, the ARS Invasive Plant Research Unit in Ft. Lauderdale, Florida (which focuses on biological controls) and the ARS Exotic and Invasive Weeds Research Unit in Albany, CA (with a more comprehensive research program on biocontrol and integrated weed management). Both laboratories are a good resource of information for Alaska with respect to its invasive weed concerns. The ARS Exotic and Invasive Weeds Research Unit has recently established a program on the development of biological controls for insect pests, such as the brown marmorated stink bug and the bagrada bug. The ARS Horticultural Crops Research Unit in Corvallis, OR, also develops biological control systems for insect pests of horticultural crops.

5. 2017 marks the year of the Census of Agriculture. The Census is a critical tool that provides an important view of the landscape of U.S. agriculture. The information provided by the Census is used in many different ways, not the least of which is right here in this Committee as we work to shape farm policy. Can you talk about where you are in the process of conducting the 2017 Census of Agriculture? When can we expect to see the results and how will you share that information with those that need it?

   Response: The National Agricultural Statistics Service (NASS) is currently finalizing the mail list in preparation for data collection to begin in December. Our final push to get farmers and ranchers to sign up to receive a 2017 Census of Agriculture questionnaire ends on June 30. Other preparatory activities include finalizing edit and summary systems along with testing data collection and processing instruments, specifically a new online reporting tool. NASS is also completing data collection from the National Agricultural Classification Survey to measure the completeness of the Census Mail List. This is a critical component of the statistical methodology used to provide official, comprehensive and uniform agricultural data for every state and county or county equivalent in the United States.

   NASS will spend all of 2018 collecting, editing, analyzing, and summarizing the responses from the 2017 Census of Agriculture. Currently, NASS is preparing to release results from the 2017 Census of Agriculture in February 2019. The Agency's communication plans are ongoing. The communication plan changes over time from encouraging farmers and ranchers to sign up, through promoting responses, and culminates in marketing the many data products from the Census of Agriculture program. Along the way, NASS reaches out extensively to producers, industry experts and leaders, academia, and many in the public and private sectors to gain support, promote response, and share the published results of the 2017 Census of Agriculture.

6. The responsibility of NASS to provide timely, objective, accurate, and useful statistics is extremely important to the agricultural sector. Many row-crop and livestock producers use NASS data for farm management planning, forecasting line items such as input costs, as well as determining the supply and demand landscape for agricultural commodities. Additionally, commodity markets rely on this data to determine actual and forecasted conditions for a wide-range of economic variables. With the Administration's budget proposal to reduce sample sizes from select NASS reports, what unintended consequences would this create with regard to marketplace volatility? Would certain farmers be at a disadvantage due to reduced sample sizes?

   Response: The proposed sample size reduction will result in reduced statistical precision for some states and/or counties. Hence, some state or county estimates will not be available for publication. Therefore, certain farmers would be at a disadvantage, because the data for their particular state would not be available. Without state level data, NASS will not be able to publish county level data.

7. The Union of Concerned Scientists is opposed to biotechnology, despite the science being very clear regarding health and environmental effects. Please elaborate on your comments

during the hearing relating to the Union of Concerned Scientists and their involvement with any of the processes used by the REE agencies or in its mission area regarding scientific integrity. Did the Union of Concerned Scientists approve any of the processes used to ensure scientific integrity? If so, why? Is there other precedent for an agency or mission area to request that a portion of their internal processes regarding scientific determinations be approved by an outside group? Were other groups approached for similar involvement?

Response: The Union of Concerned Scientists (UCS) was not involved in the establishment nor the subsequent update of the USDA Scientific Integrity Policy (SIP) and Departmental Manual. In December 2015, the USDA Departmental Scientific Integrity Officer and the Agency Scientific Integrity Officers, with support of USDA's Science Council, initiated an internal review and update of the 2013 USDA SIP. In November 2016, USDA issued a revised version of DR 1074-001 (Scientific Integrity) and a new Departmental Manual, providing detailed and robust procedures for responding to allegations of compromised scientific integrity. Following that issuance, UCS independently conducted their own review of the revised SIP, and the SIPs of 18 other federal science agencies. In their January 2017 report, "Preserving Scientific Integrity in Federal Policymaking," UCS gave USDA's updated SIP the highest rating, and based on USDA's release of an accompanying new procedural manual, USDA was one of only five federal departments/agencies to receive a "strong" rating for its response procedures to scientific integrity concerns.

8. In your testimony you discuss the 'fast growing phenomenon' of urban agriculture and the role the Research, Education, and Economics mission area plays in urban focused research. As U.S. farmers and ranchers are currently facing critically tough times, including destructive weather patterns, the spread of pests and disease, and low commodity priees, can you explain how prioritizing urban agriculture research provides a meaningful return on the taxpayer dollars that are expended? Please provide data explaining the impact investment in urban agriculture has on addressing the issues our U.S. producers are facing during these tough economic times.

Response: Through the Farm Bill and appropriations, NIFA invests in and advances agricultural research, education, and extension to solve societal challenges. NIFA's programs promote the productivity and profitability of our farmers with every dollar invested in agricultural research now returning over $20 to the U.S. economy. Urban agriculture has economic, health, and social impacts, with the majority of urban related projects relevant to all agricultural production systems and rural communities, not just urban environments. Across NIFA's granting programs, 127 projects related to urban and community based agriculture at a value of $34,773,341 in fiscal year 2015 were funded. States reported $2,703,000 expended on related capacity projects in the same year. Between 2009 and 2015, NIFA awarded a total of 831 competitive projects related to urban and community based agriculture at a value of $198,214,308, with States reporting capacity expenditures of $9,502,000. Of this total, $41,271,174 was awarded through the Community Foods Projects grant programs. Capacity funding is NIFA's support for research and extension activities at land-grant institutions through grants to the states on the basis of statutory formulas, as determined by the Congress. See chart below illustrating NIFA administered research, education, and extension funding for urban agriculture related projects.

	Competitive	Capacity	Total
2009	$22,200,036	$607,000	$22,807,036
2010	$33,744,367	$832,000	$34,576,367
2011	$39,849,622	$806,000	$40,655,622
2012	$26,309,244	$883,000	$27,192,244
2013	$21,926,265	$1,483,000	$23,409,265
2014	$19,411,433	$2,188,000	$21,599,433
2015	$34,773,341	$2,703,000	$37,476,341
Total	$198,214,308	$9,502,000	$207,716,308

9. Can you provide for the Committee a list of the REE authorities, including the amount of funds authorized, that can be used for urban agriculture? Additionally, please identify all activities you are referring to when you state that key urban research areas 'work across and within disciplines to identify a holistic approaches to sustaining urban agriculture.'

   Response: A representative list of relevant programs is included in the Urban Agriculture Toolkit, https://www.usda.gov/sites/default/files/documents/urban-agriculture-toolkit.pdf. Urban agriculture is a diverse discipline within agriculture that requires the knowledge of traditional agricultural practices with research focused on the unique issues that exist within urban systems. Research within urban agriculture spans all disciplines of agricultural research – soil health and quality, water access and quality, geospatial assessments, urban forestry, biology, ecology, pollinator health, education and workforce development, agricultural engineering and production strategy development – however, there are unique outputs. The sum of these research activities helps yield high output, successful urban farms.

   Urban agriculture requires long-term research focused on the overall goals of enhancing operational and production efficiencies; improving economic returns to producers; and reducing the environmental impact of urban agricultural production. Specific themes for such research in ARS include: **Production Environment**: Characterization of atmospheric gases, pollutants and light intensities experienced by crops grown in urban settings whether at ground-level or, but especially, on rooftops of high-rise buildings. Technologies for CO2 capture and release into CO2-starved greenhouse environments are particularly important for urban crop production during the winter months. **Water**: Technologies are needed for more effective use and re-use of water, be it municipal or rain feed, and water runoff collection and recycling. **Aquaculture**: Technologies for aquaculture/aquaponics in urban settings, either as a stand-alone system or coupled with vertical farming and hydroponic farming. **Postharvest Quality**: Technologies are needed to assure food quality and food safety, via superior product handling/ processing/ packaging and storage for produce from urban agriculture.

   ERS has conducted research on local food systems that spans both rural and urban areas that is, rather than based on proximity to cities per se, the research is defined based on marketing arrangements in which farmers sell directly to consumers at regional farmers' markets or to schools. ERS has published reports covering local food markets, characteristics of local food

farmers, and the local foods supply chain. Academic expertise and research on local foods has grown during this period and provides information on local food markets and the effects on farmers and rural communities thus reducing the value of the ERS research on local foods. Thus, ERS' FY18 budget includes a request to discontinue this research area (a requested funding decrease of $200,000 and 1 staff year for local foods research).

NASS did not receive additional funds in the FY2017 budget for the urban agriculture survey.

NIFA supports a broad spectrum of urban and community based agricultural projects through competitive grants programs and capacity programs, and indirectly through grants awarded and administered through regional centers. NIFA defines urban and community based agriculture as agricultural practices that take place within a community setting. Across our granting programs, we funded 127 projects related to urban and community based agriculture at a value of $34,773,341 in fiscal year 2015. States reported $2,703,000 expended on related capacity projects in the same year. Between 2009 and 2015, NIFA awarded a total of 831 competitive projects related to urban and community based agriculture at a value of $198,214,308, with States reporting capacity expenditures of $9,502,000. Of this total, $41,271,174 was awarded through the Community Foods Projects grant programs. Capacity funding is NIFA's support for research and extension activities at land-grant institutions through grants to the states on the basis of statutory formulas, as determined by the Congress.

[see separate table as attachment]

10. Your testimony states that urban agriculture provides benefits such as closer neighborhood ties, reduced crime, and education and job training opportunities. You also mention that research done under REE assists communities in transitioning to a more sustainable future. Please provide evidence as to these claims, as well as what, if any, USDA resources are being used in evaluating these results.

Response: Our response focuses on activities in the REE mission area.

Urban agriculture benefits from the Food Insecurity Incentive Program (FINI), which funds projects intended to "increase the purchase of fruits and vegetables by low-income consumers participating in [SNAP] by providing incentives at the point of purchase." For FINI grants, NIFA defines "fruits and vegetables" as "any variety of fresh, canned, dried, or frozen whole or cut fruits and vegetables without added sugars, fats, or oils, and salt (i.e. sodium)." Incentivizing purchases of fruits and vegetables increases their affordability and consumption.

USDA's Food and Nutrition Service recently completed an evaluation of a FINI predecessor, the Healthy Incentives Pilot (HIP) in Hampden County, Massachusetts (pilot from November 2011 to December 2012), which investigated the impact of making fruits and vegetables more affordable to SNAP participants. Under HIP, SNAP households received 30 cents on every SNAP dollar spent on targeted fruits and vegetables at participating SNAP-authorized retailers, including large supermarkets, grocery stores, and farmers markets. A rigorous

evaluation showed that HIP significantly increased the consumption of targeted fruits and vegetables, with the increased consumption of about one quarter of a cup per day.

The USDA's Forest Service has supported research that evaluates the benefits of urban green space and its relationship to less crime. For example Kuo, F.E., and W.C. Sullivan (2001) published in Aggression and Violence in the Inner City: Effects of Environment Via Mental Fatigue. *Environment and Behavior* 33, 4:543-571. That "the presence of nearby nature may positively influence social interactions and lessen aggressive and violent behavior. Comparing similar buildings (within Chicago public housing), 145 women were asked to recall aggressive and violent behaviors within their household. Those who had trees and grass cover outside their apartments reported significantly less aggression against their partners than did those living in unlandscaped areas."

In 2016 USDA Forest Service scientists Troy, A., Nunery, A., and Grove, J.M. published The relationship between residential yard management and neighborhood crime: An analysis from Baltimore City and County. In this study USDA Forest Service scientists analyzed the relationship between crime and indicators of residential yard management in Baltimore City and County. After controlling for income, population density, Block-scale tree canopy and housing type, they found a consistently significant relationship between crime and number of indicators of yard management. Specifically, Forest Service scientists found that indicators of yard management, from cut lawns to presence of yard trees, are inversely associated with crime, while indicators of neglect are positively associated with crime.

The USDA Forest Service Philadelphia Field Station is working with city groups such as the Parks and Recreation Department and the Philadelphia Water Department to establish the "triple bottom line", meaning improvements in three broad areas of impact – environmental, social and economic. In terms of crime reduction, our studies have found that "green" stormwater infrastructure improvements resulted in significant reductions in narcotics possession and theft. According to Philadelphia police detective Hugh Davis, one can feel neighborhoods changing and becoming safer over time.

Senator Debbie Stabenow

1. In 2016, Congress passed the Global Food Security Act, which codified a whole-of-government strategy to fight hunger and strengthen global food security. Please provide a comprehensive description of USDA activities within the Research, Education, and Economics mission area that are supporting this global food security strategy and in which countries.

   Response: In 2016 the U.S. Government prepared the Global Food Security Strategy (GFSS), an integrated whole-of-government strategy and agency specific implementation plans, including the U.S. Department of Agriculture (USDA), as required by the Global Food Security Act of 2016 (GFSA). USDA identified Research, Education, and Economics mission area (REE) activities in support of the GFSS in the FY17 USDA GFSS Implementation Plan. Generally, USDA research collaborations focus on those

that are mutually beneficial to the U.S. and its foreign collaborators. These cooperative activities leverage foreign and domestic resources (human, financial, and infrastructural) to more quickly and efficiently produce solutions for the pressing challenges facing American agriculture. When applicable and appropriate USDA aligns REE mission area activities with the GFSS, but said activities are typically not initiated solely to support the GFSS nor are they specific to any country.

In the area of research, USDA can leverage over $2 billion in annual investments in the REE mission area which contribute to a wide range of research programs focused on global food security. USDA research investments can directly, or indirectly, support U.S. Department of State- and USAID-funded international research collaborations for food security. The following specific REE activities are named in the FY17 USDA GFSS Implementation Plan:

GODAN. The United States is a founding member of, and financial contributor to, the Global Open Data for Agriculture and Nutrition (GODAN) initiative. U.S. participation is managed by the USDA Office of the Chief Scientist (OCS). This initiative seeks to support global efforts to make data that is relevant to agriculture and nutrition available, accessible, and usable for unrestricted use worldwide. Open access to research, and open publication of data, are vital resources for food security and nutrition.

Livestock Improvement and Health. USDA intramural research is cooperating with USAID and an international consortium of researchers to develop a new generation vaccine for East Coast fever, a devastating disease of cattle in East Africa. In addition, USDA is cooperating in bringing advanced genomics and genetic approaches to improving goat production in Africa. These projects are funded under Feed the Future but are leveraged by existing Agricultural Research Service (ARS) research funding support of intramural research projects and by the extensive network of cooperation that includes several Land Grant universities.

Wheat Improvement and UG99. USDA has active research addressing one of the greatest threats to the global wheat supply. UG99, the highly virulent wheat stem rust, continues to be a major threat to what is arguably one of the most important food commodities, and actively preventing this threat from spreading any further is a high priority globally. USDA coordinates intramural and extramural research in wheat, particularly UG99, through the Borlaug Global Rust Initiative, the International Wheat Yield Program, and the International Wheat Consortium, in addition to coordinating with producer organizations and universities in the United States.

Agricultural Model Intercomparison and Improvement Project (AgMIP). USDA coordinates with the AgMIP, a distributed climate-scenario simulation exercise for historical model intercomparison and future climate change conditions, with participation of multiple crop and world agricultural trade modeling groups around the world. AgMIP is an important tool in identifying the impacts on crop, and eventually animal, production

and will help policy makers prepare in advance as climate shifts and impacts the viability of various production systems.

ARS Office of International Research Programs (OIRP). Working with the ARS Office of National Programs, the OIRP works to engage strategic international partnerships that can enhance the productivity, effectiveness, and impact of ARS National Programs, as well as further the goals of the United States government. The OIRP enhances coordination of research that supports the GFSS.

Technical contributions. USDA embodies robust technical and policy expertise for sustainable agriculture, nutrition, and food systems. USDA's expertise and work—such as research, education, and economics—concurrently meet the needs of U.S. agriculture and support global food security. In addition, USDA experts are directly engaged in international cooperative research and capacity building and development programs, both independently and through reimbursable partnerships. For example, several agencies plan to provide subject matter experts and/or conduct cooperative research to support USAID's food security and nutrition work worldwide.

Finally, the USDA National Institute of Food and Agriculture's (NIFA) domestic research agenda will provide a foundation for new and ongoing USDA international partnerships in key areas such as agricultural production and resiliency, food safety, nutrition, youth development, and agricultural extension.

2. As leader of USDA's urban agriculture interagency working group, can you describe how the Department is supporting urban farmers? What are some of the major challenges urban farmers have accessing USDA programs? Where are the biggest opportunities at USDA to support urban farmers?

Response: USDA established the internal Urban and Community Agriculture Working Group (UCAWG) which has representation from fourteen USDA agencies and various offices within the Office of the Secretary who provide technical assistance to or have programs that can assist urban farmers. The goal for this Working Group is to contribute to ongoing USDA-wide efforts, including strengthening local and regional food systems and by studying and supporting urban and community agricultural systems, and connections to rural farmers.

One of the major challenges urban farmers have regarding USDA programs is a lack of knowledge or understanding that USDA has programs available to assist urban farmers. In order to assist with this issue, the UCAWG developed the *USDA Urban Agriculture Tool Kit (https://www.usda.gov/sites/default/files/documents/urban-agriculture-toolkit.pdf)*, which provides a foundation for urban farmers. It lays out operational elements that urban farmers must consider, and it identifies technical and financial

resources and Federal programs and services that can support a variety of activities related to urban farming.

As outlined in the USDA Urban Agriculture Tool Kit, there are many opportunities for USDA to utilize our programs to assist urban farmers. USDA agencies need to educate staff to understand the needs of urban farmers and that USDA programs, where applicable, can be used.

3. There are limited data available on the number and impact of non-traditional farms, including farms in urban areas. What steps is NASS taking to better identify and account for these non-traditional types of agriculture?

   Response: NASS recognizes that non-traditional farms are a growing segment of U.S. agriculture. We are researching new avenues for identifying these types of operations to ensure they are available for the Census of Agriculture and the sampling frames used to produce estimates of US agricultural production. Our Regional Field Offices are charged with identifying and obtain state and local name sources for non-traditional farms. In addition, our national commodity statisticians use their commodity specific contacts and expertise to help build a more complete sampling frame that contain non-traditional operations. Some of our more prolific sources derive from grower associations and other non-traditional groups organized for the advancement of their focus. NASS has also begun to research the use of "web scraping" to identify farm operators that are considered non-traditional. NASS will continue to coordinate with other USDA agencies such as the Farm Service Agency (FSA) and Agricultural Marketing Service (AMS) to identify the traditional farm operators but we are also collaborating with these federal, state and city agencies to identify non-traditional farm operators as they begin to capture those demographics.

4. In 2014, USDA published the "Implementation Plan to Increase Public Access to Results of USDA-funded Scientific Research." One of the goals identified in the report was to "raise the profile and reputation of the food, agricultural, and natural resources as providers of significant contributions to many areas of scientific innovation and value to society." Yet on January 23, 2017, USDA Agricultural Research Service (ARS) circulated a memo telling employees to sop communicating with the public about their research, including news releases, photos, fact sheets, news feeds, and social media content. Acting deputy administrator Michael Young sent around a second memo clarifying the department's position on public engagement, and the original memo was redacted the next day. Other departments enacted similar bans on public engagement during the transition period. Do you believe that USDA should proactively engage with the public on its research findings? If yes, please explain how USDA is doing so.

   Response: ARS supports the USDA Public Access Policy and has taken great strides in making the research findings of its scientists known to the public and available for free for the public use.

For example, the ARS Office of Communications has an active social media presence that highlights research and other ARS activities. Once a month, we publish the *Agricultural Research* magazine, which contains five to seven stories about recent scientific achievements of our scientists. The magazine is available online to read electronically or for downloading to read offline.

On its home page, the ARS Web site (https://www.ars.usda.gov/) has links to the current and previous issues of the monthly magazine; the Plant Hardiness Zone map, which is popular with gardeners; the USDA National Nutrient Database, the data source for dozens of diet and nutritional smart phone applications; the annual Technology Transfer report; and the annual progress reports for each of our 690 projects. The Web site also has many other resources, such as GRIN-Global, our plant genetic database of ARS genebank holdings; databases and modeling software; and a host of other consumer-friendly publications (i.e., *Scientific Discoveries*; *Science in your Shopping Cart*; and *Plants of the West*, a review of recent plant releases specifically for western U.S. rangelands and pastures).

The primary method for relaying the detailed findings of our research is through the publication of articles in peer-reviewed journals. During the past 5 years (2012-2016), ARS scientists have published more than 21,000 articles in more than 150 different journals.

ARS has worked hard to make these publications available to the public through the Web site of the National Agricultural Library (NAL), the largest and most accessible agricultural research library in the world. In 2016, NAL's PubAg portal for literature searches and full-text access held more than 49,000 full-text journal articles by USDA researchers, mostly from 1997 to 2014.

In addition, NAL digitized and created citation information for 20,275 new items (1.1 million pages) in FY 2016, bringing the total number of digitized items in the library's collection to 115,500 (or approximately 5.4 million pages). These collections have proven popular with researchers and the public alike. In FY 2016, users downloaded 13.4 million full-text items from NAL, an increase of 48 percent over FY 2015.

One important way ARS shares its research findings is in the collaborations it maintains with Land-Grant University and industry researchers. Through these collaborations ARS is able to expand our circle of knowledge, while leveraging our resources to extend our research goals. Because the universities also integrate extension service outreach in their research programs, these researchers are able to share the knowledge from that collaborative research with farmers, producers, and backyard gardeners in their areas.

5. All of the agricultural research conducted by USDA results in the generation of lots of data. New technologies can collect information at almost every step of the food supply chain. The challenge will be managing and analyzing all of this information in order to find solutions to current challenges. How is USDA approaching big data?

Response: Several years ago, it became evident that the amount of data our scientists were collecting was enormous, and that as the data grew in size, it was getting increasingly more difficult to share and use. ARS established an aggressive program to create a high-speed computer network backed by a computing cloud base to facilitate the transfer and storage of large amounts of data between ARS scientists at our 90 locations.

ARS has committed $5 million each year since FY 2014 to develop a high-performance computing cluster (named CERES) at the ARS location in Ames, Iowa, to offer big data ingress/egress. CERES is attached to an Internet2-based wide-area network (SCINet) connected at six initial locations— large ARS facilities in Beltsville, Maryland (including NAL); Ames, Iowa; Fort Collins, Colorado; Clay Center, Nebraska; Stoneville, Mississippi; and Albany, California. These six hubs serve as the access points for ARS locations. The design allows all ARS scientists to access CERES and SCINet as long as they can connect to the Internet. ARS staff can now conduct a myriad of high-performance computing operations and leverage a growing suite of user-friendly graphical interface applications.

In the broader context, ARS is continuing to work with the National Science Foundation (NSF) and researchers at several universities, including Iowa State University, to develop cyberinfrastructure—the hardware, software, and people—to harness the new data tools and make high performance computing more available through the NSF-sponsored extension to the flagship CyVerse program.

NIFA convened a summit in October 2016, to identify the frontiers and future of data in agriculture and build on existing U.S. government-wide efforts and investments in Big Data. Following the summit, NIFA accepted online input from the agricultural and broader data science communities. The summit featured distinguished leaders in the fields of data science and agriculture and engaged a diverse array of stakeholders to identify new opportunities for data science in agriculture. At the summit, a new initiative, the Food and Agriculture Cyberinformatics and Tools (FACT), was announced to develop data-driven solutions for addressing complex problems facing agriculture today. The FACT initiative recognizes that analyses of agricultural systems to identify novel solutions require multi-scale data, machine learning, data visualization, and predictive modeling. The priorities expressed by stakeholders at the Summit and online are integrated in NIFA's future investment strategies. In the FY 2018 budget proposal, NIFA included $11M for investing in the FACT initiative in America's flagship competitive grants program, the Agriculture and Food Research Initiative. A roadmap is being developed that will help NIFA make FACT investments in the subsequent years.

ERS is actively engaged in Big Data initiatives and has implemented new technologies and methodologies to widen and expand the reach of our information services to the general public. New products and tools extend and expand access to ERS research findings, market outlook, and data—making the Agency's information more readily available to decision makers, other researchers, and the general public, to help our stakeholders more easily access critical information. Improvements for enhanced research capabilities include:

- Developing big data analytic capabilities by linking micro level farm and conservation program administrative data with natural resource and market data at the field level.
- Commercial cloud services to provide ERS analysts with big data computing tools. ERS researchers use these tools to develop predictive models of yield using neural networks (a "machine learning" technique), which are trained on very large/high-resolution weather, satellite spectra, survey, and administrative datasets. These models are used in research on weather/climate risks, and collaboratively with sister agencies to improve in-season yield forecasts.
- Hiring economists with expertise in predictive statistics and machine learning. These researchers plan to facilitate capacity-building seminars in these topics, which will be open to their colleagues.
- Training: ERS staff are taking advance training in Applied Big Data Analytics offered by a consortium of the University of Chicago, New York University, and the University of Maryland. The training includes case studies, introduction to Python language, web scraping, APIs, data linkage techniques, data quality and curations, spatial analysis, and advanced data visualization techniques. The training is the first of its kind to give government professionals an opportunity to develop key data science skills necessary to harness the wealth of newly-available data.
- Work with the University of Chicago National Opinion Research Center (NORC) to provide big data analytics capacity to ERS researchers and external collaborators. The NORC system provides access to over 50 billion records of food purchase and household data from sources such as ERS' National Household Food Acquisition and Purchase Survey (FoodAPS) and Information Resources, Inc. (IRI). NORC allows a secure way for ERS' external collaborators to access the data, and NORC uses the Vertica Analytics Platform which offers faster performance than traditional relational databases. Having this faster access allows researchers to explore a broader set of food policy research questions using a combination of robust data sources.

6. What percentage of resources goes towards the rural economic development portion of ERS research today compared to years past? Housing, transportation, health, and education are major drivers in rural communities; how many staff work on these components of rural development?

Response: ERS's Rural Economy Branch conducts economic and social science research related to rural economic development. In recent years, it has had between 13-19 staff researchers, similar in size to most research branches at ERS. Approximately 10% of our current research resources are focused on rural economics topics.

ERS currently has 8 full time equivalent researchers focused on topics related to rural housing, health, and education as detailed below:

Within the topic of rural housing, ERS is currently investigating the rising rental cost-burden in many rural areas and the factors affecting it, and high risk mortgage lending in rural areas and economic and demographic changes associated with it. We also plan to investigate risk factors for reduced availability of multi-family housing available through the Section 515 Rural Rental Housing Program administered by the USDA Rural Housing Service. We are also working with a collaborator at Middlebury College on the high risk mortgage lending issue via a cooperative agreement.

The research on rural health includes three components. One component is investigating the linkages between rural health care and the rural economy, by investigating how much rural hospitals and health care providers affect the rural economy via employment multiplier impacts, impacts on property values and other means; and how changes in the economy of rural communities affect their ability to attract and retain health care providers. A second component is investigating how immigration of health care providers through the H-1B visa program is affecting rural economies and rural health. A third component is investigating changes in mortality in rural areas and the factors affecting it, including but not limited to the opioid epidemic. We are also working with a collaborator at Penn State University on the mortality/opioid epidemic issue via a cooperative agreement.

ERS research on rural education currently focuses on trends and geographic variations in rural education and school quality and the effects of these on migration of businesses and people to or from rural areas. A recent publication from this program discussed trends in rural education (https://www.ers.usda.gov/publications/pub-details/?pubid=83077). We also plan research to investigate the impacts of rural school quality on property values in rural areas.

In general, rural research at ERS focuses on understanding geographic variations and trends in rural economic activity and the well-being of rural people – including changes in population, employment, earnings, income, poverty, wealth, and health – and factors affecting and affected by those changes. We place special emphasis on understanding the effects of policies and policy-relevant factors, such as access to broadband, government programs to promote rural and regional development, anti-poverty programs, and others. We also emphasize development of data sources and research that supports targeting of government programs to rural areas or to specific rural populations, such as frontier and remote areas or persistently poor people. ERS has developed and maintains several classifications of different types of rural areas based upon their geographic proximity to urban areas, population density and level, and economic and social characteristics. These and other descriptive data on rural areas of the United States are made available through publications such as our annual Rural America at a Glance series, the ERS Atlas of Rural and Small Town America, State Fact Sheets, and other materials available on the ERS website.

7. In the 2014 Farm Bill, changes were made to USDA research programs. From your perspective can you discuss how the implementation of these changes has gone?

a. How has USDA improved transparency and accountability with regard to intramural and extramural research programs?

Response: As required by Section 7513 of the Agricultural Act of 2014, Pub. L. 113-79, the Secretary of Agriculture has submitted to Congress, in each year since 2014, a report containing a description of the agricultural research, extension, and education activities within the REE mission area. This report describes the current set of Federal government priorities for REE over the next five-year period; the role of the USDA in the national food and agricultural research and innovation system; and the mechanisms the USDA uses to coordinate activities among the Federal, State, and private partners in the system, including coordination among different agencies in the REE mission area.

Transparency and accountability are paramount to ARS and are implemented through its robust 5-year National Program Cycle. The approximately 690 ARS research projects are aligned into 17 National Programs, each of which are led by a team of National Program Leaders (NPLs). The overarching objectives of the 5-year cycle are to ensure the relevance, quality, and impact of ARS research. Prior to the start of the cycle, ARS holds customer and stakeholder workshops to gather formal input about critical research needs. NPLs use this information to write National Program Action Plans that outline research goals for the ensuing 5-year cycle period. ARS scientists then write their 5-year project plans to reflect the Action Plan research goals. The plans are sent to the ARS Office of Scientific Quality Review (OSQR) for review by an external panel of peers prior to implementation to ensure the science meets the highest standards of quality.

NPLs, Area Directors, and scientists interact with customers and stakeholders throughout the research phase of the 5-year cycle to ensure the research and its outcomes are relevant and impactful and address critical, emerging issues. Ongoing monitoring of project quality and performance takes place throughout the program cycle, and adjustments are made when necessary to improve performance or meet emerging challenges.

At the end of the program's 5-year cycle, a National Program retrospective review is convened to ensure, based on feedback from an external group of experts, that the research was conducted as indicated in the Action Plan and to gain advice and insight as to the future direction of the research.

Each year, ARS prepares a performance report for the Government Performance and Results Act (GPRA) and includes performance updates in the Agency's annual budget documents. In the past year, ARS redesigned its Agency annual report to an Annual Report on Science that contains eight Agency measures on scientific knowledge and knowledge transfer. The report also describes progress on important

Agency emerging priorities; new accomplishments for ARS' critical agriculture resources and research tools that include collections, databases, scientific models, and software; accomplishments of the National Agricultural Library; and a compilation of ARS' international collaborations. Research accomplishments are written clearly and concisely and specifically highlight what results mean to the average U.S. citizen.

National Program Action Plans, annual reports of ARS research projects and National Programs, and the Annual Report on Science are all publicly accessible from the ARS Web site.

ERS consists primarily of intramural research programs. Stakeholders are consulted both in the planning and reporting stages of research programs. Research results and economic indicators on important agricultural, food, natural resource, and rural issues are fully disseminated to public and private decision makers through reports and articles; special staff analyses, briefings, and presentations; databases; and individual contact. Starting in 2015, ERS has conducted annual program reviews by external evaluators in order to cover the breadth of research topics covered by agency output over a five year period.

To improve transparency, NIFA continues to provide details of proposed budget request for the President's budget proposal in its Explanatory Notes on the NIFA website (https://nifa.usda.gov/budget). For the Agriculture and Food Research Initiative (AFRI) program, this includes discussion of historical funding allocations, funding levels for the AFRI budget request, proposed new initiatives, changes to programs, and anticipated release of Requests for Applications (RFAs). For accountability, AFRI is strictly aligned with the priorities authorized in the 2014 Farm Bill and the program tracks all grant awards relative to these authorized priorities. At the individual AFRI award level, progress toward accomplishing approved objectives is monitored annually through thorough review of required annual progress reports and through face-to-face interaction with awardees who are required to attend annual Project Director meeting.

The National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board is also charged by Congress to complete an annual review of the relevance of REE programs and activities to the established priorities and the adequacy of funding for those programs. The NAREEE Advisory Board performs this review by focusing the review on one or two program areas across all REE agencies with the goal of reviewing all of the programs in 5 years. The results of these reviews have identified strengths and areas for improvement between the REE agencies.

b. What changes have been made to the annual Presidential Budget Submission on future spending plans regarding extramural competitive grant programs and intramural research spending?

Response: ARS budget submissions comply with the requirements of Section 7513, Budget Submission and Funding, of the 2014 Farm Bill, and requests for funding reflect the President's priorities related to intramural agricultural research.

ERS's future spending plans have been clarified in recent annual Presidential Budget Submissions by providing details of the highest priority planned intramural research projects and enhanced performance metrics to track outcomes and impacts of agency research efforts. In addition, ERS regularly reports in its budget documentation a list of extramural funding amounts for topics of interest to policymakers that have been recently awarded to various academic institutions.

The House Report No. 114-531 that accompanies the 2017 Appropriations Bill states: "The Committee appreciates NIFA's efforts to provide additional information in its budget requests over the past three years. For the FY 2018 budget request, the Committee is particularly interested in the request for AFRI, and requests that the agency provide greater detail on the levels proposed to be allocated to and the expected publication date, scope, and allocation level for each request for awards to be published under each priority area specified in section 2(b)(2) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)(2))."

Similar requirements were included in the 2014 Farm Bill. In response to the need for additional information on the Requests for Proposals, NIFA has added a new exhibit to the Explanatory Notes. NIFA provided a listing of anticipated RFA dates and RFA priority areas in the FY 2018 Explanatory Notes, the Congressional Budget Justifications. NIFA also provides ongoing updates on our website for RFA release dates.

c. How have the different research agencies at USDA improved their planning and coordination to ensure resources are used in a smart and efficient manner?

Response: As part of an overarching commitment to strategic investments in agriculture science and research, the USDA Research, Education, and Economics Mission Area (REE) developed an Action Plan to coordinate research, education, and extension goals and to align priorities across the REE agencies. Originally published in 2012 and revised in 2014, the Action Plan highlights a curated list of goals and subgoals to cultivate a process for strategic planning that links agency and Administration priorities to USDA investments. Goal Teams, consisting of intra-agency subject matter experts, are the direct link between REE leadership, which develops the policy goals in the Action Plan, and the scientists performing or funding the agricultural research, education, and extension in pursuit of those goals. Twice each year the Goal Team members meet to coordinate and report REE activities for the annual REE Progress Report to monitor and track how REE agencies work to meet Action Plan goals, and they also make suggestions for implementation of and revisions to the Action Plan to reflect the nation's evolving agricultural needs.

As stewards of public funding, and especially in times of constrained budgets, ARS regularly communicates and coordinates its activities with the other research agencies within the USDA and those external to the Department. A recent report of the Government Accountability Office (GAO-13-255) did not find duplicative research in a review of ARS and National Institute of Food and Agriculture (NIFA) projects. In response to report recommendations, ARS is updating its information in the CRIS system on a quarterly basis, enabling scientists from NIFA and ARS access to more up-to-date information in their searches to check for research duplication. ARS and NIFA leadership have established agency mechanisms for coordinating research directions and avoiding overlap or duplication of research. This includes holding joint agency meetings with stakeholders; participation in inter-agency working groups; and active communication between NPLs at both agencies. In addition, the ARS Associate Administrator for National Programs and the NIFA Director jointly prepare a quarterly report that list coordination activities between the two agencies; the most recent report listed more than 100 activities and workgroups.

ERS develops its research program in coordination with other REE and USDA research agencies, USDA program agencies, and other external collaborators. Priority research projects are initiated after input from stakeholders. ERS also selects partners and recipients of cooperative agreements and grants based on the highest priority needs for external expertise that can be brought to bear on core research program areas. In addition, ERS fully participates in REE and OCS meetings and discussions to help coordinate USDA science research and reports on research progress and findings through the REE Action Plan.

NIFA has evaluated the Agriculture and Food Research Initiative (AFRI) program to prevent duplication and ensure complementarity with programs of other agencies. For example, AFRI recently coordinated with the USDA Economic Research Service to offer a joint funding priority of importance to both agencies. Another recent example is that NIFA has completed two stakeholder workshops in Animal Production and Animal Health conducted jointly with the Agricultural Research Service to obtain stakeholder input and assess programmatic needs of both agencies.

The NAREEE Advisory Board has developed six questions to help guide the annual, mandated relevance and adequacy review of the REE programs, which results in a comprehensive report of recommendations communicated back to USDA.

- What are the key research, education and extension programming and their specific goals for this REE Action Goal(s)?
- What documented client/stakeholder needs are being addressed by the programming for this Action Goal(s)?
- Does the research, education and extension for the Action Goal(s) advance agricultural and/or natural resource science and its application? [Address strengths and limitations in answering this question.]

- Is the funding of this Action Goal(s) adequate to achieve its specific goals and how has its investment accomplished theses?
- What does this Action Goal(s) need to do to address remaining gaps between the activities and accomplishments, evolving stakeholder needs and the current state and application of agricultural science?
- Is there complementarity and collaborative effort across REE in terms of intramural, extramural and infrastructure funding and short and long term research, education and extension that does not duplicate effort in REE or other federal effort?

To date, the reviews have documented substantial planning and coordination amongst the REE agencies within the program areas reviewed.

8. In the 2014 Farm Bill, the application process for USDA research programs was improved in order to make the process more streamlined. Can you explain specifically what changes were made, and how the implementation has gone?

Response: NIFA has established government-wide forms for research, streamlined the process for additional increments of funding for continuation awards, established the Just in Time pilot (where only proposals selected for funding will be required to provide all supplementary forms and information), established a pre-application process, and streamlined matching. Opportunities to streamline in the future also exist as more functionality is achieved with the implementation of ezFedGrants.

9. Agriculture is growing beyond our farmers' fields, and is now happening in many of our cities across the country. From small acre farms to roof tops and indoor vertical farming, new economic opportunities can be found through urban agriculture. Can you discuss research that needs to be done to support urban agriculture?

Response: Urban agriculture requires long-term research focused on the overall goals of enhancing operational and production efficiencies; improving economic returns to producers; and reducing the environmental impact of urban agricultural production. Specific themes for such research in ARS include: **Production Environment**: Characterization of atmospheric gases, pollutants and light intensities experienced by crops grown in urban settings whether at ground-level or, but especially, on rooftops of high-rise buildings. Technologies for CO2 capture and release into CO2-starved greenhouse environments are particularly important for urban crop production during the winter months. **Water**: Technologies are needed for more effective use and re-use of water, be it municipal or rain feed, and water runoff collection and recycling. **Aquaculture**: Technologies for aquaculture/aquaponics in urban settings, either as a stand-alone system or coupled with vertical farming and hydroponic farming. **Postharvest Quality**: Technologies are needed to assure food quality and food safety, via superior product handling/ processing/ packaging and storage for produce from urban agriculture.

NIFA supports a broad spectrum of urban and community based agricultural projects through both competitive granting programs, capacity funds, and indirectly through grants awarded and administered through regional centers. NIFA defines urban and community based agriculture as agricultural practices that take place within a community setting. Across our granting programs, we funded 127 projects related to urban and community based agriculture at a value of $34,773,341 in fiscal year 2015. States reported $2,703,000 expended on related capacity projects in the same year. Between 2009 and 2015, NIFA awarded a total of 831 competitive projects related to urban and community based agriculture at a value of $198,214,308, with States reporting capacity expenditures of $9,502,000. Of this total, $41,271,174 was awarded through the Community Foods Projects grant programs. Capacity funding is NIFA's support for research and extension activities at land-grant institutions through grants to the states on the basis of statutory formulas, as determined by the Congress. See chart below illustrating NIFA administered research, education, and extension funding for urban agriculture related projects.

	Competitive	Capacity	Total
2009	$22,200,036	$607,000	$22,807,036
2010	$33,744,367	$832,000	$34,576,367
2011	$39,849,622	$806,000	$40,655,622
2012	$26,309,244	$883,000	$27,192,244
2013	$21,926,265	$1,483,000	$23,409,265
2014	$19,411,433	$2,188,000	$21,599,433
2015	$34,773,341	$2,703,000	$37,476,341
Total	$198,214,308	$9,502,000	$207,716,308

10. Antimicrobial resistance is one of the greatest threats to public health. While there is speculation that antimicrobial use in food animals contributes to antimicrobial resistant bacteria, more evidence is needed to investigate those links as well as find solutions. A GAO report published on March 16, 2017 titled "Antibiotic Resistance: More Information Needed to Oversee Use of Medically Important Drugs in Food Animals", made three recommendations to the Secretary of Agriculture regarding this topic, though all focused on APHIS and FSIS. Can you please explain how the research and extension mission area at USDA is addressing antimicrobial resistance, including areas of research focus and efforts to share this information with producers? Can you explain how the research mission area at USDA coordinates with APHIS and FSIS on antimicrobial resistance?

Response: Monitoring/surveillance, research, education, and outreach are interdependent. FSIS monitors for resistance through the National Antimicrobial Resistance Monitoring System (NARMS) and ARS works closely with FSIS to further characterize emerging resistance. Communication of collaborative findings is through

annual web reports, publications, and presentations, but can also be through blogs such as in the federal government's announcement of findings of colistin resistance in the U.S. last year: https://www.usda.gov/media/blog/2016/05/26/proactive-efforts-us-federal-agencies-enable-early-detection-new-antibiotic. APHIS, in collaboration with NASS conducts on-farm sampling and surveys through the National Animal Health Monitoring System (NAHMS). Monitoring helps to further inform research by identifying how and why antibiotics are being used. APHIS communicates AMR-related information with producers and producer groups through several channels, including disseminating NAHMS findings via publications and presentations. ARS publishes and presents research.

FSIS, APHIS, and ARS have an annual meeting where food safety researchers describe their current ongoing research, and FSIS/APHIS define their needs and challenges faced in the field for researchers to address. Through ARS intramural research and NIFA-funded extramural research, USDA agencies are studying the ecology of AMR, exploring products to improve the health of animals to decrease the need for antibiotics and identifying alternatives to antibiotics. In addition, the agencies are trying to identify better management practices to address AMR. NIFA-funded AMR studies can be found at: http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=fastlink1.txt&id=anon&pass=&search=(GC=A4171)&format=WEBTITLESGIY. Research feeds into education/outreach. Through NIFA's Agriculture and Food Research Initiative (AFRI) competitive program, NIFA awards grants that target research and either an education or outreach component. Since grantees have to include an education or outreach component, results of research can be immediately communicated and applied in real-world situations.

11. With the average age of the American farmer increasing, we need to encourage the next generation to engage in agriculture in order to feed the future. How does your respective agencies and programs help bring America's youth into agriculture? What are other ways to attract new farmers and ranchers?

Response: The REE agencies employ over 100 interns every year in addition to participating in numerous conferences and outreach activities.

NIFA specifically brings America's youth into agriculture through several programs.

- The 4-H Youth Development Program, or 4-H, is the youth outreach program from the land-grant institutions' cooperative extension services and USDA through NIFA. 4-H serves as a model program for the practice of positive youth development by creating positive learning experiences; positive relationships for and between youth and adults; positive, safe environments; and opportunities for positive risk taking. NIFA-supported 4-H programs reaches over 6 million children across the United States.

- NIFA's Agriculture in the Classroom Program (AITC) serves nearly 5 million students and 150,000 teachers annually through workshops, conferences, field

trips, farm tours, and other educational activities. AITC programs include working with state AITC activities engaged in a variety of issues relating to agricultural literacy. Other programs emphasized by the NIFA AITC office include Science literacy, Agricultural careers, Nutrition and Pre-service and professional develop opportunities for teachers.

- The Beginning Farmer and Rancher Development Program provides grants to organizations for education, mentoring, and technical assistance initiatives for beginning farmers or ranchers. Ensuring there will be a "new generation" of beginning farmers and ranchers, regardless of age or production choice, is especially important to the continuation of agricultural production in the U.S.

Agricultural science, technology, engineering, and mathematics (STEM) education has been described as a "leaky pipeline," as fewer students remain as they progress through advanced study. NIFA's education programs are designed to enhance the pipeline through programs that support agricultural workforce development, increase student recruitment and retention, and build capacity. ARS, ERS, and NASS also engage students at all levels to help fill the pipeline.

12. In the past few years, we have seen several devastating animal disease outbreaks in the U.S., including highly pathogenic avian influenza and porcine epidemic diarrhea virus. Does USDA have the appropriate authority and funding to adequately prepare for and investigate the next animal disease outbreak?

Response: Yes, the Animal Health Protection Act (AHPA) gives USDA the authority it needs to address large animal health emergencies, such as the 2014-2015 outbreak of highly pathogenic avian influenza (HPAI). The AHPA gives USDA a wide range of tools to address foreign animal disease outbreaks, which we utilize in coordination with our State regulatory partners, such as the ability to quarantine and restrict movement of animals. Additionally, the AHPA gives the Secretary, upon apportionment by the Office of Management and Budget, the authority to transfer emergency funding from other agencies and corporations of the Department—typically the Commodity Credit Corporation—to the Animal and Plant Health Inspection Service (APHIS) to address outbreaks. This authority provided the overwhelming majority of the funding utilized to respond to the HPAI outbreak in 2014-2015.

Beyond that, USDA requested additional funding for animal health emergencies in the 2017 budget request. APHIS received an additional $24 million to improve the Agency's preparedness to detect, analyze, and respond to foreign and emerging animal health events.

13. Can you discuss current research being conducted on pre-harvest interventions to address food safety concerns in meat and poultry?

Response: The ARS Food Safety program develops and validates intervention strategies to assist in reducing or eliminating pathogens in food animals during production.

Reduced shedding of zoonotic pathogens by food producing animals subsequently helps reduce the pathogen load during slaughter/harvesting and subsequent processing and storage. The Program addresses the continued need to develop and subsequently combine new and/or innovative technologies. Interventions can be additive and/or synergistic, leading to improved control over pathogen growth without potential changes in food quality or reduction in nutrition. The challenge is that the pathogen load on a product must be significantly reduced by any processing intervention strategy to avoid the consequences in food production resulting from "dirty in, dirty out" processing.

ARS specifically conducts research in meat to:

- Characterize the ecological niches and reservoirs to identify mechanisms of foodborne pathogen, especially biofilms, for their ability to colonize and persist leading to the development of intervention strategies.
- Develop and evaluate novel intervention strategies that reduce or eliminate the occurrence, transmission, or persistence of foodborne pathogens in host animals, including cattle and swine, and the environment. Survey ecological niches and reservoirs using a systems approach to identify sites for potential interventions to reduce foodborne pathogens.
- Identify environmental and management (intervention) practices that influence antimicrobial resistance, colonization of lymph nodes, and colonization rates of cattle, veal, and swine.
- Develop interventions that prevent/mitigate colonization of gut of food-producing animals (particularly lower GI tract before slaughter) or that reduce pathogenic/antimicrobial-resistant bacteria in production environment.

ARS specifically conducts research in poultry to:

- Identify, develop, and test interventions, including exploring possible synergies of multiple interventions and alternatives to antibiotics that can kill pathogenic or antibiotic resistant foodborne pathogens or mitigate their persistence, shedding, virulence and resistance in the animal production environment.
- Evaluate these products in multiple production/processing systems including conventional, pasture raised, and organic systems.
- Develop new vaccination strategies based on innate immunity to reduce Salmonella contamination in broiler chickens and turkeys.
- Develop strategies to reduce foodborne pathogens by targeting host immune-metabolic signaling pathways affected by Salmonella and Campylobacter virulence factors.
- Develop innovative strategies for increasing disease resistance and improving immunity to foodborne pathogens of poultry using egg shell membrane technology.

- Assess the impact of dietary regimens, housing systems, and different chicken genetic lines on Salmonella (S.) infections of hens, Salmonella contamination of the production environment and eggs, and physical and functional egg quality.
- Assess the effects of key management practices using experimental and field models of different housing systems on hen health, microbial ecology of foodborne bacteria, and antimicrobial resistance associated with egg contamination.

NIFA has funded 20 projects on pre-harvest food safety focused on meat and poultry, ranging from $50,000 to $25,000,000. These projects include research, education, and extension activities to reduce Shiga Toxin Producing *E. coli* (STEC) in beef, and *Salmonella* and *Campylobacter* in poultry. Some projects are focused on reducing antimicrobial resistance. Four of the projects were or are currently being conducted at the Michigan State University:

- Dr. Shannon Manning just completed a project to improve the understanding of the factors affecting colonization and shedding of shiga toxin-producing *Escherichia coli* (STEC) in cattle. Shiga toxin-producing *Escherichia coli* (STEC) are major pathogens of humans, resulting in severe illness and occasionally death. About 29% of the cases in the U.S. are attributable to beef. The information generated enhances our efforts to control this deadly pathogen and was provided to USDA's Food Safety and Inspection Service to inform their regulatory decision-making.
- Dr. Julie Funk just completed a project on the epidemiology of shiga toxin-producing *Escherichia coli* (STEC) in pigs. This project filled a critical information gap regarding the prevalence of STEC on commercial swine farms, the factors associated with shedding of STEC by swine, and the relationship between STEC isolated from swine to those isolated from cattle and humans. The information generated was provided to USDA's Food Safety and Inspection Service to inform their regulatory decision-making and to representatives of the swine industry.
- Dr. Linda Mansfield is working on two projects focused on improving the understanding of *Campylobacter jejuni*. *Campylobacter* is a major cause of gastroenteritis with vomiting and diarrhea.

14. What research is currently being done at your agencies on the effectiveness of voluntary conservation programs authorized in the Farm Bill in addressing natural resource concerns, like water quality, drought, soil health, and wildlife habitat? Are there positive results or data from this research that you can share that will help justify the federal investment in voluntary conservation programs? Can you explain how do your agencies work with the Natural Resources Conservation Service on research to demonstrate the environmental outcomes from conservation activities on farms and ranches?

Response: ARS research supports the agencies that lead voluntary conservation programs and initiatives arising from the Farm Bill. Our scientists work very closely with

NRCS and other agencies at USDA that implement conservation programs. Our scientists develop new cropping systems, management strategies, practices, tools and technologies that inform, strengthen, or provide the scientific underpinnings for things such as NRCS Conservation Practice Standards. Often our data and measurement protocols are used in quantifying the benefits of conservation programs. The expanding application of improved conservation management in areas such as conservation tillage, cover cropping, nutrient use efficiency and similar management practices, that have been extensively researched by ARS scientists, are documented by NRCS data through the National Resources Inventory (NRI) and their beneficial impact on conservation accounted for in NRCS Conservation Effects Assessment Project (CEAP) regional and national reports and elsewhere. Another example is within the Chesapeake Bay Watershed, where runoff of sediment and nutrients has been a documented problem. ARS research throughout the watershed and across the country is resulting in improved management practices that conserve soil and hold fertilizers and manure nutrients in place where they can be utilized by crops. EPA and USGS data over recent decades are demonstrating a positive trend resulting in improving water quality across the watershed. These examples, along with some additional recent accomplishments noted below, show how ARS research efforts support Farm Bill related conservation programs, helping ensure soil health, water quality, and wildlife habitat availability while also enhancing our ability to sustainably produce food, feed and fiber.

ARS's collaboration with NRCS on the Conservation Effects Assessment Project (CEAP) includes ARS leadership of the CEAP Watershed Assessment Study (WAS), which involves more than 60 ARS scientists, plus additional technical support staff, working in 14 benchmark watersheds at 12 ARS locations. The ARS-CEAP-WAS project is a fully peer-reviewed national effort that is highly relevant to the conservation policy of the USDA. In the CEAP-WAS, scientists collect, manage and provide data to researchers and other users, develop and validate models and tools, and measure and quantify water quality, water quantity, soil quality, and ecosystem effects of conservation practices at the watershed scale in a variety of hydrologic and agronomic settings.

One strategic conservation target for USDA conservation programs is reducing nutrient losses that impact the Gulf of Mexico and Great Lakes and water bodies across our landscape. This challenge is continental in scale, but involves the management of thousands of small watersheds comprising millions of farm fields. A new GIS-based conservation toolbox, called the Agricultural Conservation Planning Framework (ACPF), has been developed by ARS to address local planning needs on a site-specific basis, and is being trialed in a range of landscape and farm management settings across the Midwest. The ACPF toolbox is now available for download through the North Central Region Water Network website. The ACPF is based on a holistic planning concept that emphasizes soil health. ACPF considers key 'soil-building' practices that promote agricultural soil health (e.g., minimum tillage, nutrient management, cover crops) as well as additional conservation practices as needed to "trap and treat" nutrient losses when and where they occur. The ACPF provides a way to identify those locations in agricultural landscapes where water accumulates and that are suited for the placement of "trap and

treat" conservation practices. The ACPF is a set of tools, and the combined results provide an 'inventory' of conservation opportunities found in fields, below fields, and in riparian zones where water quality improvement and other ecosystem services can be realized.

Soil organic matter is key to many aspects of conservation, including the ability of the soil to hold water and nutrients until the crop requires them. Additionally, increasing soil organic matter provides many ecosystem services and conservation benefits. ARS scientists have developed a research and data network called GRACEnet, (Greenhouse gas Reduction through Agricultural Carbon Enhancement network) which spans 36 ARS research locations collecting data on management practices that increase soil organic matter and soil carbon storage. This has resulted in development of standard sampling and measurement protocols, improved quantification of conservation benefits, and notable improvements to the ability of both USDA and EPA to do required agricultural greenhouse gas inventory reporting, and provided much of the basis for development of decision support tools such as NRCS's COMET-Farm and COMET-Planner tools.

The ARS Resilient Economic Agricultural Practices (REAP; initially called Renewable Energy Assessment Project) effort has developed cropping systems, cover cropping practices, residue management and tillage harvest strategies. The goal of this effort is the utilization of crop residues in such a way that also maintains or enhances soil health and quality, allowing for increased utilization of the biomass produced, increased margin for the producer, and reduced negative impact on the environment. ARS REAP science has been utilized in conservation and renewable energy programs at USDA Rural Development and NRCS as well as by the Department of Energy.

ARS scientists are researching a variety of practices and technologies that improve the management and use efficiency of nutrients in agricultural systems. Research and data on precision fertilizer practices such as changing the timing of application or the placement of the nutrients have resulted in new strategies that increase the amount of nutrients used by crops and reduce losses to the environment. Development of tools for quantifying the use, efficiency and loss of nutrients have been developed (such as the Nitrate Leaching and Economic Analysis Package [N-LEAP]) as well as related decision support systems (e.g., the Great Plains Framework for Agricultural Resource Management [GPFARM]) which help land managers reduce their environmental impact and improve conservation on their lands. Similarly, ARS researchers have developed numerous manure treatment and application practices and technologies to ensure that the nutrients in animal manures are captured and utilized rather than lost to the environment.

Remote sensing research at ARS has a long history of the development of methods, data, analysis and tools that are useful to NRCS for conservation planning and programs as well as to USDA- National Agricultural Statistics Service (NASS) and other agencies. One recent example is related to remote sensing techniques to map leaf area index (LAI). LAI is a key parameter used in land surface flux estimates, water resource management, and crop growth monitoring. Current coarse resolution leaf area index tools - at the kilometer scale - are sufficient for global, continental, and regional scale

applications. Agricultural field scale applications, however, require leaf area index with both high spatial and temporal resolution. ARS scientists have developed an automated mapping method for leaf area index that generates a four-day time-series of a 30-meter leaf area index. This method was tested over central Nebraska from 2002 to 2012 and showed promise for generating frequent map leaf area indices at field scales –using data from current satellites. This approach demonstrates potential for crop modeling at field scales, which is information needed by NASS for crop condition monitoring and yield estimates.

The above are clear examples of ARS efforts and tools that have been developed and which can be used in volunteer conservation programs or conservation activities on farms and ranches - across the country and throughout the world, either by direct access, through USDA conservation program office and NRCS conservation technicians, or by partnering with ARS, NRCS or other USDA experts.

Annually, NASS conducts the Agricultural Resource Management Survey (Phase II) that measures the on-farm chemical use and production practices of farmers. NASS surveys U.S. Farmers to collect information on the chemical ingredients they apply to agricultural commodities through fertilizers and pesticides. On a rotating basis, the program currently includes fruits; vegetables; major field crops such as cotton, corn, potatoes, soybeans and wheat. Each survey focuses on the top-producing states that together account for the majority of U.S. acres or production of surveyed commodity.

The Census of Agriculture, which is published every five years, publishes data on the number acres fertilizers, chemical and soil conditioners were applied. NASS also collects agricultural practices: such as tillage practices, irrigation practices and cover crop.

NASS also collaborate with the Natural Resources Conservation Service to collect data on the Conservation Effects Assessment Project (CEAP). This is a multi-agency effort to quantify the environmental effects of conservation practices and programs and develop the science base for managing the agricultural landscape for environmental quality. Project findings will be used to guide USDA conservation policy and program development and help conservationists, farmers and ranchers make more informed conservation decisions.

ERS research examines how economic incentives influence the adoption of management practices that can improve the environmental performance of agriculture and conserve scarce natural resources, including land, water, soil, air and biodiversity. Special attention is paid to the role of conservation programs in farmers' adoption decisions, and of options for improving the economic efficiency and environmental effectiveness of those programs. Research efforts also examine potential environmental and land use implications of farm commodity, crop insurance, and disaster programs.

ERS research also examines options for improving the economic, environmental and distributional performance of voluntary programs. Design features examined include the baseline level of performance necessary to receive payments or participate in markets;

options for targeting specific producer types (e.g., socially disadvantaged farmers), regions, or environmental attributes; the use of auctions for soliciting high benefit or lower cost offers; and procedures for selecting participants from among all applicants.

Recent and current research include:

- Conservation payments lead to improvement in environmental quality only if farmers and ranchers who receive them adopt conservation practices that would not have been adopted without the payment. When a voluntary payment causes a change in practice(s) that lead(s) to improved environmental quality, these changes are "additional." ERS found that additionality depends largely on practice characteristics; practices that are expensive to install or provide only limited onfarm benefits (such as structural and vegetative practices and nutrient management) are unlikely to be adopted without payments. The study found that it may be possible to design programs to increase additionality, and program cost-effectiveness, by putting higher priority on practices that are less likely to be undertaken without payment support.
- ERS found that conservation programs help farmers adapt to drought. Farms in more drought-prone regions are more likely to offer eligible land for enrollment in CRP—a 1-percent increase in drought risk leads to a 2.4-percent increase in the offer rate. Irrigators facing higher drought risk are more likely to be enrolled in EQIP contracts with irrigation practices. And crop farms facing higher drought risk are more likely to be enrolled in EQIP contracts with conservation tillage practices.
- An ERS study found that environmental compliance incentives would be reduced on many farms, potentially increasing environmental quality problems, if direct payments were sharply reduced or eliminated to help reduce the Federal budget deficit. The study showed that making federally subsidized crop insurance subject to compliance could make up some of the lost incentive to farmers. The report was timely and relevant to the debate on re-linking crop insurance subsidies to environmental compliance.
- ERS is conducting an ambitious set of experiments to test how alterations in design can improve the performance of voluntary conservation programs. Examples of these experiments include testing the efficacy of additional targeted outreach efforts on participation in FSA's microloans program, which provides loans up to $50,000 to farmers, with less stringent eligibility criteria, and aimed at nontraditional farmer subgroups. The CRP "nudge" experiment demonstrated how targeted outreach reminder letters can encourage additional offers to re-enroll in the program participation of farmers who had not previously applied to the program.
- ERS is currently conducting research on the legacy effects of conservation programs. An aspect of conservation policy that has received little attention is how financial assistance may provide conservation benefits beyond the specific location and duration of program participation. ERS researchers are using EQIP

administrative data along with satellite data to study the extent to which participation leads farmers to retain conservation tillage practices after the contract has expired or to adopt conservation tillage on non-contract fields, or the extent to which participation leads neighboring farmers to adopt conservation tillage on their land.

- ERS researchers are examining reasons why conservation practices get dropped from contracts. ERS is using EQIP program administrative data to ascertain whether changes to conservation plans are due solely to adaptive management (adjusting to unforeseen weather or financial conditions) or to other reasons related to contract design.
- ERS is currently conducting research on the mix and geographic location of conservation practices for most efficiently reducing nutrient loads to the Gulf of Mexico and to sub-basins within the Mississippi Basin. This research will provide information that could be used to more effectively target conservation effort for water quality protection.

ERS also conducts research on agro-environmental issues that can inform resource management agencies such as NRCS.

- ERS recently completed a study on the effects of land use on pollinator health and trends in pollinator forage quality as land uses and land covers have changed in the United States over the last 30 years. The contribution of CRP to forage quality was noted.
- ERS analyzed national and regional adoption of several important conservation systems, including no-till and strip till, cover crops, and nitrogen fertilizer management. Results show that farmers' adoption of these practices varies widely by crop and region.
- ERS evaluated how changing environmental conditions due to shifts in temperature and precipitation patterns affect crop yields, crop-water demand, water-supply availability, farmer livelihoods, and consumer welfare. The study highlighted the adaptations farmers can make to mitigate the economic impacts of these changes, and regional variations in impact and response.

NRCS is an important stakeholder for ERS research. When conducting research on conservation programs, ERS routinely seeks NRCS input so that the research best support NRCS's informational needs. NRCS has shared some of its survey and modeling data with ERS so that it can better link conservation practice adoption to environmental quality measures. The study on reducing nutrient loads to the Gulf of Mexico would not have been possible without data from NRCS's Conservation Effects Assessment Program (CEAP), and administrative data for EQIP is critical for research on conservation contract design and on conservation program legacy effects.

ERS research on conservation policies and programs is dependent on high quality farm and field-level data. The Agricultural Resources Management Survey, managed by NASS and ERS, provides much of the practice and financial data that enables ERS to produce high-quality and timely research that supports USDA's conservation missions. A reduction in support for this survey would make it more difficult to conduct such research.

NIFA supports research, education, and outreach on the scientific bases or translational difficulties that might relate to conservation practices. In terms of efficacy of voluntary conservation programs, NIFA participated in the competitive funding of CEAP (Conservation Effects Assessment Program) through the National Integrated Water Quality Program (NIWQP) where 13 watershed studies were funded to evaluate the efficacy of several cropland/grazingland conservation programs through retrospective analysis. A summary and series of Fact Sheets on the outcome of those studies is accessible at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/ws/?cid=stelprdb1047821. The lessons learned from this synthesis strengthen the knowledge base for evaluating the impacts of conservation practices on water quality, improving management of agricultural landscapes for improved water resource outcomes, and informing conservation policy.

Additionally, sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility. NIFA promotes sustainable agriculture through national program leadership and funding for research and extension, offers competitive grants programs and a professional development program, and collaborates with other federal agencies through the USDA Sustainable Development Council.

15. The Specialty Crop Research Initiative addresses the critical needs of the specialty crop industry from plant breeding and genomics, to pest and disease management, and innovative technologies. What are some groundbreaking research examples of how this program used? What is the return on investment of this program to the specialty crop industry and the economy? How are these funds being used to support both basic and applied specialty crop research?

Response: A basic tenet of the Specialty Crop Research Initiative (SCRI) is that all projects funded produce outcomes that lead to a sustainable future for agricultural production, with a major emphasis of new knowledge being translated into useable information that producers can implement during the life of the project. Since 2012, SCRI has funded 83 projects totaling $193,041,063.

Pollination is an absolute requirement for sustainable production of specialty crops. Declines in honey bee and native pollinator populations, as well as increased acreage of crops that require cross pollination, have threatened specialty crop producers. To address this need, NIFA, through SCRI, funded the Integrated Crop Pollinator project led by Dr. Rufus Isaacs at Michigan State University. Research sites for this project have provided

visibility to the ICP project on over 10,000 acres of specialty crop fields across more than 100 farms. In Florida, the project has influenced how growers use pesticides, thus avoiding not just impacts on bees but also reducing groundwater contamination. In Pennsylvania pumpkins, one grower has cut honey bee stocking rate in half, from 1 to 0.5 hives/acre without a decrease in yield. This has resulted in a savings of about $14,000 per year for this one grower.

The Rosaceae crop family includes many important crops such as apple, blackberry, peach, pear, rose, strawberry, sweet and tart cherry, and roses. Growers of these crops have expressed a need for new varieties that display disease resistance and superior quality of fruits or flowers. Developing new cultivars of many Rosaceae crops can take longer than 10 years, however. Since 2009, the SCRI has invested more than $13,000,000 in the RosBreed project, led by Dr. Amy Iezzoni at Michigan State University. This project brings modern genomic and genetics tools, in a nationally coordinated effort, to augment the efforts of traditional breeders in the efforts to efficiently and effectively deliver cultivars with producer-required disease resistances and market-essential horticultural quality within time frames that are useful to the commercial sector. By combining fundamental genomic discovery with practical breeding, the RosBreed team has been able to cut the time required to develop new cultivars in half, while saving individual breeding programs hundreds of thousands of dollars.

16. As we prepare for the 2018 Farm Bill, there clearly are some areas where research and data can have a direct impact on how well the farm safety net functions.

    a. Federal Crop Insurance is a critical part of the farm safety net that is delivered through a partnership between USDA and private companies and agents. The cost in premiums to producers for these crop insurance policies is based on the level of risk for their particular crop, location and coverage options. There are certain management practices such as cover crops or different types of precision agriculture that appear to reduce the risks of losses in addition to other benefits to the environment and input costs. To what extent have the research agencies of USDA sponsored or summarized research projects that could be directly applicable to this question of risk reduction? Please summarize any specific results and the degree that risk was reduced. Have you coordinated with the Risk Management Agency to share these results, or used their program and actuarial needs to target future research?

    Response: There is growing interest in what farmers can do to improve soil quality (soil health) and how that may increase crop yields or reduce yield variability. For example, healthier soils can increase drought resilience by capturing and retaining moisture in the soil and making it available for plant growth. An extensive review of the agronomic literature by the USDA Natural Resource Conservation Service (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=stelprdb1257753) suggests that soil health can be improved under a wide range of soil and climatic conditions, but only through the consistent

application of a suite of practices over a period of years. Soil health can be built through long-term and continuous use of no-till, cover crops, double cropping, mulching, and rotation with permanent grass, such as pasture or hay. For example, continuous no-till used in conjunction with high residue/cover crops can have a positive effect on key soil properties including soil organic matter, soil aggregate size and stability, water infiltration, and water-holding capacity. There is also some research to suggest that precision agriculture can improve yields and reduce yield variability. ERS research shows that GPS mapping, guidance systems, and VRT reduce input costs and increase yields.

While there is strong evidence that some practices could be used to improve soil health, there is no database linking the use of specific practices to yield experience that could be used to rate crop insurance premiums. In crop insurance analysis published to date, ERS has used statistical analysis derived from actual yield data and not from agronomic models. While the former approach is likely produce analysis that is representative of the real world, the downside is that it requires sufficient data to obtain statistically meaningful results; there is insufficient yield data linked to specific practices benefiting soil health that is available to ERS to date, to do analysis of how yield would change, and consequently how premium rates would change. RMA already makes adjustments for many common practices that are known to impact yields. However, ERS has published research on the risk reduction provided by federal crop insurance more generally, and on the impacts of policy changes on risk reduction. ERS found that on average for the US, if farmers adopted the Revenue Protection insurance policy with a 75 percent coverage rate, their downside revenue risk protection increases by around 200 percent for corn and soybeans and around 550 percent for winter wheat (https://www.ers.usda.gov/publications/pub-details/?pubid=45515).

Statistical analysis presented at an ERS-sponsored workshop (The Economics of Soil Health, September 2015, https://www.farmfoundation.org/webcontent/Economics-of-Soil-Health-1914.aspx) show that soil quality is strongly predictive of yields and that models including measures of soil quality could be used to better predict insurance premiums. Nonetheless, links between the use of specific practices and soil quality or soil health have not yet been clearly quantified and may depend significantly on soil characteristics and climate.

b. The Farm Service Agency's Agriculture Risk Coverage program relies of thousands of yields by crop and county in order to calculate guarantees and payments. The program relies particularly on yield data collected by NASS through surveys of producers. In some cases, insufficient responses are received despite repeated attempts by NASS, but I understand that NASS does not have the option of increasing the sample size. Is this restriction of expanding the number of producers surveyed related to budget constraints or other restrictions such as the paperwork reduction act requirements? Are there any areas where added

flexibility would provide NASS county-level data more consistently, instead of requiring FSA to switch between data sources?

Response: NASS contacts over 365,000 farmers throughout the country to collect data to publish county estimates. There are four modes of data collection: mail, internet, telephone and personal interview. NASS has partnered with associations marketing the survey which resulted in more counties published for the commodity of interest. An increase in resources would allow NASS to improve the marketing plan informing the farmers the benefits of responding to NASS surveys. Currently, NASS utilizes unpaid media opportunities such as USDA Radio, RFD-TV interviews, national news releases, reminders in weekly crop progress and monthly crop production reports, short items for use in FSA newsletters, USDA blogs when available and Twitter to garner earned media coverage that encourages response to these and other surveys. We provide enumerator training materials, news release templates, survey cover letters, etc. for regional offices to localize so that our own staff have pertinent information and can leverage local knowledge and connections. Additionally, we've built partnerships with national commodity organizations for wheat, corn, and soybeans to help further encourage farmers and ranchers to respond. All have included content in their member communications.

Senator Kirsten Gillibrand

1. New York has more than a thousand certified organic operations and many farmers I talk to have considered transitioning to organic – particularly young farmers who are looking to start farming on a modest scale without incurring huge debt. In the last ten years, we have tripled the number of organic farms and still our growers struggle to meet the demand for local grains and produce. Those farmers need research support like the grants made available through the Organic Agriculture Research and Extension Initiative (OREI). While the organic industry has experience rapid growth with sales reaching $47 billion last year, the OREI budget has stayed flat for nearly a decade.
   Can you discuss the ways in which your mission area supports organic production across the REE programs?
   How do you intend to increase the resources available to organic farmers, or those that are transitioning, so that we can meet domestic demand without having to rely so heavily on imports?

   Response: The United States has fast-growing consumer demand for organic food, as well as an expanding organic production sector—although some commodity segments, organic feed grains in particular, haven't kept pace. USDA is widening access for organic and transitioning farmers to crop insurance, conservation programs, and other farm programs. ERS research and analysis related to the organic farm sector, includes:

   - Expanding USDA's major economic producer survey (Agricultural Resources Management Survey) to, for example, provide information on the price premiums

needed to cover higher organic production costs in major crop and livestock sectors. ERS has included targeted organic oversamples in the ARMS survey to examine the dairy sector (in 2005, 2010 and 2016), soybeans (in 2006), apples (2007), wheat (2009), and corn (2010).

- Examining the challenges as well as the factors that positively influence farmers' decision to adopt organic production systems.
- Calculating the trends in organic price premiums for various food products and agricultural commodities, and examining the market penetration of organic products at the retail level.

A recent ERS Amber Waves feature discusses and illustrates the broad trends in U.S. organic demand, production, and trade, see "Growing Organic Demand Provides High-Value Opportunities for Many Types of Producers."

Despite a sustained double-digit growth in annual demand for organic products, domestic production has not been able to satisfy that demand. It is only possible to meet the growing demand for organic products from domestic sources through the transition of new producers, land, and facilities into certified organic production.

2. I am concerned about the concentration in production agriculture on many levels, but certainly in the way it that has limited the availability of regionally adapted seeds. Public plant breeding programs have declined significantly in the past 20 years and more in the Northeast than any other part of the country. This makes our growers more reliant on big corporations and limits their access to new varieties of seeds that grow best in their communities
What are your plans to bolster plant-breeding programs at our land grant universities to make more regionally adapted seeds available to our growers and how will you ensure that these new varieties are publically released?

Response: USDA/ARS conducts plant breeding/genetic improvement projects for more than 50 different crops. Most of these projects are closely coordinated with land-grant university efforts, many to the extent that they are actually "joint ARS-university" breeding projects which jointly release new varieties. ARS also partners closely with some commodity groups and seed companies to develop and release new varieties. In all cases, ARS designs its plant breeding/genetic improvement projects to complement and bolster—but not compete with—university and private-sector efforts. Many ARS plant breeding/genetic improvement projects could not operate without those strong partnerships, and vice-versa.

During the period 2011-2016 USDA/ARS released a total of almost 800 new varieties or improved germplasm for more than 50 crops. All of USDA/ARS' new varieties are released publically. Most of them are free of intellectual property rights. But, some are protected by Plant Variety Protection Certificates (also known as plant breeders' rights) which enable companies to recoup investments in additional research and marketing while still making the varieties available for additional breeding by other public and private-sector organizations.

Because of the nature of crop genetic diversity, the highly variable conditions in numerous distinct local and regional growing regions, and the disparate demands of local and regional producers and their markets, the crop varieties ARS develops are adapted to production in specific growing regions. For example, in the Northeast U.S., ARS potato breeders in Beltsville, Maryland, and their university cooperators at the University of Maine and Cornell University, breed potatoes adapted for production in the Northeast. Other ARS breeders in Beltsville breed sweet pepper and tomato varieties resistant to the strong disease pressures that often occur in the Northeast and adjacent production regions. ARS apple rootstock breeders and their Cornell University cooperators in Geneva, New York, breed outstanding apple rootstock varieties that bolster apple yields and quality throughout the Northeast and other production areas. ARS plum and pear breeders in Kearneysville, West Virginia, publically release new varieties which underpin Northeast production of these fruits. ARS breeders and their Rutgers University colleagues in Chatsworth, New Jersey, publically release blueberry and cranberry varieties for the Northeast. ARS breeders in Washington, DC, publically release woody landscape ornamental (e.g., ornamental cherries, hemlocks, and red buds) varieties adapted to challenging Northeast urban and suburban growth conditions. Finally, ARS breeders in Beltsville publically release strawberry varieties, adapted to the diverse growing conditions of the Northeast and adjacent regions, which are significantly lengthening the production season and the profitability for u-pick-it operations and fresh market sales. Similar examples of ARS/land-grant university partnerships that breed and publically-release regionally-adapted varieties could be recounted for the US Southeast, Midwest, Plains, Northwest, Southwest, Caribbean, and Pacific crop production regions.

Given these longstanding (100+ years old, in the case of strawberries) cooperative ARS/land-grant university and private-sector partnerships, the infrastructure (including shared facilities and land) exists to bolster and expand these cooperative ARS/land-grant university programs for breeding regionally adapted crop varieties and making them widely available to growers in the Northeast and other production regions. This is particularly important now when a large cohort of senior ARS and land-grant university plant breeders have retired or will retire. A new generation of plant breeders must be trained to continue and extend these cooperative plant breeding programs that have long underpinned local, regional, and national crop production.

The FY 2017 AFRI Foundational Plant Breeding for Agricultural Production priority area supports opportunities for researchers to develop publicly available seed and cultivars that are bred to be adapted to the soils, climates, and farming systems of farmers of all regions. Research can include, but is not limited to, prebreeding and germplasm enhancement, cultivar development, selection theory, applied quantitative genetics, and participatory breeding. Public release of germplasm and cultivars are an integral requirement of AFRI funded breeding projects. In addition, the 2014 Farm Bill enables eligible state and national commodity boards to submit topics for research and outreach that can be specific to their states or regions and are willing to equally co-fund through AFRI. In FY 2016, the first year of collaboration with commodity boards, two plant breeding projects were supported. In general, NIFA's AFRI program is highly competitive, with an average of only 13 percent of proposals submitted during the last three years being funded. This results in a huge number

of highly worthy proposals being unfunded. With additional funding for AFRI, the agency can fund many more proposals, including in plant breeding.

There are also two other NIFA programs that support opportunities for land grant universities to provide regionally adapted seeds and cultivars to growers. The Specialty Crops Research Initiative supports plant breeding, genetics, and genomics to improve crop characteristics in a wide variety of crops and crop families; and the Organic Agriculture Research and Extension initiative supports priorities to strengthen organic crop seed systems, including seed and transplant production and protection, and plant breeding for organic production, with an emphasis on publically available releases.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. John Floros

Senator Debbie Stabenow

1. One of the highlights of the U.S. agricultural research framework is our cooperative extension system to disseminate information learned in the latest research to the people who need it most. What are the greatest challenges for our extension system currently? How can we empower extension agents?

   Our Extension system has experienced significant budget cuts for decades. Funding from federal, state, local, and other sources is not what it used to be throughout our nation. As a result, the number of Extension faculty and staff, from Extension specialists and educators to Extension agents, has been drastically reduced. Today, many of the counties, districts, or regions across the country employ very few agents, and some employ only one Extension agent.

   This reduced human capital is the single most important challenge facing our Extension system today. One Extension agent alone could not effectively lead programs in and answer questions on issues as diverse as crop production and diseases, animal growth and wellbeing, organic agriculture and gardening, water and natural resources, ag policy and fiscal matters, food safety and processing, nutrition and human health, family wellbeing and community revitalization, youth development and leadership, just to name a few.

   Looking forward, we must restructure our system to take advantage of all the science, technology and communication methods available today. We must find the resources to adequately rebuild our human capital and expertise to cover all content areas needed. We must find sufficient funding to redesign our Extension system to be nimble, relevant and responsive.

2. Can you discuss what you believe to be the greatest research gaps in our food system across the entire food supply chain?

   A. *In my view, a major gap is that we've abandoned research and development at the land-grant universities in food processing and manufacturing and in food product development. Food scientists and food engineers with such expertise are becoming much less common at the land-grants. That is a result of essentially no federal funding for research in this area. Lack funding also resulted in lack of graduate*

student training, and thus, having fewer and fewer food scientists and food engineers going into this line of academic work.

B. *Using Kansas State University as an example, we have placed considerable effort and resources to develop strengths in selected crop and livestock sectors that fit our state. On the crop side, we are very good at wheat and grain sorghum. Our efforts, however, have been heavily slanted toward production of these grains largely for commodity markets. With grain sorghum, we've devoted almost all of our efforts from genetics to grain production up through harvest, and that is pretty much where our efforts cease. Although with our unique Department of Grain Sciences and Industry, we have done more with post-harvest handling and processing of wheat, in general, once the wheat is milled to flour, again, our efforts stop at that level of the value chain. The point is, as land-grants, in general, we have left much of the value-added research and development to the private sector over the past 2-3 decades, and now the private sector is turning to us (the land-grants) for research and development, and we are finding ourselves thin in terms of the breadth of food science/product development skills to fully address those needs. It is reasonable to think we can generalize this situation to many states, especially in the north central region/corn belt. Neither USDA nor other federal funding agencies have research programs that allow faculty to develop research careers in these areas.*

C. *As a nation, we have a huge food waste problem, as I noted in my testimony. In the United States, waste occurs mostly after all of the inputs and value-added have taken place. In general, that means in homes, restaurants and grocery stores. We have to figure out how to solve this complex problem. Our work (at Kansas State) through USAID in developing countries is focused on minimizing losses post-harvest and sustainable intensification of food production. Post-harvest loss, rather than post-processing/value-added loss is the problem in most developing countries, but the United States can and should play a critical role there too for not only humanitarian reasons, but also because of the potential instability that comes with food insecurity.*

D. *Finally, another important gap is the effective use of irrigation and other technologies to reduce water consumption in agricultural production and throughout the food system. The declining levels of underground aquafers across the country and around the world is a clear sign that urgent solutions are needed.*

3. How has Kansas State changed its extension framework to reflect the broad needs of rural communities, including economic development, community leadership, etc., rather than focus on agriculture alone?

A. *We put together a strategic plan with broad input from all of our stakeholders. The plan addresses issues pertaining to agriculture, natural resources, and the food system, but it also recognizes that we must help our communities, families and youth to develop, grow and prosper. To that end, we are partnering with other*

entities and working closely with communities, and philanthropic foundations to provide human capital and operating funding dedicated to economic development and community vitality programs.

B. *In addition, we have initiated a program to help counties join forces and form larger districts. Each multi-county district now has more shared resources (more than one or two Extension agents) to address not only one or two major challenges, but many more. As a result, programs in most of our districts now include leadership development, community and board leadership, economic development, community discussion facilitation, needs assessment, and strategic implementation.*

4. Land grant universities and other research institutions conduct cutting edge research to address the latest challenges in agriculture, funding these projects through competitive grants or capacity funds. Less exciting, but equally important, is funding maintenance of the infrastructure involved with ag research. Can you describe where infrastructure funding typically comes from, and challenges associated with finding money to keep our research laboratories and farms up to date?

This is a major, major problem. I referenced the Sightlines study in my written testimony for the record. At Kansas State University, we receive very minar investments from the main campus budget to address renovation and repair—it falls dramatically short of the need. Our main campus budget, like most, derives mostly from tuition revenue and a smaller percentage comes from state appropriations. As the Sightlines study noted, only 20% of colleges of agriculture invest at levels that would at least stabilize, if not decrease, the backlog of deferred maintenance; 80% of the campuses are investing capital at such a low level that they continue to add to the backlog of deferred maintenance every year. As a result, most colleges of agriculture continue to do modern science in ever aging facilities.

At K-State, we recently completed our own infrastructure needs assessment, which showed that only about 20% of our facilities were satisfactory or better. The remaining 80% were in desperate need of repair, renovation or removal. The tatal amount needed to renovate and rebuild our facilities, and bring them up to 21st Century standards, was $550 Million. This is not an amount we can raise philanthropically. Together with our stakeholders, alumni and friends will do our part, but without state and federal support, we may never get there.

5. The 2014 Farm Bill changed the matching requirements for funding to Land Grant Universities and for some of the competitive grant programs. Can you discuss how these changes have impacted your respective institutions?

The changes have not impacted us dramatically. Beginning on 10/1/2014, an additional requirement was made, but included exceptions, one of which is 1862 land grant institutions. Details can be found here, https://nifa.usda.gov/new-matching-requirement-frequently-asked-questions, under item #2. With this exception, we typically say in the budget justification: "Kansas State University is exempt from match as an 1862 Land-Grant Institution with a State Agricultural Experiment Station receiving funding under the Hatch Act of 1887."

6. With an aging farmer population, agriculture needs to attract more young people, and our colleges and universities can help do that. Young people can help transform the agricultural industry by applying new technologies and new thinking. What are the greatest challenges for getting students at colleges and universities engaged in agricultural science programs and going into careers in agriculture? What are the greatest gaps in our current agricultural education programs? Can you describe the job prospects for students graduating with degrees in agricultural sciences?

A few years ago, USDA and Purdue University published a study regarding the workforce needs in the US Food and Agriculture for the period of 2015-2020. It clearly showed that all the public and land-grant universities together would only produce about 60% of the trained workforce needed. Therefore, I suggest that the job prospects for students graduating with degrees in agricultural and food sciences are excellent and will continue to be for a long time. At K-State, we have grown our student numbers by 55% in the last 6-7 years, but we continue to have nearly100% placement of our graduates. The need is so large for some of our majors, that even if we produced 3-5 times as many graduates, we would still be able to place all of them. However, some of our programs are now at or near capacity. We simply don't have the faculty nor the infrastructure to accommodate many more students in those programs. In other programs, although we have the capacity, and the need is there, we cannot attract enough students. Somehow we have to make food and agriculture the #1 choice for high school students. And when they graduate from college, we must guide enough of them toward our graduate programs. Increased undergraduate scholarships for students to study agriculture, and improved funding for food and agricultural research, which supports graduate education, will definitely help attract more and better students our way.

Senator Kirsten Gillibrand

1. We know that by 2030 about 44 percent, or 400 million acres, of privately owned farmland will transfer to new ownership and I think we are going to need many new, skilled farmers to take over those operations. It seems we face a similar problem with our agricultural research workforce.

You mention in your testimony the need to recruit, train, and retain talented students to become the next generation of Ag researchers. Do you think that the Committee should consider increasing directing USDA to increase Food and Agricultural Science Enhancement (FASE) Grants that are set aside for new investigator grants and pre- and post-doctoral students?

Such an approach sounds like a good start. However, what we really need is for that increase to come out of a larger pool of funds going to NIFA's AFRI program. So if we could bring AFRI up to its authorized level, that would help fund this program and expand resources for other needed programs, existing or new. The fully authorized level, of course, is still a rounding error compared to NIH and NSF. Therefore, I would like to see both of these agencies, NSF and NIH, as well as other federal funding agencies, invest more in the sciences and engineering that underlie food and agriculture, including new investigator grants and pre- and post-doctoral students' support.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. Kerry Hartman

Senator Debbie Stabenow

1. In your testimony you recommend additional research investment in Tribal colleges that offer Forestry degrees. As USDA's Forest Service houses the largest forestry research institution in the world, I'm sure there are ample opportunities for collaboration. Can you give us some more detail about the importance of training forestry professionals at our Tribal colleges and universities? What types of jobs would these foresters take in the workforce after they graduate?

Response: I'll have to answer this question from discussions I've had with other TCU faculty who actually have forestry programs. Very similar to many agricultural career areas forestry jobs could be involving biological botanical area, business entrepreneurship area or a tourism and/or cultural area. The natural resource botanical area would involve foresters, forestry technicians, horticulturalists, plant and soil scientists, and also geo-spatial analysts and technicians. Careers involving a business/entrepeneer could range from sawmill operators and owners to lumber jacks. Additionally forestry technicians would be needed. Forests could also provide jobs in the area of eco-tourism including plant and wildlife tour guides, ethnobotanical scientists and technicians and tribal cultural/historical experts. The Tribal Colleges could provide multiple levels of training ranging from certificate to Bachelor degrees to preparation for graduate studies.

2. With an aging farmer population, agriculture needs to attract more young people, and our colleges and universities can help do that. Young people can help transform the agricultural industry by applying new technologies and new thinking. What are the greatest challenges for getting students at colleges and universities engaged in agricultural science programs and going into careers in agriculture? What are the greatest gaps in our current agricultural education programs? Can you describe the job prospects for students graduating with degrees in agricultural sciences?

   Response: The challenges involved with college students in agriculture programs would include many that are across all programs. Broad topic areas range from lack of academic preparation to family/social areas ranging from parenting to personal issues and must include the social and economic issues man of our students face in attempting to complete their degrees. In my previous answer I discussed the possible

careers and jobs that the TCUs could prepare students to have. Unfortunately, TCUs are in remote, underserved, and economically disadvantaged areas where it is extremely difficult to find and retain the highly qualified diverse pool of faculty that would be required for that broad variation of career preparation. These many scientists and faculty would also require sufficient lab and field supplies to prepare the future professionals in these varied fields.

Today's rural youth are also very aware of the HUGE economic challenges facing any new young farmer/rancher trying to get established in the agricultural business. I believe that this is also a stumbling block for getting students into the agricultural fields.

On the Fort Berthold Indian Reservation there are four high schools. Of those four high schools only one has an FFA Chapter or any level of farm or ranch course work. Therefore, the students on our reservation are simply not exposed to any middle or high school course work introducing them to the possible careers or education involving agriculture unless they are involved in 4-H. As stated in the previous answer, there is a grossly insufficient supply of educational and economic resources for new young farmers and ranchers. It is virtually impossible for a young person to start a new farm or ranch. The only way young people in our area make a career out of farming or ranching is through inheritance.

Senator Amy Klobuchar

1. According to some estimates, monarch butterfly populations have declined by nearly 90 percent in the last 20 years. I have worked with the United States Department of Agriculture (USDA), the United States Fish and Wildlife Service (FWS), and the United States Department of Transportation on interagency actions and public-private partnerships to halt and reverse these declines.

   You explain in your testimony that you are currently working on a NIFA project to develop and sustain the environment needed to support native pollinators. Can you speak more about your research and the current problems pollinators face?

   Response: The focus of my current Juneberry research project is to investigate the identities, diversity, and status of the native pollinators and other native fruits. There has never been any scientific pollinator research in this geographic area of Western North Dakota. Previous research studies have been conducted in South Dakota's Black Hills, Montana's mountains and the Red River's tall grass prairie region. So there was little to no scientific evidence regarding the native pollinators, identification, diversity, and community. Therefore the first major topic of my research project is to survey, trap, and identify and quantify, as many different native pollinators as possible. We are in our second season of trapping and identifying pollinators and have determined

that Bumbus (bumblebees) are the most prevalent visitor and pollinator to the wild fruits on the Fort Berthold Indian Reservation. An additional goal of the research is to attempt to increase the nesting sites and food sources for the pollinators. We have therefore placed straw bale nesting sites and pollinator food plots and will attempt to document their impact on the pollinator community on the Fort Berthold Indian Reservation. As with all my previous NIFA Tribal College Research Grants the current project also includes an educational component which involves providing students information and resources on designing, conducting, and reporting scientific research and enhancing our College's Science Department through the inclusion of entomology coursework and curriculum modules. The ultimate outcome of the project will assumedly be a baseline of data and knowledge on native pollinators' community in Western North Dakota.

Our current understanding of the issues facing our local pollinators is similar to those in many other areas of the country. There has been massive disruption and loss of their native habitat including nesting locations and food and nutrition availabilities. Locally there are little data to document the impact of pesticide use on the local pollinator populations, but it is logical to conclude that the many agricultural insecticides used in this area have had a negative impact on that population. Our local pollinators also face the additional challenge of a lack of knowledge regarding their identities and habits. Hopefully, my research will provide some scientific evidence relevant to these issues.

2. My home state of Minnesota is home to four land-grant universities and colleges – the University of Minnesota, White Earth Tribal & Community College, Leech Lake Tribal College, and the Fond du Lac Tribal & Community College.

   Can you speak about the importance of Cooperative Extension programs in tribal communities?

   Response: Cooperative Extension programs offer a variety of important resources ranging from educational coursework to nutritional information and economic and agricultural resources. On the Fort Berthold Indian Reservation we have an NRCS Extension Agent who assists farmers with everything from crop rotation to installing water systems and tree rows. The Extension Agent also holds informational sessions and provides a wide range of products from information on seed mixes to access to trees for the area farmers and ranchers. There is also an NDSU Extension Agent who also serves the reservation. That person provides assistance and resources in many various ways ranging from assisting the Boys and Girls Clubs to organizing the local Farmer's Market to providing educational resources on a wide range of topics from water quality to child development. Local extension agents provide an extremely valuable service to the reservation community.

Senator Kirsten Gillibrand

1. We depend on pollinators for nearly $24 billion dollars of agricultural production each year. Native bees and wild pollinators account for one third of this total or $9 billion dollars. Like the more studied honeybee, native bees have suffered greatly over the past few years from exposure to pesticides, parasites, disease, habitat degradation, and decreased forage quality.

   You mentioned in your testimony that you've received some funding from the NIFA TCU program to improve the environment to support native pollinators which in turn will increase the yield of your juneberry crop. I think a lot of New York specialty crop growers would be interested in your research since they benefit from native pollinators too. Could you describe your research and what you plan to do to sustain native pollinators?

   Response: As stated in my previous response, my research involves indentifying and increasing the native pollinators of the Indigenous wild berries of Western North Dakota. My current TGRG project also involves improving the resources and capabilities of our College's Science Department and our students' education. Specifically our research is identifying the local native pollinators, building nesting structures, and creating /food plots that they prefer. The results of my research will be disseminated to the Scientific community as well as the tribal and local farmers, ranchers, and home owners so that they can improve their efforts to increase the numbers of the local pollinators.

   Thank You very much for accepting these responses.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. Chavonda Jacobs-Young

Chairman Pat Roberts (R-KS)

1. You talked about the new National Bio- and Agro-Defense Facility (NBAF), in Manhattan, Kansas. Can you both elaborate on the education and training needs to develop the necessary workforce that will be required to operate this critical facility? How are you tapping into and coordinating with the existing animal health expertise in the region, and how will you continue to develop skilled workers after the facility is operational?

   Response: To prepare for our research mission at NBAF, the education and training of veterinary and animal health research scientists are critical needs. Specifically, we need veterinarians to go through graduate programs to obtain their Ph.D in the following key scientific disciplines: pathology, virology, immunology, entomology, epidemiology and microbiology. In addition, scientists without veterinary degrees, but trained in these disciplines or in computational biology will be needed. Currently, ARS only has 44 veterinarians working in our agency. It is critical that we train the next generation of veterinary scientists. Veterinarians and animal health focused research scientists are essential not only for animal health research but also for veterinary and medical entomology, food safety, and our biodefense research program. For NBAF, our objective is to ensure that a viable and qualified scientific workforce is available to implement a program with expertise in biodefense research, with a focus on foreign and emerging animal diseases, including dangerous zoonotic pathogens. The mechanism for identifying and training scientists in biodefense research will be established in collaboration with the College of Veterinary Medicine, Kansas State University, and with the guidance of the American Association of Veterinary Medical Colleges. ARS does not presently have high containment facilities (BSL-3E, BSL-3Ag, and BSL-4) to train biodefense research scientists in Manhattan, Kansas. Therefore, the research projects needed to obtain a doctoral degree in one of the seven core scientific disciplines listed above will be conducted at the Plum Island Animal Disease Center (PIADC), Orient Point, New York, and/or the research facilities of collaborators contributing to the implementation of the ARS biodefense research programs, including the Biotechnology Research Institute, in Manhattan, Kansas. In the 2017 Appropriations, congress provided $1million for ARS to begin workforce education and training to prepare workers for the NBAF facility. Once NBAF is operational, we will continue to train researchers in the unique skills necessary for work in high containment facilities at NBAF and in coordination with colleagues in other high containment facilities across the United States and the globe.

2. You mentioned the public health threat of antimicrobial resistance. Various government agencies, medical professionals, agriculture stakeholders and public health organizations have been working collaboratively to further understand and curtail this threat. In addition to the research efforts of ARS mentioned during the hearing, please provide information that supplements this discussion regarding details of the surveillance monitoring that APHIS is

conducting, including how USDA is using voluntary National Animal Health Monitoring System surveys to analyze antibiotic use on farms, and through the food chain, to observe resistance trends? Please include a description of industry input and cooperation with this effort and how and when results will be reported.

Answer: Monitoring/surveillance, research, education, and outreach are interdependent. FSIS monitors for resistance through the National Antimicrobial Resistance Monitoring System (NARMS) and ARS works closely with FSIS to further characterize emerging resistance. Communication of collaborative findings is through annual web reports, publications, and presentations, but can also be through blogs such as in the federal government's announcement of findings of colistin resistance in the U.S. last year: https://www.usda.gov/media/blog/2016/05/26/proactive-efforts-us-federal-agencies-enable-early-detection-new-antibiotic. APHIS, in collaboration with NASS conducts on-farm sampling and surveys through the National Animal Health Monitoring System (NAHMS). Monitoring helps to further inform research by identifying how and why antibiotics are being used. APHIS communicates AMR-related information with producers and producer groups through several channels, including disseminating NAHMS findings via publications and presentations. ARS publishes and presents research.

FSIS, APHIS, and ARS have an annual meeting where food safety researchers describe their current ongoing research, and FSIS/APHIS define their needs and challenges faced in the field for researchers to address. Through ARS intramural research and NIFA-funded extramural research, USDA agencies are studying the ecology of AMR, exploring products to improve the health of animals to decrease the need for antibiotics and identifying alternatives to antibiotics. In addition, the agencies are trying to identify better management practices to address AMR. NIFA-funded AMR studies can be found at: http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=fastlink1.txt&id=anon&pass=&search=(GC=A4171)&format=WEBTITLESGIY. Research feeds into education/outreach. Through NIFA's Agriculture and Food Research Initiative (AFRI) competitive program, NIFA awards grants that target research and either an education or outreach component. Since grantees have to include an education or outreach component, results of research can be immediately communicated and applied in real-world situations.

Senator Debbie Stabenow

1. Thank you for making necessary changes to the review process on the use of animals for research by the Agricultural Research Service. I am pleased that ARS now follows the requirements of the Animal Welfare Act that all registered entities follows, including an agreement between ARS and APHIS Animal Care. It is important that ARS facilities are inspected and undergo protocol reviews through a properly constituted Institutional Animal Care and Use Committee. In the process of implementing these changes, were any ARS facilities found to have violations directly impacting animal welfare? If so, what changes were made to address those concerns? Has USDA posted the inspection reports, as directed by the FY17 omnibus? Can you explain the new role of the Animal Welfare

Ombudsman? The public has a strong interest in having these reports be accessible and transparent, and in ensuring that ARS facilities comply with the basic animal welfare standards that other registered research facilities in the U.S. must comply with.

Response: Thank you for acknowledging the significant progress that ARS has made relevant to animal welfare. We fully endorse the protections conferred to animals used in research, teaching, and testing through the Animal Welfare Act Regulations, and will continue to adhere to the spirit and intent of these regulatory principles. The policies and procedures we have implemented for Institutional Animal Care and Use Committee (IACUC) membership currently exceed regulatory requirements, and we are actively working with industry and university partners to establish scientifically based standards and practices specifically designed for the optimum care of agricultural animals maintained in a production environment for research purposes. We are confident that these collective efforts will ultimately lead to enhanced management practices that will further improve the health and welfare of livestock and poultry under our care.

The IACUC serves as a critical control point in the local oversight system, and ARS has strategically targeted efforts to ensure that all of the committees have the appropriate composition, training, and resources needed to administer these responsibilities effectively. Our success in achieving this goal has been validated through an internal inspection program established with our sister Agency, the USDA Animal and Plant Health Inspection Service (APHIS) Animal Care, and through numerous external assessments of ARS programs conducted by recognized authorities and experts in animal welfare. While specific locations have received advice to improve record keeping and animal care protocols, none of our locations are non-compliant and we have implemented a process of constant improvement. ARS has also implemented an expanded reporting system that gives employees and members of the public the open opportunity to raise issues about the care and use of animals at ARS locations. Individuals are encouraged to work through local representatives and also have the option of directly contacting the ARS Animal Welfare Ombudsman, who serves as a neutral third-party advocate for employees with concerns about animal welfare. There have been no reports or findings of animal neglect or mistreatment at any of the ARS locations.

We appreciate the public's support for ARS, and understand the trust placed in our research is founded on our unwavering assurance we have committed to follow or exceed the same principles and standards required of universities and private industry. ARS is confident we have reinstated this trust, and are actively working to improve the public's understanding of our commitment to quality animal care. Inspection reports of ARS facilities are available on the APHIS Animal Welfare Act (AWA) Inspection and Annual Reports web-site.

2. Organic agriculture now accounts for over 5% of total retail food sales, making it one of the fastest growing agriculture sectors in America. We know that the Organic Research and Extension Initiative has contributed to this success. Can you provide an update on what ARS is doing to support organic research?

Response: Listed below are a few representative ARS research accomplishments from 2 016 that support the organic sector.

Reduced-till, but continuous cropping gives better yields and more nutritious organic crops. Reducing the number of times a field or garden plot is tilled alters soil chemical properties in ways that increase crop yield and nutrient density. ARS researchers found over a 30-year study that reduced tilling coupled with continuous cropping increased beneficial soil mineral concentrations; improved plant vigor; and annualized crop yield; and maintained beneficial soil pH and calcium concentration levels compared with conventional heavy tillage in a crop/fallow rotation. The higher levels of soil minerals also resulted in higher levels of these healthful minerals in the grown crops. This long-term research definitively shows that producers can better maintain long-term dryland soil fertility, increase crop yields, and provide consumers with a more nutrient dense product by adopting reduced tillage while cropping continuously.

Updated tool for organic and conventional cover crop selection. Producers are interested in growing cover crops for the multiple benefits they may provide. However, there are many cover crop choices, many of which are unfamiliar to producers. ARS researchers developed an updated Cover Crop Chart (CCC) as a user-friendly tool to determine the suitability of specific cover crops for addressing production and natural resource goals. The chart categorizes 57 cover crops based on the plant type and general growth characteristics, and provides basic descriptive information. The CCC is available via the internet and is being used by producers and conservation agencies to increase cover crop use.

A hairy vetch/rye mixture stores more soil carbon and nitrogen than hairy vetch or rye alone. Scientists from ARS and Fort Valley State University, an 1890 institute in GA, collaborated on a study of the effect of cover crop use on soil carbon and nitrogen retention. The research was targeted to small landholders and minority producers. Results showed that a hairy vetch/rye mixture stored more soil carbon and nitrogen than hairy vetch or rye alone, or the no cover crop treatment. Organic and conventional farmers can adopt the hairy vetch/rye cover crop mixture to increase carbon sequestration, nitrogen cycling, and improve soil and surrounding environment.

Nitrate contamination of surface water is reduced in organic systems. Environmental impacts associated with conventional agricultural production have encouraged producers to investigate alternative management practices, including organic farming methods. ARS scientists initiated a long-term study of tile drainage water nitrate losses from conventional (corn-soybean) and organic (corn-soybean-oat/alfalfa-alfalfa) grain cropping systems. The study demonstrated that average annual nitrate concentrations were lower in tile drainage water collected from the organically-managed rotation compared to the conventionally-managed rotation. Total nitrate loss for the conventional rotation

was nearly twice as much as from the organic rotation. These results suggest that organic farming practices can improve water quality, especially in tile-drained landscapes.

Sustainable, profitable organic tomato production using biomass mulch. Plant-based mulch is a profitable alternative to plastic mulch in organic tomato production systems. Tomato producers are faced with uncertain yields and prices, and utilizing a production system that will reduce risk while maintaining yield may keep tomato producers economically sustainable into the future. ARS scientists compared the economics of 'conservation tillage production' using a variety of cover crops, such as cereal rye and crimson clover, and different tillage tools for fresh-market tomato production compared to a commonly-used plastic mulch, to determine the economic yield benefit. Rye and clover were just as effective as plastic mulch in controlling weeds and reducing soil moisture loss in tomato production, and net returns using a rye cover crop were 103% higher than plastic mulch in 2 of the 4 years. Net returns for clover were 119% higher in 1 out of the 4 years. Given tomato prices and weather conditions observed during the 2005–2008 growing season, the preferred treatment for a risk neutral producer would be a rye cover crop. For a strongly risk averse producer, all cover crop treatments were preferred to plastic mulch. The use of high biomass cover crops in tomato production, be it a conventional or organic production system, has the potential to be both profitable, and less environmentally risky than plastic mulch.

Subsurface banding of organic poultry litter improves soil quality. Traditionally soil surface application of broiler litter exposes nutrients, particularly nitrogen (N) and phosphorus (P), to potential loss, which reduces its value as a fertilizer, reduces growers' profits, and degrades air and water quality. ARS scientists evaluated the impacts of subsurface banding of pelletized broiler litter on organic and conventional cotton growth, yield, and N utilization and found that in the long-term, the practice resulted in greater cotton lint yield than surface-applied litter or commercial fertilizers at approximately equivalent N rate. This strategy reduces the use of costly inorganic fertilizers, improves soil quality, and enables growers to maximize the return on their nutrient management practices. If the technology is developed and commercialized as a practical option for the producers, subsurface banding of pelletized broiler litter could be considered as an effective management practice for row crop productions, and, at some point, become a method of choice for applying solid manures.

Novel and inexpensive hoe for weeding organic and conventional strawberry and vegetable beds. Controlling weeds along plastic mulch covered beds is extremely difficult because the rigid blades of standard hoes can easily tear the plastic. An ARS researcher developed a light-weight, adjustable and flexible

bladed hoe made from 100% recycled material that efficiently slices through weeds but not plastic mulch. This 'recycle strap hoe' was a major breakthrough in weed management in cover cropped furrows that are being promoted to conserve soil and reduce winter runoff in strawberry fields. This novel hoe was rapidly adopted by small-scale farmers in California and Hawaii, and has broad application world-wide in plastic mulch-covered beds that are typically used for high value vegetables and berry production. The hoe also works well for hand weeding vegetables without plastic mulch.

3. One of the highlights of the U.S. agricultural research framework is our cooperative extension system to disseminate information learned in the latest research to the people who need it most. Can you explain how ARS shares information learned from its research with producers?

Response: The primary method ARS scientists use to relay the detailed findings of their research is through the publication of articles in peer-reviewed journals. During the past 5 years (2012-2016), ARS scientists have published more than 21,000 articles in more than 150 different journals. ARS has worked hard to make these publications available to the public through the Web site of the National Agricultural Library (NAL), the largest and most accessible agricultural research library in the world. In 2016, NAL's PubAg portal for literature searches and full-text access held more than 49,000 full-text journal articles by USDA researchers.

ARS also shares its research findings through the collaborations it maintains with Land-Grant University and industry researchers. Through these collaborations ARS is able to expand its circle of knowledge, while leveraging resources to extend our research goals. Because the universities also integrate extension service outreach in their research programs, these researchers are able to share the knowledge from that collaborative research with farmers, producers, and backyard gardeners in their areas.

However, the most direct way ARS scientists are able to convey their research findings is through the open houses and field days many of our research locations have at various times of the year. The locations invite local stakeholders and producers, extension service personnel, industry researchers, government representatives, and the general public to tour the laboratories and fields where the research is on-going. Scientists involved in the research are on hand to explain their research and to provide updates on their findings to date. The value of these field days is invaluable to stimulating interaction with the local communities and identifying potential collaborators for future projects.

4. In the 2014 Farm Bill, the application process for USDA research programs was improved in order to make the process more streamlined. Can you explain specifically what changes were made, and how the implementation has gone?

Response: NIFA has established government-wide forms for research, streamlined the process for additional increments of funding for continuation awards, established the just in time pilot (where only proposals selected for funding will be required to provide all supplementary forms and information), established a pre-application process, and streamlined matching. Opportunities to streamline in the future also exist as more functionality is achieved with the implementation of ezFedGrants.

5. Agriculture is growing beyond our farmers' fields, and is now happening in many of our cities across the country. From small acre farms to roof tops and indoor vertical farming, new economic opportunities can be found through urban agriculture. Can you discuss research that needs to be done to support urban agriculture?

   Response: Urban agriculture requires long-term research focused on the overall goals of enhancing operational and production efficiencies; improving economic returns to producers; and reducing the environmental impact of urban agricultural production. Specific themes for such research include: **Production Environment:** Characterization of atmospheric gases, pollutants and light intensities experienced by crops grown in urban settings whether at ground-level or, but especially, on rooftops of high-rise buildings. Technologies for CO2 capture and release into CO2-starved greenhouse environments are particularly important for urban crop production during the winter months. **Water:** Technologies are needed for more effective use and re-use of water, be it municipal or rain feed, and water runoff collection and recycling. **Aquaculture:** Technologies for aquaculture/aquaponics in urban settings, either as a stand-alone system or coupled with vertical farming and hydroponic farming. **Postharvest Quality:** Technologies are needed to assure food quality and food safety, via superior product handling/ processing/ packaging and storage for produce from urban agriculture.

6. Antimicrobial resistance is one of the greatest threats to public health. While there is speculation that antimicrobial use in food animals contributes to antimicrobial resistant bacteria, more evidence is needed to investigate those links as well as find solutions. A GAO report published on March 16, 2017 titled "Antibiotic Resistance: More Information Needed to Oversee Use of Medically Important Drugs in Food Animals", made three recommendations to the Secretary of Agriculture regarding this topic, though all focused on APHIS and FSIS. Can you please explain how the research and extension mission area at USDA is addressing antimicrobial resistance, including areas of research focus and efforts to share this information with producers? Can you explain how the research mission area at USDA coordinates with APHIS and FSIS on antimicrobial resistance?

   Response: Monitoring/surveillance, research, education, and outreach are interdependent. FSIS monitors for resistance through the National Antimicrobial Resistance Monitoring System (NARMS) and ARS works closely with FSIS to further characterize emerging resistance. Communication of collaborative findings is through

annual web reports, publications, and presentations, but can also be through blogs such as in the federal government's announcement of findings of colistin resistance in the U.S. last year: https://www.usda.gov/media/blog/2016/05/26/proactive-efforts-us-federal-agencies-enable-early-detection-new-antibiotic. APHIS, in collaboration with NASS conducts on-farm sampling and surveys through the National Animal Health Monitoring System (NAHMS). Monitoring helps to further inform research by identifying how and why antibiotics are being used. APHIS communicates AMR-related information with producers and producer groups through several channels, including disseminating NAHMS findings via publications and presentations. ARS publishes and presents research.

FSIS, APHIS, and ARS have an annual meeting where food safety researchers describe their current ongoing research, and FSIS/APHIS define their needs and challenges faced in the field for researchers to address. Through ARS intramural research and NIFA-funded extramural research, USDA agencies are studying the ecology of AMR, exploring products to improve the health of animals to decrease the need for antibiotics and identifying alternatives to antibiotics. In addition, the agencies are trying to identify better management practices to address AMR. NIFA-funded AMR studies can be found at: http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=fastlink1.txt&id=anon&pass=&search=(GC=A4171)&format=WEBTITLESGIY. Research feeds into education/outreach. Through NIFA's Agriculture and Food Research Initiative (AFRI) competitive program, NIFA awards grants that target research and either an education or outreach component. Since grantees have to include an education or outreach component, results of research can be immediately communicated and applied in real-world situations.

7. With the average age of the American farmer increasing, we need to encourage the next generation to engage in agriculture in order to feed the future. How does your respective agencies and programs help bring America's youth into agriculture? What are other ways to attract new farmers and ranchers?

Response: The REE agencies employ over 100 interns every year in addition to participating in numerous conferences and outreach activities.

NIFA specifically brings America's youth into agriculture through several programs.

- The 4-H Youth Development Program, or 4-H, is the youth outreach program from the land-grant institutions' cooperative extension services and USDA through NIFA. 4-H serves as a model program for the practice of positive youth development by creating positive learning experiences; positive relationships for and between youth and adults; positive, safe environments; and opportunities for positive risk taking. NIFA-supported 4-H programs reaches over 6 million children across the United States.

- NIFA's Agriculture in the Classroom Program (AITC) serves nearly 5 million students and 150,000 teachers annually through workshops, conferences, field

trips, farm tours, and other educational activities. AITC programs include working with state AITC activities engaged in a variety of issues relating to agricultural literacy. Other programs emphasized by the NIFA AITC office include Science literacy, Agricultural careers, Nutrition and Pre-service and professional develop opportunities for teachers.

- The Beginning Farmer and Rancher Development Program provides grants to organizations for education, mentoring, and technical assistance initiatives for beginning farmers or ranchers. Ensuring there will be a "new generation" of beginning farmers and ranchers, regardless of age or production choice, is especially important to the continuation of agricultural production in the U.S.

Agricultural science, technology, engineering, and mathematics (STEM) education has been described as a "leaky pipeline," as fewer students remain as they progress through advanced study. NIFA's education programs are designed to enhance the pipeline through programs that support agricultural workforce development, increase student recruitment and retention, and build capacity. ARS, ERS, and NASS also engage students at all levels to help fill the pipeline.

8. In the past few years, we have seen several devastating animal disease outbreaks in the U.S., including highly pathogenic avian influenza and porcine epidemic diarrhea virus. Does USDA have the appropriate authority and funding to adequately prepare for and investigate the next animal disease outbreak?

   Response: Yes, the Animal Health Protection Act (AHPA) gives USDA the authority it needs to address large animal health emergencies, such as the 2014-2015 outbreak of highly pathogenic avian influenza (HPAI). The AHPA gives USDA a wide range of tools to address foreign animal disease outbreaks, which we utilize in coordination with our State regulatory partners, such as the ability to quarantine and restrict movement of animals. Additionally, the AHPA gives the Secretary, upon apportionment by the Office of Management and Budget, the authority to transfer emergency funding from other agencies and corporations of the Department—typically the Commodity Credit Corporation—to the Animal and Plant Health Inspection Service (APHIS) to address outbreaks. This authority provided the overwhelming majority of the funding utilized to respond to the HPAI outbreak in 2014-2015.

   Beyond that, USDA requested additional funding for animal health emergencies in the 2017 budget request. APHIS received an additional $24 million to improve the Agency's preparedness to detect, analyze, and respond to foreign and emerging animal health events.

9. Can you discuss current research being conducted on pre-harvest interventions to address food safety concerns in meat and poultry?

   Response: The ARS Food Safety program develops and validates intervention strategies to assist in reducing or eliminating pathogens in food animals during production.

Reduced shedding of zoonotic pathogens by food producing animals subsequently helps reduce the pathogen load during slaughter/harvesting and subsequent processing and storage. The Program addresses the continued need to develop and subsequently combine new and/or innovative technologies. Interventions can be additive and/or synergistic, leading to improved control over pathogen growth without potential changes in food quality or reduction in nutrition. The challenge is that the pathogen load on a product must be significantly reduced by any processing intervention strategy to avoid the consequences in food production resulting from "dirty in, dirty out" processing.

ARS specifically conducts research in meat to:

- Characterize the ecological niches and reservoirs to identify mechanisms of foodborne pathogen, especially biofilms, for their ability to colonize and persist leading to the development of intervention strategies.
- Develop and evaluate novel intervention strategies that reduce or eliminate the occurrence, transmission, or persistence of foodborne pathogens in host animals, including cattle and swine, and the environment. Survey ecological niches and reservoirs using a systems approach to identify sites for potential interventions to reduce foodborne pathogens.
- Identify environmental and management (intervention) practices that influence antimicrobial resistance, colonization of lymph nodes, and colonization rates of cattle, veal, and swine.
- Develop interventions that prevent/mitigate colonization of gut of food-producing animals (particularly lower GI tract before slaughter) or that reduce pathogenic/antimicrobial-resistant bacteria in production environment.

ARS specifically conducts research in poultry to:

- Identify, develop, and test interventions, including exploring possible synergies of multiple interventions and alternatives to antibiotics that can kill pathogenic or antibiotic resistant foodborne pathogens or mitigate their persistence, shedding virulence and resistance in the animal production environment.
- Evaluate these products in multiple production/processing systems including conventional, pasture raised, and organic systems.
- Develop new vaccination strategies based on innate immunity to reduce Salmonella contamination in broiler chickens and turkeys.
- Develop strategies to reduce foodborne pathogens by targeting host immune-metabolic signaling pathways affected by Salmonella and Campylobacter virulence factors.
- Develop innovative strategies for increasing disease resistance and improving immunity to foodborne pathogens of poultry using egg shell membrane technology.
- Assess the impact of dietary regimens, housing systems, and different chicken genetic lines on Salmonella (S.) infections of hens, Salmonella contamination of the production environment and eggs, and physical and functional egg quality.
- Assess the effects of key management practices using experimental and field models of different housing systems on hen health, microbial ecology of

foodborne bacteria, and antimicrobial resistance associated with egg contamination.

10. What research is currently being done at your agencies on the effectiveness of voluntary conservation programs authorized in the Farm Bill in addressing natural resource concerns, like water quality, drought, soil health, and wildlife habitat? Are there positive results or data from this research that you can share that will help justify the federal investment in voluntary conservation programs? Can you explain how do your agencies work with the Natural Resources Conservation Service on research to demonstrate the environmental outcomes from conservation activities on farms and ranches?

Response: ARS research supports the agencies that lead voluntary conservation programs and initiatives arising from the Farm Bill. Our scientists work very closely with NRCS and other agencies at USDA that implement conservation programs. Our scientists develop new cropping systems, management strategies, practices, tools and technologies that inform, strengthen, or provide the scientific underpinnings for things such as NRCS Conservation Practice Standards. Often our data and measurement protocols are used in quantifying the benefits of conservation programs. The expanding application of improved conservation management in areas such as conservation tillage, cover cropping, nutrient use efficiency and similar management practices, that have been extensively researched by ARS scientists, are documented by NRCS data through the National Resources Inventory (NRI) and their beneficial impact on conservation accounted for in NRCS Conservation Effects Assessment Project (CEAP) regional and national reports and elsewhere. Another example is within the Chesapeake Bay Watershed, where runoff of sediment and nutrients has been a documented problem. ARS research throughout the watershed and across the country is resulting in improved management practices that conserve soil and hold fertilizers and manure nutrients in place where they can be utilized by crops. EPA and USGS data over recent decades are demonstrating a positive trend resulting in improving water quality across the watershed. These examples, along with some additional recent accomplishments noted below, show how ARS research efforts support Farm Bill related conservation programs, helping ensure soil health, water quality, and wildlife habitat availability while also enhancing our ability to sustainably produce food, feed and fiber.

ARS's collaboration with NRCS on the Conservation Effects Assessment Project (CEAP) includes ARS leadership of the CEAP Watershed Assessment Study (WAS), which involves more than 60 ARS scientists, plus additional technical support staff, working in 14 benchmark watersheds at 12 ARS locations. The ARS-CEAP-WAS project is a fully peer-reviewed national effort that is highly relevant to the conservation policy of the USDA. In the CEAP-WAS, scientists collect, manage and provideata to researchers and other users, develop and validate models and tools, and measure and quantify water quality, water quantity, soil quality, and ecosystem effects of conservation practices at the watershed scale in a variety of hydrologic and agronomic settings.

One strategic conservation target for USDA conservation programs is reducing nutrient losses that impact the Gulf of Mexico and Great Lakes and water bodies across our landscape. This challenge is continental in scale, but involves the management of thousands of small watersheds comprising millions of farm fields. A new GIS-based conservation toolbox, called the Agricultural Conservation Planning Framework (ACPF), has been developed by ARS to address local planning needs on a site-specific basis, and is being trialed in a range of landscape and farm management settings across the Midwest. The ACPF toolbox is now available for download through the North Central Region Water Network website. The ACPF is based on a holistic planning concept that emphasizes soil health. ACPF considers key 'soil-building' practices that promote agricultural soil health (e.g., minimum tillage, nutrient management, cover crops) as well as additional conservation practices as needed to "trap and treat" nutrient losses when and where they occur. The ACPF provides a way to identify those locations in agricultural landscapes where water accumulates and that are suited for the placement of "trap and treat" conservation practices. The ACPF is a set of tools, and the combined results provide an 'inventory' of conservation opportunities found in fields, below fields, and in riparian zones where water quality improvement and other ecosystem services can be realized.

Soil organic matter is key to many aspects of conservation, including the ability of the soil to hold water and nutrients until the crop requires them. Additionally, increasing soil organic matter provides many ecosystem services and conservation benefits. ARS scientists have developed a research and data network called GRACEnet, (Greenhouse gas Reduction through Agricultural Carbon Enhancement network) which spans 36 ARS research locations collecting data on management practices that increase soil organic matter and soil carbon storage. This has resulted in development of standard sampling and measurement protocols, improved quantification of conservation benefits, notable improvements to the ability of both USDA and EPA to do required agricultural greenhouse gas inventory reporting, and provided much of the basis for development of decision support tools such as NRCS's COMET-Farm and COMET-Planner tools.

The ARS Resilient Economic Agricultural Practices (REAP; initially called Renewable Energy Assessment Project) effort has developed cropping systems, cover cropping practices, residue management and tillage harvest strategies. The goal of this effort is the utilization of crop residues in such a way that also maintains or enhances soil health and quality, allowing for increased utilization of the biomass produced, increased margin for the producer, and reduced negative impact on the environment. ARS REAP science has been utilized in conservation and renewable energy programs at USDA Rural Development and NRCS as well as by the Department of Energy.

ARS scientists are researching a variety of practices and technologies that improve the management and use efficiency of nutrients in agricultural systems. Research and data on precision fertilizer practices such as changing the timing of application or the placement of the nutrients have resulted in new strategies that increase the amount of nutrients used

by crops and reduce losses to the environment. Development of tools for quantifying the use, efficiency and loss of nutrients have been developed (such as the Nitrate Leaching and Economic Analysis Package [N-LEAP]) as well as related decision support systems (e.g., the Great Plains Framework for Agricultural Resource Management [GPFARM]) which help land managers reduce their environmental impact and improve conservation on their lands. Similarly, ARS researchers have developed numerous manure treatment and application practices and technologies to ensure that the nutrients in animal manures are captured and utilized rather than lost to the environment.

Remote sensing research at ARS has a long history of the development of methods, data, analysis and tools that are useful to NRCS for conservation planning and programs as well as to USDA- National Agricultural Statistics Service (NASS) and other agencies. One recent example is related to remote sensing techniques to map leaf area index (LAI). LAI is a key parameter used in land surface flux estimates, water resource management, and crop growth monitoring. Current coarse resolution leaf area index tools - at the kilometer scale - are sufficient for global, continental, and regional scale applications. Agricultural field scale applications, however, require leaf area index with both high spatial and temporal resolution. ARS scientists have developed an automated mapping method for leaf area index that generates a four-day time-series of a 30-meter leaf area index. This method was tested over central Nebraska from 2002 to 2012 and showed promise for generating frequent map leaf area indices at field scales –using data from current satellites. This approach demonstrates potential for crop modeling at field scales, which is information needed by NASS for crop condition monitoring and yield estimates.

The above are clear examples of ARS efforts and tools that have been developed and which can be used in volunteer conservation programs or conservation activities on farms and ranches - across the country and throughout the world, either by direct access, through USDA conservation program office and NRCS conservation technicians, or by partnering with ARS, NRCS or other USDA experts.

11. The Specialty Crop Research Initiative addresses the critical needs of the specialty crop industry from plant breeding and genomics, to pest and disease management, and innovative technologies. What are some groundbreaking research examples of how this program used? What is the return on investment of this program to the specialty crop industry and the economy? How are these funds being used to support both basic and applied specialty crop research?

Response: A basic tenet of the Specialty Crop Research Initiative (SCRI) is that all projects funded produce outcomes that lead to a sustainable future for agricultural production, with a major emphasis of new knowledge being translated into useable information that producers can implement during the life of the project. Since 2012, SCRI has funded 83 projects totaling $193,041,063.

Pollination is an absolute requirement for sustainable production of specialty crops. Declines in honey bee and native pollinator populations, as well as increased acreage of crops that require cross pollination, have threatened specialty crop producers. To address this need, NIFA, through SCRI, funded the Integrated Crop Pollinator project led by Dr. Rufus Isaacs at Michigan State University. Research sites for this project have provided visibility to the ICP project on over 10,000 acres of specialty crop fields across more than 100 farms. In Florida, the project has influenced how growers use pesticides, thus avoiding not just impacts on bees but also reducing groundwater contamination. In Pennsylvania pumpkins, one grower has cut honey bee stocking rate in half, from 1 to 0.5 hives/acre without a decrease in yield. This has resulted in a savings of about $14,000 per year for this one grower.

The Rosaceae crop family includes many important crops such as apple, blackberry, peach, pear, rose, strawberry, sweet and tart cherry, and roses. Growers of these crops have expressed a need for new varieties that display disease resistance and superior quality of fruits or flowers. Developing new cultivars of many Rosaceae crops can take longer than 10 years, however. Since 2009, the SCRI has invested more than $13,000,000 in the RosBreed project, led by Dr. Amy Iezzoni at Michigan State University. This project brings modern genomic and genetics tools, in a nationally coordinated effort, to augment the efforts of traditional breeders in the efforts to efficiently and effectively deliver cultivars with producer-required disease resistances and market-essential horticultural quality within time frames that are useful to the commercial sector. By combining fundamental genomic discovery with practical breeding, the RosBreed team has been able to cut the time required to develop new cultivars in half, while saving individual breeding programs hundreds of thousands of dollars.

12. As we prepare for the 2018 Farm Bill, there clearly are some areas where research and data can have a direct impact on how well the farm safety net functions.

    a. Federal Crop Insurance is a critical part of the farm safety net that is delivered through a partnership between USDA and private companies and agents. The cost in premiums to producers for these crop insurance policies is based on the level of risk for their particular crop, location and coverage options. There are certain management practices such as cover crops or different types of precision agriculture that appear to reduce the risks of losses in addition to other benefits to the environment and input costs. To what extent have the research agencies of USDA sponsored or summarized research projects that could be directly applicable to this question of risk reduction? Please summarize any specific results and the degree that risk was reduced. Have you coordinated with the Risk Management Agency to share these results, or used their program and actuarial needs to target future research?

       Response: There is growing interest in what farmers can do to improve soil quality (soil health) and how that may increase crop yields or reduce yield variability. For example, healthier soils can increase drought resilience by capturing and retaining moisture in the soil and making it available for plant

growth. An extensive review of the agronomic literature by the USDA Natural Resource Conservation Service (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=stelprdb1257753) suggests that soil health can be improved under a wide range of soil and climatic conditions, but only through the consistent application of a suite of practices over a period of years. Soil health can be built through long-term and continuous use of no-till, cover crops, double cropping, mulching, and rotation with permanent grass, such as pasture or hay. For example, continuous no-till used in conjunction with high residue/cover crops can have a positive effect on key soil properties including soil organic matter, soil aggregate size and stability, water infiltration, and water-holding capacity. There is also some research to suggest that precision agriculture can improve yields and reduce yield variability. ERS research shows that GPS mapping, guidance systems, and VRT reduce input costs and increase yields.

While there is strong evidence that some practices could be used to improve soil health, there is no database linking the use of specific practices to yield experience that could be used to rate crop insurance premiums. In crop insurance analysis published to date, ERS has used statistical analysis derived from actual yield data and not from agronomic models. While the former approach is likely produce analysis that is representative of the real world, the downside is that it requires sufficient data to obtain statistically meaningful results; there is insufficient yield data linked to specific practices benefiting soil health that is available to ERS to date, to do analysis of how yield would change, and consequently how premium rates would change. RMA already makes adjustments for many common practices that are known to impact yields. However, ERS has published research on the risk reduction provided by federal crop insurance more generally, and on the impacts of policy changes on risk reduction. ERS found that on average for the US, if farmers adopted the Revenue Protection insurance policy with a 75 percent coverage rate, their downside revenue risk protection increases by around 200 percent for corn and soybeans and around 550 percent for winter wheat (https://www.ers.usda.gov/publications/pub-details/?pubid=45515).

Statistical analysis presented at an ERS-sponsored workshop (The Economics of Soil Health, September 2015, https://www.farmfoundation.org/webcontent/Economics-of-Soil-Health-1914.aspx) show that soil quality is strongly predictive of yields and that models including measures of soil quality could be used to better predict insurance premiums. Nonetheless, links between the use of specific practices and soil quality or soil health have not yet been clearly quantified and may depend significantly on soil characteristics and climate.

b. The Farm Service Agency's Agriculture Risk Coverage program relies of thousands of yields by crop and county in order to calculate guarantees and payments. The program relies particularly on yield data collected by NASS

through surveys of producers. In some cases, insufficient responses are received despite repeated attempts by NASS, but I understand that NASS does not have the option of increasing the sample size. Is this restriction of expanding the number of producers surveyed related to budget constraints or other restrictions such as the paperwork reduction act requirements? Are there any areas where added flexibility would provide NASS county-level data more consistently, instead of requiring FSA to switch between data sources?

Response: NASS contacts over 365,000 farmers throughout the country to collect data to publish county estimates. There are four modes of data collection: mail, internet, telephone and personal interview. NASS has partnered with associations marketing the survey which resulted in more counties published for the commodity of interest. An increase in resources would allow NASS to improve the marketing plan informing the farmers the benefits of responding to NASS surveys. Currently, NASS utilizes unpaid media opportunities such as USDA Radio, RFD-TV interviews, national news releases, reminders in weekly crop progress and monthly crop production reports, short items for use in FSA newsletters, USDA blogs when available and Twitter to garner earned media coverage that encourages response to these and other surveys. We provide enumerator training materials, news release templates, survey cover letters, etc. for regional offices to localize so that our own staff have pertinent information and can leverage local knowledge and connections. Additionally, we've built partnerships with national commodity organizations for wheat, corn, and soybeans to help further encourage farmers and ranchers to respond. All have included content in their member communications.

Senator Sherrod Brown

1. Given that domestic production is not able to keep up with growing demand for organic products, and the fact that organic research benefits all farmers, what role can ARS play in furthering organic research, particularly for farmers interested in transitioning to organic? As we examine agriculture research in the next Farm Bill, how can we best focus organic research to increase our output of organic products?

Response: The information below explains ARS' role in organic research.

What role can ARS play in furthering organic research, particularly for farmers interested in transitioning to organic? The biggest challenges to increased domestic organic production today are: i) an insufficient number of organic farmers due to transition issues, and ii) insufficient yields in existing organic farms, due to production issues. ARS is well positioned to further both transition and production issues through its research, which has greatly improved our understanding of many aspects of organic weed control and soil fertility.

*How can we best focus organic research to increase our output of organic products?*The focus should be on improving varieties of both crops and cover crops to meet specific

needs of organic farmers. ARS has a cover crop project to suppress weeds and maintain soil moisture, and to assess available germplasm with insect and disease resistance that includes both crops and cover crops. Additionally, there is a need for more organic research to be conducted over the long term at a variety of locations, as production results are currently more site-specific for organic farming systems than for conventional farming systems due to the strong dependence of organic systems on soil types, weather and other local features.

2. Central State University in Wilberforce, Ohio is the newest 1890 land-grant, even though it has been around for quite some time. It's my understanding that CSU has already started a STEM summer program to engage middle-school students in agriculture related fields. How is ARS working with Central State and other HBCU's to increase capacity at the University and to best utilize its existing strengths?

   Response: ARS Midwest Area officials and scientists from the ARS research location in Columbus, Ohio, have met with Central State University representatives several times since August 2016 to discuss potential research collaborations. It was agreed that soil nutrient management is an area of common interest.

   ARS' overall support of HBCUs and 1890 institutions, includes, but is not limited to, the USDA's 1890 National Scholar Program and the ARS Faculty Research Fellowships for Capacity Building at 1890 Land Grant Universities. In December 2016, a Central State University professor, Dr. DeBonne Wishart, was awarded an ARS Faculty Research Fellowship for Capacity Building at 1890 Land Grant Universities to work with ARS researchers in Columbus.

   At Central State University, ARS provides tuition, fees, books, and salary for one scholar. The second-year student is an Agricultural Engineering major and currently gaining invaluable research experience at the ARS Sugarcane Research Unit in Houma, Louisiana.

Senator Amy Klobuchar

1. Minnesota farmers have been able to improve the efficiency of corn production and have increased the yield of corn per acre. In order to take advantage of these production improvements, it is critical that we expand the end uses for corn and other agricultural commodities to add value to every bushel.

   a. What research initiatives have the Agricultural Research Service (ARS) and the National Institute of Food and Agriculture (NIFA) undertaken to expand the uses of agricultural commodities in non-food markets?

      Response: ARS engages in long-term problem-solving, postharvest utilization-research that does not involve foods (e.g. corn) for non-food purposes. However, corn stover and dried distiller grains (containing corn kernel waste) are used as

feedstocks in biorefining efforts by numerous ARS scientists generating new, commercialized products such as: sugars, biochars, carotenoids, lipids, acids (butaric, itaconic, triacedic, succinic), hydrogels, films/polymers, plastics, nylon, nanomaterials, xylitol, antimicrobial agents, cosmetics and pharmaceuticals.

b. How could existing research programs be improved in the next Farm Bill to expand the uses of agricultural commodities and better leverage private and public investment?

Response: ARS is funded by the Agriculture Appropriation Bill tasked with long-term, problem-solving research, such as solving wasted food/food waste; which is an excellent example of leveraging public and private investments utilizing agricultural commodities. ARS in collaboration with industry has utilized grain and plant material -- be it from fresh fruit and vegetable processing or grain distillation (i.e. alcoholic beverage production) -- in product development generating new foods such as cookies, health-food bars, and non-gluten food wraps. This ARS/private investment, in addition to generating new foods from processing 'waste', has helped feed, with existing agricultural sources, the ever increasing population while generating new commercial enterprises. ARS is perfectly positioned to expand the aforementioned public/private investment examples to many other agricultural commodities.

c. What opportunities do you see for new programs to expand uses for agricultural commodities?

Response: The research conducted by the USDA ARS supports the rural communities of the United States by providing more efficient, environmentally safe, and profitable methods and technology for the Nation's farmers and producers of food, feed, and fiber. In this effort a few examples of foreseeable postharvest utilization-research efforts that expand agricultural commodities are:

- Simpler, cheaper, and more accurate methods for mycotoxin detection and removal that will reduce exposure to human toxins (e.g., vomitoxin and fumonisins) and facilitate U.S. grain exports;
- Novel alternatives to antibiotics that address the emerging problem of antimicrobial resistance;
- New renewable agriculture-based lubricants and lubricant additives that reduce automobile emissions, improve fuel efficiency, and extend engine life;
- Next-generation, plant-based packaging materials for fresh food products (i.e., meat and produce) that reduce microbial contamination, including antibiotic resistant bacteria;
- New food products from food waste that promote human health using waste cereal grains, oilseeds, and non-traditional food plants;
- Environmentally friendly biological control agents for insects (i.e., mosquitoes that transmit the Zika virus) and microbial pests and pathogens of plants and animals.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Mr. Gary McMurray

Senator Debbie Stabenow

1. Given your role on one of the Scientific Advisory Council members for the Foundation for Food and Agriculture Research, can you discuss your experience of working with the FFAR? What are the greatest strengths of funding research in this novel way? What are the greatest challenges?

Answer: I have been involved at FFAR since the advisory councils were created in the Spring of 2016. Originally, I was on the Food System Innovation council, but in December of 2016, they reorganized the councils to align more closely to the research priorities for FFAR and I moved to the Food Waste and Loss council. I believe that the first year of being on the council has been one of great change as FFAR has attempted to build a new organization to address the major issues it has identified. I think that this is to be expected with any new organization and I believe that the new structure is very good. I believe that the organization is nimble in that it can fund high quality projects very quickly and that is unusual for most agencies. They have assembled an extremely experienced group of council members with a diverse set of backgrounds which I believe is very important to obtaining the goals of FFAR. The greatest challenge FFAR has is their ability to raise matching funds. For example, it can be difficult for junior faculty to obtain matching funds from industry at the level required for some of the larger grants. In addition, understanding the selection process and how and why FFAR moves forward with some projects/priorities and not others, is something the community as a whole does not understand clearly.

2. You mentioned your work on sensor technology. Can you discuss how you are applying this technology to address challenges in both plant and animal health?

Answer: We are using a variety of different sensors in both plant and animal health. We are using imaging with machine learning algorithms in poultry grow out houses to monitor the weight of the birds in real time. We also use imaging of plants from low flying unmanned aerial vehicles to monitor the growth rate of individual plants. In agriculture, identifying plants or animals that are statistically different is an early indicator of disease infection and this allows for early interventions.

We are also using the micro-gas chromatograph that we have developed for identification of diseases in both plants and animals through the analysis of the volatile organic compounds emitted by plants and animals when infected by a disease. This sensor provides a unique insight into what is happening at the cellular level of the plants and animals. This is

a new sensing modality, but one that could have significant impact for early disease detection in plants and animals.
We are also developing novel root sensors to monitor changes in the root mass over time. At this time, the only method to examine the roots is to use a shovel to dig up the plant or tree to examine the roots – not a very practical method for an actual farm. We are developing techniques that would provide farmers with a minimally invasive technique of monitoring the root mass using a technology called electro-resistive tomography and electro-capacitive tomography.

For live animals, we are actually monitoring the sounds that chickens make in a poultry grow-out house. These sounds can be used to monitor an entire flock to determine stress due to temperature or ammonia levels in the house or infection due to a variety of diseases. This technique can provide an early warning detection systems and a general animal welfare indicator for animal production.

3. In your testimony you discussed bringing engineering and robotic technology into the agricultural space. Robots can now be used to milk cows and has other applications across the industry. This new technology is even more important now due to the challenges many specialty crops growers face with workforce uncertainty and pest and disease. Can you explain how your research on robotics can be used to help solve current challenges faced by specialty crop growers? Can you describe the value of integrating science to find innovative solutions to today's problems?

Answer: The application of robotic systems has grown dramatically in the past few years. The number of industries outside of automotive and electronic manufacturing that use robotics as a key part of their operations is amazing. There are several key areas in agriculture where robotics is making and will provide significant value to the growers. The first is harvesting. The business case for automation is simple: we are growing more specialty crops that need to be harvested several times over the season and a judgement is required by the human to decide what is ready to harvest. Given the significant issues with labor supply for these types of tasks, turning to automation is a natural fit and there are several systems coming out that will attempt to solve this problem at an affordable price point.

The other major task that is ideally suited for robotics is crop maintenance. Given that we lose 12% of our crops to disease and another 16% to pests, robotic systems give the grower the ability to scout the fields on an almost continuous basis with a combination of unmanned aerial and ground vehicles (UAVs and UGVs). The next task is the development of sensors and the analytical capability to interpret the data to identify diseased plants and pests on an individual plant basis. By doing this, the goal would be to reduce the loss of plants due to disease or pest and thus directly improve the yield of the farms. It would also allow for targeted interventions that could dramatically reduce the cost and unintentional drift of chemicals during traditional spraying operations.

The sensing required to identify presymptomatic plants and plants infected with pests is a very difficult problem. Current techniques can identify plants after they have suffered rather significant damage and have affected a rather large area. Identifying this on a plant by plant basis is very challenging. This is a great example of how the collaboration between engineers and scientists can solve big problems. As an engineer working in robotics for over 25 years, I was not even aware that the ability to detect infected plants was a critical problem. The scientists were keenly aware of the problem but they had resigned themselves to the fact that no solution existed. When the two groups began to talk, we quickly realized that robots were the key enabling technology for this problem because of their ability to provide the 24/7 coverage of the fields that was necessary (this was a topic of much work in the military and security industry for years). We also realized that we could apply concepts from the chemical and biological sensing communities of the military to the tasks of detecting the volatile organic compounds emitted by the plants. Only through getting experts in these very different technical domains were we able to recognize and brain storm a solution to the problem.

I feel that this is not an unusual experience. The type of basic science that USDA and other federal organizations has funded for years has made significant discoveries. However, it requires the union of scientists and engineers to transfer that knowledge from the laboratory into a practical solution for the real world.

When I look at the other critical problems facing agriculture, I see that this same process of bringing in experts in diverse domains is critical to solving them. This includes problems such as high throughput phenotyping, water optimization, food safety, and automation of field tasks.

4. With an aging farmer population, agriculture needs to attract more young people, and our colleges and universities can help do that. Young people can help transform the agricultural industry by applying new technologies and new thinking. What are the greatest challenges for getting students at colleges and universities engaged in agricultural science programs and going into careers in agriculture? What are the greatest gaps in our current agricultural education programs? Can you describe the job prospects for students graduating with degrees in agricultural sciences?

Answer: Georgia Tech is not a land-grant institution and does not an extensive background in agricultural sciences when compared to traditional land-grants. However, we are very interested in engaging with students around the technology for agriculture. We are currently running two classes at Georgia Tech in a former NSF program called VIP (Vertically Integrated Projects). These are project classes that are open to sophomores, juniors, and seniors from all engineering and computer science majors and they work with a faculty member and their graduate students on a long-term project. Currently, we are teaching one class on agricultural robotics and another class on technology for humanitarian aid and they are both very popular.

For our students, we find that they are very open to all problems where they feel that they can make a difference. These classes provide an environment where the professors are leaders in their areas and they bring in experts from the other relevant domains so that the students can contribute in a meaningful way.

At the U.S. non-land-grant engineering research universities, agriculture is not typically a central research domain. While there are individuals that are doing some work in agriculture, there is no systematic education of the critical problems or opportunities in this space. Our students are looking for opportunities to solve the critical problems of the day. NIFA's leadership has made efforts to reach out to these non-traditional entities, but I feel that USDA should find a way to engage with the major engineering schools in a more systematic manner to bring the problems of agriculture to the forefront of engineering research. In this way, graduate students and the undergraduate will be exposed to the problems and opportunities in agriculture. Given the inherent multidisciplinary nature of agriculture, this will lead to new opportunities for the land-grant and non-land grant institutions to develop the required transformational innovations that are required to feed the world in 2050 and beyond.

Senator Kirsten Gillibrand

1. We have a real shortage of skilled agricultural labor in New York and I saw in the written testimony that Georgia Tech is working with some very systems to reduce labor inputs in fields, orchards, and processing plants.

   Two things in your testimony jumped out at me, the first is the sophistication of the visual and robotic systems created at Georgia Tech and the second is their tremendous complexity. I am a bit concerned that the cost of these systems will put them out of reach for all but the largest companies or farmers.

   As you conduct your research, do you think about technology that is appropriate to farmers who grow or process at different scales?

   Answer: The cost of new technology is always an issue that concerns many end users. However, I have seen and continue to see the cost of these systems coming down dramatically as new innovations occur. For instance, much of research benefits from the use of a 3D camera – a camera that can provide the 3D location of points that it sees. Fifteen years ago, researchers were paying $30,000 for a single camera. Today, we can purchase an Xbox Kinect camera for $150 and get the same performance. The same is true for robotic arms. Instead of paying $100,000 for a robotic arm, we can currently purchase a similar arm for approximately $25,000. The cost of unmanned aerial vehicles has dropped even more dramatically in the past 10 years. I believe that if the research

community can develop the technology to provide outstanding value to the farmers, the free market system has been very successful at reducing the price to an affordable level.

The issue of scale in engineering is always important. For many problems, the issue is how do we do things faster and better? This can many times lead to expensive solutions that are not affordable to average farmer. I believe that the market will deploy these solutions once the value of the technologies has been proven; however, this still requires more research.

2. I saw that some of the research at Georgia Tech is focused on detecting pathogens like Salmonella in poultry.

   Food safety is very important to me and I know everyone on the Committee shares my concern.

   Can you tell us about the research on Salmonella detection and where you think we might see this technology deployed – in the processing plant or on the farm?

   Could the use of pathogen detection technologies change the way poultry farmers care for their flocks? Could it be used to make management decisions like whether to administer antibiotics?

   Answer: At GTRI, we have a long history of developing sensors for novel applications. For the Department of Defense, we have developed a variety of sensors for the rapid detection of chemical and biological agents. Building on this technology, our team has developed sensors that can detect the presence of Salmonella and Avian Influenza for the poultry industry.

   Our work has mainly focused on the food processing environment to provide feedback to the plant operations staff on the effectiveness of the chemical interventions. For this task, our focus has been on the collection of water samples at various points in the processing plant. We are exploring the use of nano-particles to extract out any Salmonella that might be present and concentrate it down to a sample that can be run through our micro-fluidic device. This device can provide an answer the presence or absence of Salmonella in several minutes.

   In the live production of poultry, rapid detection of pathogens requires a physical sample from the bird for testing. This is expensive and difficult given the size of the flocks. However, we are developing other technologies that can help farmers manage their flocks without taking physical samples from each bird. One project that has

tremendous promise is our bird audio work. This project continuously listens to the sounds of the birds to detect the unique sounds that the birds make in response to stress (temperature or ammonia levels) or a disease. In addition, we are deploying mobile robots that can build 3D models of the birds to monitor their weight gain as well as look at other physical parameters such as the gait of the birds or mobility of the birds.

The application of this technology to actual managing of a poultry flock is an example of potential collaboration between the engineering and animal science community. The development of new sensor systems and the various methods of deploying them is a strong point of engineering. However, the engineers need to partner with the animal science to understand how to interpret the data and use the data to improve the health of the flocks. The general question of how this data could help growers make decisions about when to administer antibiotics is an open question and one worthy of more research.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. Sonny Ramaswamy

Chairman Pat Roberts

1. Dr. Ramaswamy, the Organic Transitions Program supports "the development and implementation of research, extension and higher education programs to improve the competitiveness of organic livestock and crop producers, as well as those who are adopting organic practices." Various colleges and universities are eligible entities for these grants, and prioritization for the program occurs in consultation with the National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB). How has this consultation process incorporated the 2014 Farm Bill requirement that the NAREEEAB consult with industry groups and make recommendations based on that consultation?

   Response: The NAREEEAB provides general oversight and advice for all research, education, and economics programs of USDA's REE mission area, including the Organic Transitions Program (OTP) managed by NIFA. The advisory board meets two times a year and the executive committee meets via teleconference at least once a month. Information about OTP and other NIFA programs are shared with the NAREEEAB. During the last few years, the advisory board has undertaken "adequacy and relevance" analysis of REE programs, including nutrition, food safety, and climate change; likely undertaking such an analysis of OTP and other programs, as well. Additionally, the National Organic Standards Board provides input to NIFA about the Organic Agriculture Research and Extension Initiative (OREI) and the OTP program, which has helped NIFA develop priorities of relevance to the organic industry.

2. The Beginning Farmer and Rancher Development Program (BFRDP), under NIFA, was created to provide educational and technical assistance to new farmers. The Agricultural Act of 2014 provided more than $100 million in mandatory funding for this program. Beyond BFRDP, there was an additional $83 million provided in mandatory funding to new and underserved farmers, for Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers and Veteran Farmers and Ranchers and CRP-TIP. New farmers were also eligible for federal crop insurance premium reductions, using mandatory funds from the 2014 Farm Bill. The upcoming reauthorization is unlikely to result in new mandatory funding, and the BFRDP is one of the 2014 Farm Bill programs without a budget baseline after fiscal year 2018. How has the work of the BFRDP helped address the issues related to the rising average age of U.S. farmers, as well as the overall decrease in number of farmers and ranchers? Could limited funds be better utilized for beginning farmers and ranchers more broadly?

   Response: The Beginning Farmer and Rancher Development Program (BFRDP) provides grants to organizations for education, mentoring, and technical assistance initiatives for beginning farmers or ranchers. Project work ensures that there will be a new generation of beginning farmers and ranchers regardless of age or production choice which is important to

the continuation of agricultural production in the United States. In accordance with the Agricultural Act of 2014, priority is given to partnerships and collaborations led by or including nongovernmental, community-based organizations and school-based agricultural, educational organizations with expertise in new agricultural producer training and outreach. At least 5 percent of the funds support programs and services that address the needs of beginning farmers or ranchers with limited resources; socially disadvantaged beginning farmers or ranchers; and farm workers desiring to become farmers or ranchers. Also, at least 5 percent of the funds support programs and services that address the needs of veteran farmers and ranchers. A third party is currently conducting the first ever comprehensive evaluation of BFRDP funded projects to date, by analyzing qualitative and quantitative data from project reports, conducting additional evaluation activities as needed, and assessing the long-term impacts of completed projects for which data has not yet been collected. The results from this evaluation should be complete and publicly available by mid-2018.

3. Please provide a breakdown of the funds allocated to each Agriculture and Food Research Initiative (AFRI) priority areas since the enactment of the Agricultural Act of 2014. Additionally, please provide the percentage of the total funds each priority area has received annually, out of the overall funding provided to AFRI.

   Response: The information on the breakdown of the funds allocated to each Agriculture and Food Research Initiative (AFRI) priority areas since the enactment of the Agricultural Act of 2014 is provided for the record. The AFRI Program is currently receiving proposals for Fiscal Year 2017; therefore, no awards have been made using FY 2017 funds.

AFRI 2014 Farm Bill Priority Area	FY 2014	Percentage of Total Funds*	FY 2015	Percentage of Total Funds*	FY 2016	Percentage of Total Funds*	Total	Percentage of Total Funds*
A. Plant health and production and plant products	$59,500,745	20%	$58,482,055	20%	$66,542,378	21%	**$184,525,178**	20%
B. Animal health and production and animal products	$49,683,898	17%	$49,315,353	17%	$47,425,901	15%	**$146,425,152**	16%
C. Food safety, nutrition, and health	$65,958,433	23%	$60,994,254	21%	$58,854,194	18%	**$185,806,881**	20%
D. Bioenergy, natural resources, and environment	$73,877,837	25%	$75,220,189	25%	$47,096,107	15%	**$196,194,133**	22%
E. Agriculture systems and technology	$13,239,064	5%	$16,882,798	6%	$27,243,780	8%	**$57,365,643**	6%
F. Agriculture economics and rural communities	$19,553,329	7%	$21,179,772	7%	$24,071,998	8%	**$64,805,098**	7%
Sub Total	**$281,813,305**	**96%**	**$282,074,420**	**95%**	**$271,234,358**	**85%**	**$835,122,085**	**92%**
*Payments to States Amount	$292,740,853		$297,111,946		$320,740,856		**$910,593,655**	
Federal Admin/Small Business/Biotech.Risk/Peer Panel Costs	$23,668,147		$27,888,054		$29,259,144		**$80,815,345**	
Appropriation Amount	$316,409,000		$325,000,000		$350,000,000		**$991,409,000**	
Untracked Data	**$10,927,548**	**4%**	**$15,037,526**	**5%**	**$49,506,498**	**15%**	**$75,471,570**	**8%**

Senator Debbie Stabenow

1. In the Consolidated Appropriations Act for 2017 (P.L. 115-31), Congress directed NIFA to give priority to projects addressing the opioid abuse epidemic in rural communities when considering applications for the Rural Health and Safety Education Competitive Grants program. Are there additional NIFA programs or projects that can improve the

health and wellbeing of rural communities and small towns, including by addressing the opioid epidemic? Please describe.

Response: Economic productivity in rural America is linked to the health and well-being of its individuals, families, and communities. Supported in part by NIFA's Smith-Lever funds, Cooperative Extension Services at land-grant universities across the nation are empowering local residents to lead healthier lifestyles and prevent chronic diseases and other health issues through unbiased, research-based programming and informational resources. The opioid epidemic is a major issue that rural communities across the country are facing.

Through Smith-Lever funds, Michigan State Extension delivers a program titled Personal Action Toward Health (PATH) to Michigan residents, including those in rural areas, focused on long-term pain management issues. Examples of subjects covered in PATH include appropriate use of medications and how to evaluate new treatments. To further bolster efforts in the state to combat the opioid epidemic, in May, Michigan State Extension hired an Extension Educator to serve as the state lead for opioid abuse prevention coordination. Other related Extension programs focus include a farm stress reduction program which addressed mental health among farm families.

Also through Smith-Lever funds, the Ohio State University Extension has partnered with the College of Pharmacy on campus to expand the use of the Generation Rx program in communities across Ohio to prevent the misuse of prescription drugs. Extension educators will be trained to use Generation Rx opioid educational resources and then build community coalitions to support these educational efforts. To address mental health in rural Ohio, OSU Extension was awarded a grant from the North Central Regional Center for Rural Development to train Extension educators on the Mental Health First Aid Program, which builds mental health literacy skills to help someone who is developing a mental health problem or experiencing a mental health crisis.

2. The 2014 Farm Bill changed the matching requirements for funding some of the competitive grant programs. Can you explain how the implementation of these programs has gone from your perspective? What feedback have you heard from various stakeholders?

Response: In accordance with Section 1492 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as added by Section 7128 of the Agricultural Act of 2014, the recipient of an award must provide funds, in-kind contributions, or a combination of both, from sources other than the funds provided through such grant in an amount that is at least equal to the amount awarded by NIFA unless one of the exemptions described herein is applicable (7 U.S.C 3371), which is extended to any institution receiving Capacity Funds, such as the 1862, 1890, and 1994 Land-Grant Universities, Colleges or Schools of Forestry, Veterinary Medicine, or Human Sciences, along with Non-Land Colleges of Agriculture. The exceptions extend to applicants at institutions who partner with any of these institutions. NIFA is further

required to waive this match where proposed research or extension activities are consistent with the priorities established by the National Agricultural Research, Education, Extension, and Economics Advisory Board. This matching requirement has created undue burden for implementation, including the need for NIFA staff time and infrastructure for vetting of institutional applicants, without accomplishing any real leveraging of funds due to the large number of exemptions/exceptions/waivers.

3. Obviously not every research proposal to NIFA can be funded. For NIFA competitive grants, about 13% of proposals are funded. If all proposals submitted to you in the past year were funded, how much money would that be, broken out by ranking categories (outstanding, high priority, and medium priority)?

Response: Answer: The totals for FY 2015 received grant proposals is submitted for the record:

Fiscal Year 2015 Submission Totals:	
Outstanding/High priority:	$1,272,893,173
Medium priority:	$94,600,856
Low priority:	$2,275,473
Others*:	$108,329,746

*S107M of Others were not reviewed by the full peer panel due to not making the review threshold; remaining proposals were rated Major Changes Needed Before Funding.

4. What areas of focus does NIFA have regarding rural communities (beyond agriculture)?

Response: One of the priorities enshrined in the Agricultural Act of 2014 is Agricultural economics and rural communities, which grants NIFA the authority to continue programs that advance science for that priority. Competitive programs like the Rural Health and Safety Education Competitive Grant Program address the needs of rural Americans through individual and family health education programs delivered through cooperative extension. Additionally, the Agriculture and Food Research Initiative (AFRI) program area of Agriculture Economics and Rural Communities (AERC) supports projects that improve agricultural sustainability, protect the environment, enhance quality of life for rural communities, and alleviate poverty. In FY 2016, AFRI AERC supported projects in five program areas: 1) economics, markets, and trade; 2) environmental and natural resource economics; 3) behavioral economics; 4) small and medium-sized farms; and 5) rural entrepreneurship.

The five NIFA Regional Rural Development Centers (RRDCs) play a unique role in USDA's service to rural America by linking the research and educational outreach capacity of the nation's land-grant universities with communities, local decision-makers, entrepreneurs, families, and farmers, and ranchers to help address a wide range of development issues. RRDCs collaborate on national issues that span regions, and also respond to emerging issues, generate credible science-based information to clarify these issues, and create public-private partnerships to address them.

5. In the 2014 Farm Bill, the application process for USDA research programs was improved in order to make the process more streamlined. Can you explain specifically what changes were made, and how the implementation has gone?

Response: NIFA has taken many steps to minimize the burden and streamline the application process for NIFA financial assistance awards by establishing government-wide forms for research, streamlined the process for additional increments of funding for continuation awards, just in time pilot (where only proposals selected for funding will be required to provide all supplementary forms and information), pre-application process, streamlining matching, and opportunities to streamline in future as more functionality is gained with the implementation of ezFedGrants.

6. Agriculture is growing beyond our farmers' fields, and is now happening in many of our cities across the country. From small acre farms to roof tops and indoor vertical farming, new economic opportunities can be found through urban agriculture. Can you discuss research that needs to be done to support urban agriculture?

Response: NIFA supports a broad spectrum of urban and community based agricultural projects through competitive grants programs and capacity programs, and indirectly through grants awarded and administered through regional centers. NIFA defines urban and community based agriculture as agricultural practices that take place within a community setting. Across our granting programs, we funded 127 projects related to urban and community based agriculture at a value of $34,773,341 in fiscal year 2015. States reported $2,703,000 expended on related capacity projects in the same year. Between 2009 and 2015, NIFA awarded a total of 831 competitive projects related to urban and community based agriculture at a value of $198,214,308, with States reporting capacity expenditures of $9,502,000. Of this total, $41,271,174 was awarded through the Community Foods Projects grant programs. Capacity funding is NIFA's support for research and extension activities at land-grant institutions through grants to the states on the basis of statutory formulas, as determined by the Congress. See chart below illustrating NIFA administered research, education, and extension funding for urban agriculture related projects.

	Competitive	Capacity	Total
2009	$22,200,036	$607,000	$22,807,036
2010	$33,744,367	$832,000	$34,576,367
2011	$39,849,622	$806,000	$40,655,622
2012	$26,309,244	$883,000	$27,192,244
2013	$21,926,265	$1,483,000	$23,409,265
2014	$19,411,433	$2,188,000	$21,599,433
2015	$34,773,341	$2,703,000	$37,476,341
Total	$198,214,308	$9,502,000	$207,716,308

7. Antimicrobial resistance is one of the greatest threats to public health. While there is speculation that antimicrobial use in food animals contributes to antimicrobial resistant bacteria, more evidence is needed to investigate those links as well as find solutions. A GAO report published on March 16, 2017 titled "Antibiotic Resistance: More Information Needed to Oversee Use of Medically Important Drugs in Food Animals", made three recommendations to the Secretary of Agriculture regarding this topic, though all focused on APHIS and FSIS. Can you please explain how the research and extension mission area at USDA is addressing antimicrobial resistance, including areas of research focus and efforts to share this information with producers? Can you explain how the research mission area at USDA coordinates with APHIS and FSIS on antimicrobial resistance?

   Response: Monitoring/surveillance, research, education, and outreach are interdependent. FSIS monitors for resistance through the National Antimicrobial Resistance Monitoring System (NARMS) and ARS works closely with FSIS to further characterize emerging resistance. Communication of collaborative findings is through annual web reports, publications, and presentations, but can also be through blogs such as in the federal government's announcement of findings of colistin resistance in the U.S. last year: https://www.usda.gov/media/blog/2016/05/26/proactive-efforts-us-federal-agencies-enable-early-detection-new-antibiotic. APHIS, in collaboration with NASS conducts on-farm sampling and surveys through the National Animal Health Monitoring System (NAHMS). Monitoring helps to further inform research by identifying how and why antibiotics are being used. APHIS communicates AMR-related information with producers and producer groups through several channels, including disseminating NAHMS findings via publications and presentations. ARS publishes and presents research.

   FSIS, APHIS, and ARS have an annual meeting where food safety researchers describe their current ongoing research, and FSIS/APHIS define their needs and challenges faced in the field for researchers to address. Through ARS intramural research and NIFA-funded extramural research, USDA agencies are studying the ecology of AMR, exploring products to improve the health of animals to decrease the need for antibiotics and identifying alternatives to antibiotics. In addition, the agencies are trying to identify better management practices to address AMR. NIFA-funded AMR studies can be found at: http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=fastlink1.txt&id=anon&pass=&search=(GC=A4171)&format=WEBTITLESGIY. Research feeds into education/outreach. Through NIFA's Agriculture and Food Research Initiative (AFRI) competitive program, NIFA awards grants that target research and either an education or outreach component. Since grantees have to include an education or outreach component, results of research can be immediately communicated and applied in real-world situations.

8. With the average age of the American farmer increasing, we need to encourage the next generation to engage in agriculture in order to feed the future. How does your respective

agencies and programs help bring America's youth into agriculture? What are other ways to attract new farmers and ranchers?

Response: The REE agencies employ over 100 interns every year in addition to participating in numerous conferences and outreach activities.

NIFA specifically brings America's youth into agriculture through several programs.

- The 4-H Youth Development Program, or 4-H, is the youth outreach program from the land-grant institutions' cooperative extension services and USDA through NIFA. 4-H serves as a model program for the practice of positive youth development by creating positive learning experiences; positive relationships for and between youth and adults; positive, safe environments; and opportunities for positive risk taking. NIFA-supported 4-H programs reaches over 6 million children across the United States.

- NIFA's Agriculture in the Classroom Program (AITC) serves nearly 5 million students and 150,000 teachers annually through workshops, conferences, field trips, farm tours, and other educational activities. AITC programs include working with state AITC activities engaged in a variety of issues relating to agricultural literacy. Other programs emphasized by the NIFA AITC office include Science literacy, Agricultural careers, Nutrition and Pre-service and professional develop opportunities for teachers.

- The Beginning Farmer and Rancher Development Program provides grants to organizations for education, mentoring, and technical assistance initiatives for beginning farmers or ranchers. Ensuring there will be a "new generation" of beginning farmers and ranchers, regardless of age or production choice, is especially important to the continuation of agricultural production in the U.S.

Agricultural science, technology, engineering, and mathematics (STEM) education has been described as a "leaky pipeline," as fewer students remain as they progress through advanced study. NIFA's education programs are designed to enhance the pipeline through programs that support agricultural workforce development, increase student recruitment and retention, and build capacity. ARS, ERS, and NASS also engage students at all levels to help fill the pipeline.

9. In the past few years, we have seen several devastating animal disease outbreaks in the U.S., including highly pathogenic avian influenza and porcine epidemic diarrhea virus. Does USDA have the appropriate authority and funding to adequately prepare for and investigate the next animal disease outbreak?

Response: Yes, the Animal Health Protection Act (AHPA) gives USDA the authority it needs to address large animal health emergencies, such as the 2014-2015 outbreak of highly pathogenic avian influenza (HPAI). The AHPA gives USDA a wide range of

tools to address foreign animal disease outbreaks, which we utilize in coordination with our State regulatory partners, such as the ability to quarantine and restrict movement of animals. Additionally, the AHPA gives the Secretary, upon apportionment by the Office of Management and Budget, the authority to transfer emergency funding from other agencies and corporations of the Department—typically the Commodity Credit Corporation—to the Animal and Plant Health Inspection Service (APHIS) to address outbreaks. This authority provided the overwhelming majority of the funding utilized to respond to the HPAI outbreak in 2014-2015.

Beyond that, USDA requested additional funding for animal health emergencies in the 2017 budget request. APHIS received an additional $24 million to improve the Agency's preparedness to detect, analyze, and respond to foreign and emerging animal health events.

10. Can you discuss current research being conducted on pre-harvest interventions to address food safety concerns in meat and poultry?

Response: NIFA has funded 20 projects on pre-harvest food safety focused on meat and poultry, ranging from $50,000 to $25,000,000. These projects include research, education, and extension activities to reduce Shiga Toxin Producing *E. coli* (STEC) in beef, and *Salmonella* and *Campylobacter* in poultry. Some projects are focused on reducing antimicrobial resistance. Four of the projects were or are currently being conducted at the Michigan State University.

Dr. Shannon Manning just completed a project to improve the understanding of the factors affecting colonization and shedding of shiga toxin-producing *Escherichia coli* (STEC) in cattle. Shiga toxin-producing *Escherichia coli* (STEC) are major pathogens of humans, resulting in severe illness and occasionally death. About 29% of the cases in the U.S. are attributable to beef. The information generated enhances our efforts to control this deadly pathogen and was provided to USDA's Food Safety and Inspection Service to inform their regulatory decision-making.

Dr. Julie Funk just completed a project on the epidemiology of shiga toxin-producing *Escherichia coli* (STEC) in pigs. This project filled a critical information gap regarding the prevalence of STEC on commercial swine farms, the factors associated with shedding of STEC by swine, and the relationship between STEC isolated from swine to those isolated from cattle and humans. The information generated was provided to USDA's Food Safety and Inspection Service to inform their regulatory decision-making and to representatives of the swine industry.

Dr. Linda Mansfield is working on two projects focused on improving the understanding of *Campylobacter jejuni*. *Campylobacter* is a major cause of gastroenteritis with vomiting and diarrhea.

11. What research is currently being done at your agencies on the effectiveness of voluntary conservation programs authorized in the Farm Bill in addressing natural resource

concerns, like water quality, drought, soil health, and wildlife habitat? Are there positive results or data from this research that you can share that will help justify the federal investment in voluntary conservation programs? Can you explain how do your agencies work with the Natural Resources Conservation Service on research to demonstrate the environmental outcomes from conservation activities on farms and ranches?

Response: NIFA is conducting research, education, and outreach on the scientific bases or translational difficulties that might relate to conservation practices. In terms of efficacy of voluntary conservation programs, NIFA participated in the competitive funding of CEAP (Conservation Effects assessment Program) through the National Integrated Water Quality Program (NIWQP) where 13 watershed studies were funded to evaluate the efficacy of several cropland/grazingland conservation programs through retrospective analysis. A summary and series of Fact Sheets on the outcome of those studies is accessible at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/ws/?cid=stelprdb1047821. The lessons learned from this synthesis strengthen the knowledge base for evaluating the impacts of conservation practices on water quality, improving management of agricultural landscapes for improved water resource outcomes, and informing conservation policy.

Additionally, sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility. NIFA promotes sustainable agriculture through national program leadership and funding for research and extension, offers competitive grants programs and a professional development program, and collaborates with other federal agencies through the USDA Sustainable Development Council.

12. The Specialty Crop Research Initiative addresses the critical needs of the specialty crop industry from plant breeding and genomics, to pest and disease management, and innovative technologies. What are some groundbreaking research examples of how this program used? What is the return on investment of this program to the specialty crop industry and the economy? How are these funds being used to support both basic and applied specialty crop research?

Response: A basic tenet of the Specialty Crop Research Initiative (SCRI) is that all projects funded produce outcomes that lead to a sustainable future for agricultural production, with a major emphasis of new knowledge being translated into useable information that producers can implement during the life of the project. Since 2012, SCRI has funded 83 projects totaling $193,041,063.

Pollination is an absolute requirement for sustainable production of specialty crops. Declines in honey bee and native pollinator populations, as well as increased acreage of crops that require cross pollination, have threatened specialty crop producers. To address this need, NIFA, through SCRI, funded the Integrated Crop Pollinator project led by Dr. Rufus Isaacs at Michigan State University. Research sites for this project have provided visibility to the ICP project on over 10,000 acres of specialty crop fields across more than

100 farms. In Florida, the project has influenced how growers use pesticides, thus avoiding not just impacts on bees but also reducing groundwater contamination. In Pennsylvania pumpkins, one grower has cut honey bee stocking rate in half, from 1 to 0.5 hives/acre without a decrease in yield. This has resulted in a savings of about $14,000 per year for this one grower.

The Rosaceae crop family includes many important crops such as apple, blackberry, peach, pear, rose, strawberry, sweet and tart cherry, and roses. Growers of these crops have expressed a need for new varieties that display disease resistance and superior quality of fruits or flowers. Developing new cultivars of many Rosaceae crops can take longer than 10 years, however. Since 2009, the SCRI has invested more than $13,000,000 in the RosBreed project, led by Dr. Amy Iezzoni at Michigan State University. This project brings modern genomic and genetics tools, in a nationally coordinated effort, to augment the efforts of traditional breeders in the efforts to efficiently and effectively deliver cultivars with producer-required disease resistances and market-essential horticultural quality within time frames that are useful to the commercial sector. By combining fundamental genomic discovery with practical breeding, the RosBreed team has been able to cut the time required to develop new cultivars in half, while saving individual breeding programs hundreds of thousands of dollars.

13. As we prepare for the 2018 Farm Bill, there clearly are some areas where research and data can have a direct impact on how well the farm safety net functions.

    a. Federal Crop Insurance is a critical part of the farm safety net that is delivered through a partnership between USDA and private companies and agents. The cost in premiums to producers for these crop insurance policies is based on the level of risk for their particular crop, location and coverage options. There are certain management practices such as cover crops or different types of precision agriculture that appear to reduce the risks of losses in addition to other benefits to the environment and input costs. To what extent have the research agencies of USDA sponsored or summarized research projects that could be directly applicable to this question of risk reduction? Please summarize any specific results and the degree that risk was reduced. Have you coordinated with the Risk Management Agency to share these results, or used their program and actuarial needs to target future research?

       Response: There is growing interest in what farmers can do to improve soil quality (soil health) and how that may increase crop yields or reduce yield variability. For example, healthier soils can increase drought resilience by capturing and retaining moisture in the soil and making it available for plant growth. An extensive review of the agronomic literature by the USDA Natural Resource Conservation Service (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=stelprdb1257753) suggests that soil health can be improved under a wide range of soil and climatic conditions, but only through the consistent

application of a suite of practices over a period of years. Soil health can be built through long-term and continuous use of no-till, cover crops, double cropping, mulching, and rotation with permanent grass, such as pasture or hay. For example, continuous no-till used in conjunction with high residue/cover crops can have a positive effect on key soil properties including soil organic matter, soil aggregate size and stability, water infiltration, and water-holding capacity. There is also some research to suggest that precision agriculture can improve yields and reduce yield variability. ERS research shows that GPS mapping, guidance systems, and VRT reduce input costs and increase yields.

While there is strong evidence that some practices could be used to improve soil health, there is no database linking the use of specific practices to yield experience that could be used to rate crop insurance premiums. In crop insurance analysis published to date, ERS has used statistical analysis derived from actual yield data and not from agronomic models. While the former approach is likely produce analysis that is representative of the real world, the downside is that it requires sufficient data to obtain statistically meaningful results; there is insufficient yield data linked to specific practices benefiting soil health that is available to ERS to date, to do analysis of how yield would change, and consequently how premium rates would change. RMA already makes adjustments for many common practices that are known to impact yields. However, ERS has published research on the risk reduction provided by federal crop insurance more generally, and on the impacts of policy changes on risk reduction. ERS found that on average for the US, if farmers adopted the Revenue Protection insurance policy with a 75 percent coverage rate, their downside revenue risk protection increases by around 200 percent for corn and soybeans and around 550 percent for winter wheat (https://www.ers.usda.gov/publications/pub-details/?pubid=45515).

Statistical analysis presented at an ERS-sponsored workshop (The Economics of Soil Health, September 2015, https://www.farmfoundation.org/webcontent/Economics-of-Soil-Health-1914.aspx) show that soil quality is strongly predictive of yields and that models including measures of soil quality could be used to better predict insurance premiums. Nonetheless, links between the use of specific practices and soil quality or soil health have not yet been clearly quantified and may depend significantly on soil characteristics and climate.

b. The Farm Service Agency's Agriculture Risk Coverage program relies of thousands of yields by crop and county in order to calculate guarantees and payments. The program relies particularly on yield data collected by NASS through surveys of producers. In some cases, insufficient responses are received despite repeated attempts by NASS, but I understand that NASS does not have the option of increasing the sample size. Is this restriction of expanding the number of producers surveyed related to budget constraints or other restrictions such as the

paperwork reduction act requirements? Are there any areas where added flexibility would provide NASS county-level data more consistently, instead of requiring FSA to switch between data sources?

Response: NASS contacts over 365,000 farmers throughout the country to collect data to publish county estimates. There are four modes of data collection: mail, internet, telephone and personal interview. NASS has partnered with associations marketing the survey which resulted in more counties published for the commodity of interest. An increase in resources would allow NASS to improve the marketing plan informing the farmers the benefits of responding to NASS surveys. Currently, NASS utilizes unpaid media opportunities such as USDA Radio, RFD-TV interviews, national news releases, reminders in weekly crop progress and monthly crop production reports, short items for use in FSA newsletters, USDA blogs when available and Twitter to garner earned media coverage that encourages response to these and other surveys. We provide enumerator training materials, news release templates, survey cover letters, etc. for regional offices to localize so that our own staff have pertinent information and can leverage local knowledge and connections. Additionally, we've built partnerships with national commodity organizations for wheat, corn, and soybeans to help further encourage farmers and ranchers to respond. All have included content in their member communications.

Senator Sherrod Brown

1. It is my understanding that there is a new interpretation concerning the use of State Match funds for the 1890's programs listed in a NIFA communication dated 10/24/16. Per this document, prior approval of "Education Activities" is now required. However, the last published NIFA FAQ published in 2003, indicates that pre-approval of "Educational Activities" was not required and, in fact, were the responsibility of the University. Again, it is my understanding that this new interpretation is currently being applied to program reviews of expenditures made prior to the publication of the new interpretation. When NIFA is conducting a program review of expenditures prior to the posting of your new interpretation of October 24, 2016, which standard is used for expenditures? Shouldn't the expenditures be evaluated using the description given in the FAQ? Otherwise, doesn't this place an undue burden on the 1890 Institutions to have to return funds used in manner accepted at the time of the expenditure? Please explain.

   Response: NIFA has been monitoring matching funds to ensure expenditures are reasonable, necessary, allocable, and expended consistent with the purpose of the law. To date, no education activities costs have been disallowed. However, in finding that match was being used to support the salaries of faculty for teaching of undergraduates, NIFA reviewed its regulations and guidance. The governing regulation, 7 CFR 3419, requires prior approval for qualifying education activities. The FAQ mentioned in the question is related to guidance and a Notice of Proposed Rulemaking that was never finalized. NIFA issued clarification about the prior approval requirement in 7 CFR 3419 and indicated

that it would be implementing those requirements going forward, recognizing the previously un-finalized guidance Universities have been operating under. Additionally, NIFA is preparing a new Notice of Proposed Rulemaking (NPRM) amending 7 CFR 3419 to clarify allowable educational activities as well as matching requirements. The NPRM is expected to be published in Fall 2017, with universities being provided 60 days for notice and comment.

2. Since most States that have both 1862 and 1890 institutions submit a joint plan of agricultural research work, how can the Committee encourage states to match each institution in the state at the equivalent amount, up to 100%?

   Response: NIFA is compiling a list of total funding NIFA provides by state to 1862 and 1890 institutions. 1862s are required to provide 100% match; 1890s may request a waiver of up to 50% of match. For some programs, matching funds can be provided from any non-federal source (excluding tuition and fees). NIFA has just begun collecting information about whether the match was provided by the state, rather than another source. When NIFA has a more complete picture of where matching funds have originated, NIFA plans to share such information on its website.

3. Is Central State University (CSU) fully participating in the capacity (1890 extension and Evan Allen research) funding formula? If not, at what time will CSU fully participate based on the formula? Are there any criteria CSU should be aware of that will make them prepared to fully participate? Or is the $1 million CSU receives for each capacity program based on the formula?

   Response: The Agricultural Act of 2014 designated CSU as an 1890 Institution. While the designation was effective upon enactment of the Agricultural Act of 2014, however, per the funding restrictions contained in the law, CSU was not eligible to receive certain formula funds, including Section 1444 and Evans-Allen Research funds, until FY 2016. CSU is fully participating in capacity (1890 extension and Evans-Allen research) funding. In FY 2016, under Section 1444, 1890 extension, CSU received $1,151,046 and in FY 17, the proposed funding level is $1,151,046, which will be adjusted once final budget calculations are made. For Section 1445, Evans-Allen funding, in FY 2016, CSU received $1,117,200, and in FY 2017, the proposed funding level is $1,117,200, which will be adjusted once final budget calculations are made. CSU receives its annual Section 1444 and 1445 funding based on the same formula as other 1890s. CSU received Facilities funding in FY 2015, the first year they became eligible, also based on formula. Additionally, CSU has been added as an eligible entity for competitive funding opportunities that are open to 1890 Institutions.

4. Given that domestic production is not able to keep up with growing demand for organic products, and the fact that organic research benefits all farmers, what role can NIFA play in furthering organic research, particularly for farmers interested in transitioning to organic? As we examine agriculture research in the next Farm Bill, how can we best focus organic research to increase our output of organic products?

Response: Despite a sustained double-digit growth in annual demand for organic products, domestic production has not been able to satisfy that demand. It is only possible to meet the growing demand for organic products from domestic sources through the transition of new producers, land, and facilities into certified organic production.

5. In recent years, NIFA has funded a number of Community Food Projects across the country. How have these programs helped promote nutrition and increase access to healthy foods in program communities?
Response: The Community Food Projects Competitive Grants Program (CFP) has existed since 1996 as a program to fight food insecurity through developing community food projects that help promote the self-sufficiency of low-income communities. CFP is designed to increase food security in communities by bringing the whole food system together to assess strengths, establish linkages, and create systems that improve the self-reliance of community members over their food needs. There are several CFP examples in Ohio that have promoted nutrition and increased access to healthy foods in communities. For example, the Unearthing Franklinton's Potential: Cultivating a Vibrant Foodscape is a three-year endeavor (commenced in 2016) that involves three distinct components to address the need to: improve healthy food access through a neighborhood Community Supported Agriculture (CSA) program; strengthen community self-reliance and inspire community empowerment through cooking classes and workshops on nutrition, food processing, and leadership; expand participation of low-income Franklinton residents in programming that improves affordable healthy food access. Second, the Trumbull Neighborhood Partnership and partners will complete a Community Food Security Assessment process and community input sessions to develop a Community Food Strategy Plan that includes recommendations and goals for addressing food security needs in Warren, OH by the end of August 2017.

6. Central State University in Wilberforce, Ohio is the newest 1890 land-grant, even though it has been around for quite some time. It's my understanding that CSU has already started a STEM summer program to engage middle-school students in agriculture related fields. How is NIFA working with Central State and other HBCU's to increase capacity at the University and to best utilize its existing strengths?

Response: NIFA's 1890 land-grant institutions programs are intended to strengthen research, extension and teaching in the food and agricultural sciences by building the institutional capacities of the 1890 Institutions. The following 1890 programs increase capacity and help 1890 institutions utilize their existing strengths: 1.) 1890 Institution Teaching, Research, and Extension Capacity Building Grants Program, which is intended to support research, teaching, and extension by awarding grants that address key problems of national, regional, and multi-institutional importance in sustaining all components of agriculture, including STEM education, farm efficiency and profitability, ranching, renewable energy, forestry (both urban and agroforestry), aquaculture, rural communities and entrepreneurship, human nutrition, food safety, family and consumer sciences, biotechnology, and conventional breeding; 2.) 1890 Facilities Grants Programs, which is intended for the acquisition and improvement of agricultural and food sciences facilities and equipment, including libraries, so that the 1890 land-grant institutions,

including Central State University, may participate fully in the development of human capital in the food, agricultural, and human sciences, including STEM education; 3.) Evans-Allen Research Program, which supports agricultural research activities at 1890 Land-Grant Universities, and support student experiential learning opportunities; 4.) 1890 Extension Formula grants, which assist diverse audiences, particularly those who have limited social and economic resources, to improve their access to positive opportunities through outreach education.

In addition to funding, NIFA also provides programmatic leadership to increase capacity at the MSIs, including HBCUs, and to best utilize their existing strengths to enhance research, extension, and teaching in the food and agricultural sciences, including STEM education. For example, in FY 2016, NIFA conducted several outreach activities, especially webinars, for MSIs to increase their awareness of NIFA competitive grant opportunities and enhance their competitiveness. The 1890 Faculty Engagement Project provided an opportunity for 1890 faculty members to strengthen their research skills and expand their professional networks in the areas of animal health, well-being, and food security. To improve post-award management, NIFA also incorporated a number of MSI workshops in the annual National Extension and Research Administrative Officers Conference (NERAOC) and site visits to campuses. Several workshops focused on best grants management practices and policies for the 1890 Land Grant Universities at NERAOC.

Senator Amy Klobuchar

1. Minnesota farmers have been able to improve the efficiency of corn production and have increased the yield of corn per acre. In order to take advantage of these production improvements, it is critical that we expand the end uses for corn and other agricultural commodities to add value to every bushel.

   a) What research initiatives have the Agricultural Research Service (ARS) and the National Institute of Food and Agriculture (NIFA) undertaken to expand the uses of agricultural commodities in non-food markets?

   Response: Since 2008, NIFA has invested over $190 million in support of projects on expanding the uses of agricultural and forestry commodities in non-food markets, including bioenergy, bioproducts, and biomaterials.

   One project at the University of Minnesota is developing several processes to treat waste materials generated from intensive agricultural activities and develop valuable bioproducts to recycle nutrients, including: (i) co-digesting swine manure with other carbon-rich waste materials to increase the biogas generation and pretreat the biomass for phosphorus recovery; (ii) thermally treat the digestion effluents for fungal growth; (iii) growing filamentous fungal cells on to produce fungal biomass as biological phosphorous fertilizer and to enable the digestion effluent with a more balanced nitrogen/phosphorous ratio for use as a soil conditioner and crop fertilizer.

In addition to commodity food crops, Minnesota has a strong forest products industry that would benefit from diversification. On November 14, 2016, with jet fuel made from forest operation woody residuals and mill waste, an Alaska Airlines Boeing 730 flew from Seattle-Tacoma Airport to Reagan National Airport, the first ever commercial flight using jet fuel made from lignocellulosic biomass. A spinoff of the technology developed in this project could be used to convert corn stover to jet fuel. This project was funded by NIFA through an AFRI grant to a team of university, government, and private sector partners led by Washington State University.

Similarly, in partnership with the Department of Energy, NIFA provided funding through the Biomass Research and Development Initiative (BRDI) to Domtar Paper Company, LLC, which was able to successfully convert lignin, a heretofore waste material, into drop-in liquid fuel. This project resulted in the preservation of over 100 forest product industry jobs.

b) How could existing research programs be improved in the next Farm Bill to expand the uses of agricultural commodities and better leverage private and public investment?

Response: The authority provided through the 2008 and 2014 Farm Bills for NIFA to support research, education, and extension efforts supporting the bioeconomy has had a significant impact on expanding the use of agricultural and forestry commodities, and leveraged significant private and public investments. For example, the Northwest Advanced Renewables Alliance (NARA) project led by Washington State University was provided $40 million through an AFRI grant for producing jet fuel, from forest operation residuals and mill waste. The project successfully created jet fuel which was used by NARA industrial partner, Alaska Airlines, to fly a commercial airliner from Seattle to Washington, DC, noted above. This project leveraged an additional $110 million in cash, and materials, and facility access from a number of private and public partners.

Continued authority in the next Farm Bill and increased funding through AFRI and BRDI will be critically important to continue to achieve the promise of the bioeconomy. Increased R&D funding would also strongly enhance the Small Business Innovation Research Program (SBIR) which historically has received many proposals on developing non-food uses for commodity food crop and their residuals, e.g. corn and soybean. Recent examples include: Improved Soybean Feed for Use in Aquaculture (Arcadia Biosciences, Arizona), Product Recovery from Novel Fermentation Processes for Bio-Manufacturing High-Value Chemicals from Renewable Feedstocks (Lygos, California), Utilize Corn Derived Products Driven From Ethanol Production for Horticultural Weed Control, A Natural Fertilizer with Enhanced Plant Growth (Summit Seed, Illinois), and Biomass-Based Commodity Polymers from 5-Hydroxymethylfurfural (Lynntech, Texas).

Also, Commodity Boards can propose topics to co-fund with NIFA through AFRI's competitive awards programs. If a commodity board is specifically interested in

development of new, non-food uses of a particular commodity, this mechanism could allow them to work with AFRI to prioritize funding for such efforts.

c) What opportunities do you see for new programs to expand uses for agricultural commodities?

Response: As previously mentioned, continued authority in the next Farm Bill and increased funding through AFRI and BRDI will be critically important to continue to achieve the promise of the bioeconomy.

Senator Kirsten Gillibrand

1. I understand that NIFA will be required to vacate its current administrative offices in Washington, D.C., in the near future.

   Can you provide me with further information about your plans for the relocation and the expected costs? Do you require additional resources to facilitate this shift in location?

   Response: NIFA's lease of the General Services Administration (GSA) commercial space at the Waterfront Center, 800 9th Street SW, Washington, DC expires in January 2020. The predominant bulk of NIFA's staff is located in the Waterfront Center, although NIFA has the Office of the Director in USDA's main Whitten Building.

   GSA manages the lease renewal process and monitors Government wide standards for allowable space based on agency employment data. The USDA Office of Operations and GSA worked with NIFA to develop the lease prospectus package, which includes the Program of Requirements for our space needs in 2020. GSA also contracted with an architecture and design firm, Metropolitan Architect and Planners (MAP) to assist with this process. GSA submitted the lease prospectus package to the Office of Management and Budget for approval in Spring 2017. Current estimates for costs, excluding ongoing GSA Rent and Department of Homeland Security costs, are about $21 million over a two-year period beginning in FY 2018, which is not included in NIFA's budget request.

2. A number of individuals have raised concerns regarding the inequitable funding of some 1890's institutions when compared to 1862's in the same state. While New York lacks an 1890, the situation in North Carolina provides an example of this funding imbalance.

   Currently North Carolina A&T, an 1890 institution, receives less state matching funding for grants from NIFA than their fellow 1862 institution in the state, North Carolina State University.

   While NCSU receives well above the 1 to 1 matching funding from the North Carolina General Assembly, NC A&T receive 0.8 to 1 in funding it needs to meet its federal matching requirements for grants from NIFA.

   These grants include research, extension, and capacity funding for 1890 institutions.

It is my understanding that states must submit a work plan to NIFA that outlines how 1890's and 1862's will use the funding they received from USDA and from their state.

Please provide a list of total funding by state to 1890 and 1862 institutions so that the Committee can determine whether state governments are meeting their obligation to match the federal funding provided by to Land Grant Universities.

Response: In 2015, North Carolina A&T (NCAT) matched their full extension amount and received a wavier for 25% of their match requirement ($1,055,188 of $4,215,640) of Evans-Allen research funds. In FY 2016, NCAT received a waiver for 17% ($626,672 of $3,698,071) of their extension match requirement. For research, NCAT received a waiver of 24% of their matching requirement ($1,031,460 of $4,250,701).

The list of matching for 1890 and 1862 institutions is submitted for the record. 1862s are required to provide 100% match. 1890s may request a waiver of up to 50% of match. For some programs, matching funds can be provided from any non-federal source (excluding tuition and fees). Where this is the case, NIFA has just begun collecting information about whether the match was provided by the state, rather than another source. When NIFA has a more complete picture of where matching funds have originated, NIFA plans to share that information on its website.

3. New York has more than a thousand certified organic operations and many farmers I talk to have considered transitioning to organic – particularly young farmers who are looking to start farming on a modest scale without incurring huge debt. In the last ten years, we have tripled the number of organic farms and still our growers struggle to meet the demand for local grains and produce. Those farmers need research support like the grants made available through the Organic Agriculture Research and Extension Initiative (OREI). While the organic industry has experience rapid growth with sales reaching $47 billion last year, the OREI budget has stayed flat for nearly a decade.

   Can you discuss which of the priority areas for the OREI grant program warrant more significant investment to help organic farmers meet the demands of this growing market segment?

   Response: All eight priorities included in the National Institute of Food and Agriculture 2017 Organic Agriculture Research and Extension Initiative's Request for Applications address critical needs of the U.S. organic industry. However, if limited to one, priority one captures the most essential elements and has the potential for greatest impact.

   Priority 1: *"Conduct advanced on-farm crop, livestock, or integrated livestock-crop research and development that emphasize observation of, experimentation with, and innovation for organic farms, including production, marketing and socioeconomic issues. These issues could include both identification of factors reducing yields, efficiency, productivity, and economic returns on organic farms and the economic and*

socioeconomic contributions of organic farming to producers, processors and local communities."

4. I am concerned about the concentration in production agriculture on many levels, but certainly in the way it that has limited the availability of regionally adapted seeds. Public plant breeding programs have declined significantly in the past 20 years and more in the Northeast than any other part of the country. This makes our growers more reliant on big corporations and limits their access to new varieties of seeds that grow best in their communities.

   Can you discuss how NIFA supports plant-breeding programs, including organic seed production, through AFRI, OREI or other programs?

   Response: The FY 2017 AFRI Foundational Plant Breeding for Agricultural Production priority area supports opportunities for researchers to develop publicly available seed and cultivars that are bred to be adapted to the soils, climates, and farming systems of farmers of all regions. Research can include, but is not limited to, prebreeding and germplasm enhancement, cultivar development, selection theory, applied quantitative genetics, and participatory breeding. Public release of germplasm and cultivars are an integral requirement of AFRI funded breeding projects. In addition, the 2014 Farm Bill enables eligible state and national commodity boards to submit topics for research and outreach that can be specific to their states or regions and are willing to equally co-fund through AFRI. In FY 2016, the first year of collaboration with commodity boards, two plant breeding projects were supported. In general, NIFA's AFRI program is highly competitive, with an average of only 13 percent of proposals submitted during the last three years being funded. This results in a huge number of highly worthy proposals being unfunded. With additional funding for AFRI, the agency can fund many more proposals, including in plant breeding.

   There are also two other NIFA programs that support opportunities for land grant universities to provide regionally adapted seeds and cultivars to growers. The Specialty Crops Research Initiative supports plant breeding, genetics, and genomics to improve crop characteristics in a wide variety of crops and crop families; and the Organic Agriculture Research and Extension initiative supports priorities to strengthen organic crop seed systems, including seed and transplant production and protection, and plant breeding for organic production, with an emphasis on publically available releases.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Dr. Sally Rockey

Chairman Pat Roberts

1. **One of the main intents behind the creation of FFAR was to focus on bold and innovative ideas, and to help meet the demand for high risk, high reward agricultural research. While agriculture has benefited over the last several decades from research following the Dust Bowl and World War II, the growing world population indicates a clear need for resourceful and forward-thinking food production. What types of projects is FFAR working on that fulfill this need for unique and risk-taking research ideas, with the potential for significant gains?**

   After the June 15 research hearing, FFAR announced one of the Foundation's most innovative and cutting edge research partnerships yet. The Crops of the Future Collaborative is an international, multi-million-dollar consortium that brings together eight companies and research organizations to accelerate crop breeding. Together, members of the collaborative will target crop characteristics that no company or organization alone could invest in without substantial risk. This collaboration will accelerate discoveries by sharing costs, risks, and rewards among partners and making the results publicly available for the research community to build upon. Target crop characteristics might include enhanced nutritional qualities or ability to withstand environmental challenges such as drought, heat, or flooding. Ultimately, knowledge generated by the Collaborative will be publicly available through scientific publications and informational platforms, benefiting public and private crop breeding efforts.

   Another prime example of a unique research initiative with significant impact potential is an upcoming project investigating how to make photosynthesis, the process by which plants produce energy from the sun, more efficient, which could break through the plateau that breeders now face in terms of significantly increasing yield for staple crops. Increased yield will allow more food to be produced on the same amount of land with even less inputs, essential for feeding the world's burgeoning population.

   FFAR recently awarded funds in support of Crops *in silico*, a project to develop a suite of virtual plant models with potential to help resolve a growing gap between food supply and demand in the face of a changing climate. Fully realized, Crops *in silico* will give crop researchers a tool to examine the effects of those challenges on a molecular, cellular, and organ level within a plant to more quickly and accurately determine the best targets for breeding of new important traits and to accelerate our ability to get new crop varieties into the hands of producers. Replacing the need for field trials with virtual modelling technology will significantly shorten the time it takes to develop crops that are bred to withstand tomorrow's challenges.

2. **As I viewed the $200 million dollars provided by the last Farm Bill as a "seed investment" to establish FFAR, can you elaborate on specific plans to generate new funding that will enable FFAR to be a sustainable tool to support agriculture research into the future?**

After spending the first year and a half establishing strategies, partnerships and processes and launching initial programs, FFAR is gaining a reputation for funding game-changing research. This is the first step in becoming an impactful, sustainable organization.

It takes time to develop fundraising programs. To date, the Foundation's focus has been on raising matching funds so research initiatives can progress. We now have approximately $100 million awarded or in the pipeline to award. It takes 12 to 18 months to establish the relationships with funding partners necessary to build this pipeline. Many of these relationships began with the Foundation's board members.

Another component of our work towards organizational sustainability is the active pursuit of philanthropic contributions to FFAR. There is a critical need for science and technology to address challenges to providing sufficient, sustainable food to meet demands here in the U.S. and globally. FFAR is establishing itself as an organization that offers a solution to these challenges.

Now the Foundation's fundraising focus is broadening as we explore sources for matching funds and additional revenue streams. These include garnering additional donation revenue through major gift fundraising, board donations, online fundraising, events and the Combined Federal Campaign.

FFAR will continue to use our significant network built during and since our startup to draw potential individual donors into our mission. The Foundation is already well connected to industry, associations and foundations and is developing a plan for initiating relationships with individuals to support innovative food and agriculture research to provide endowment funds or funds directly for research. Many of these relationships will begin through our board members.

For the first time in 2017, the Foundation has made a fundraising 'ask' of board members. As is typical for leading nonprofits, FFAR expects to have 100 percent board giving.

In April, FFAR launched our 'Donate Now' website so we may enlist the public in the Foundation's mission. We drive potential donors to the webpage through public relations and social media efforts. In 2018 FFAR will hold its first fundraising event and enroll in the Combined Federal Campaign.

The Foundation supports scientists in all stages—basic, applied and entrepreneurs. Going forward, agreements with grantees will be structured to ensure the Foundation benefits when research efforts are commercialized. FFAR is reviewing effective models for these agreements and currently negotiating for the first time with a grantee to provide intellectual property revenue to support future Foundation research through royalties. Given it can take multiple years for new research to be translated into commercial products and adopted by industry, intellectual property is a long-term revenue source.

Thus, while the Foundation has made significant progress raising funds to match research investments, it is clear making the Foundation fully sustainable will take more time.

3. **You indicated that continue success will be reliant on support from Congress in the form of a statutory reauthorization and full funding. One of the largest challenges Congress faces in the next**

Farm Bill will be to find the resources needed to cover current needs as well as any new authorizations. Is the funding you are requesting to cover the operating and administration costs of FFAR, towards matching federal funds to support future research programs, or both? How are continued funds consistent with the intent that FFAR be self-sustaining?

Additional funding for the Foundation for Food and Agriculture Research would allow the Foundation to solidify itself as an institution that facilities scientific progress, funds innovation, and contributes to the success of food and agriculture as an active player in the agricultural research arena.

The Foundation's unique matching model created by Congress in the 2014 Farm Bill has been the impetus for the partnerships and projects launched to date. The long-term success of this model depends upon additional congressional investment to allow the Foundation to continue attracting new partners to grow the funding pool for food and agriculture research.

Although the Foundation is working toward the ability to independently support itself, continued support for FFAR with authorization to spend up to 5 percent of funds on operating costs would allow the Foundation to devote resources toward launching innovative research projects, including those with potential to generate revenue through intellectual property.

One opportunity offered by the FFAR model is the Foundation's ability to attract nontraditional funders to food and agriculture. Cultivating new relationships outside of the traditional food and agriculture research arena has high impact potential, but also requires significant investment of staff resources. Short-term operating stability would allow more focus on establishing long-term partnerships with unique funding partners.

The Foundation is committed to becoming a sustainable institution that continues to complement the U.S. Department of Agriculture through unique public-private partnerships, a flexible and nimble grants structure, and a focus on innovative science. Continued congressional support would greatly enhance and accelerate our ability to do so in the short term. As noted above, the key to the Foundation's success to date has been the Congressional investment and required matching funds, which together serve as a magnet for funding partners. Removing this defining component of the Foundation's model at this early stage of the new organization would halt momentum and make it much more difficult to become sustainable.

4. **The Agricultural Act of 2014 laid out seven areas of significance FFAR should be focused on addressing including:**
    1. **Plant health, production, and plant products**
    2. **Animal health, production and products**
    3. **Food safety, nutrition, and health**
    4. **Renewable energy, natural resources, and the environment**
    5. **Agriculture systems and technology**
    6. **Agriculture economics and rural communities**

In the last two years, FFAR has established a narrower framework of Challenge Areas including:

- **Food Waste and Loss**
- **Forging the Innovation Pathway to Sustainability**

- **Overcoming Water Scarcity**
- **Protein Challenge**
- **Urban Food Systems**
- **Making "My Plate" Your Plate**
- **Healthy Soils, Thriving Farms**

While I understand the intent of these Challenge Areas is to guide the proposal and awarding process, I am concerned these categories are too prescriptive and could potentially dissuade the bold and innovative research FFAR is meant to achieve. For example, in a recent interview when discussing the Protein Challenge, you stated that one of the goals of this challenge is to find alternatives to animal proteins available to feed a burgeoning population worldwide. USDA's Economic Research Service has indicated that as the middle class expands globally, meat consumption is also growing and we are seeing increased demand for animal protein, particularly in areas like the Middle East, North Africa, Southeast Asia, and South America. How can you ensure that your challenge areas are inclusive to a broad range of bold and innovative ideas, while at the same time not favoring short term, consumer driven trends that may not realistically address the challenge of feeding a growing population?

The seven Challenge Areas were established with input from external groups, the Foundation's Advisory Councils, and the Foundation's board based on areas where FFAR could generate the greatest possible impact through our public-private partnership model. The Challenge Areas are intentionally broad and designed to attract bold, innovative research with potential to catalyze real-world results that move the food and agriculture community closer to solutions within each area.

From a strategic standpoint and in particular to continue generating support and partnerships, it was important for the Foundation to narrow its initial focus. As new challenges arise and current ones begin to be resolved, the Foundation expects to add and subtract Challenge Areas accordingly.

With that said, the Foundation reserves a portion of our research portfolio for research opportunities that fulfill our mission as outlined in the 2014 Farm Bill, but fall outside the current Challenge Areas. Current examples include the Pollinator Health Fund, which will have implications for the agricultural system and the Crops of the Future Collaborative described above, which takes advantage of the opportunity to build on recent technological advancements in crop breeding.

The Challenge Areas are designed to evolve with the needs of the agricultural industry. FFAR understands the high demand for animal-based protein in the U.S. and globally. The Foundation recently adjusted the goals of the Protein Challenge to focus on advancing the sustainable production of high-quality, animal-sourced foods with emphasis on improving antibiotic stewardship, environmental sustainability, and farm-animal health and productivity. The intent of this Challenge Area is to ensure our continued ability to meet the growing demands for animal protein referenced in the question above with the limited natural resources available. Research programs launched to date have focused on animal protein from aquaculture, pork, and poultry sources.

Senator Debbie Stabenow

1. **Agriculture is growing beyond our farmers' fields, and is now happening in many of our cities across the country. From small acre farms to roof tops and indoor vertical farming, new economic opportunities can be found through urban agriculture. Can you discuss research that needs to be done to support urban agriculture?**

   FFAR believes that urban agriculture is one critical component of a thriving future for our agricultural systems, our economy and our ability to produce food for burgeoning urban populations. It is also an area, because of its newness, where research is necessary to propel the field forward. Thus, FFAR developed Urban Food Systems as one of its seven Challenge Areas.

   There is much research to be done to develop the opportunities offered by urban agriculture. FFAR is targeting areas of research that create economic opportunities for farmers, as well as the affordability of nutritious and healthy food for consumers.

   Urban settings provide unique environments for farmers, from degraded and polluted lands/waters, to roof top and vertical farms. FFAR is pursuing research funding partnerships with the private sector that increase the economic viability for urban farms. These include developing the types of crops that can be grown in different environments (vertical farms, aquaponics, greenhouses, marginal environments), and technological advances in production methods that increase the profitability of urban agriculture. Increasing the economic viability of urban agriculture will eventually take advantage of new markets, increasing the economic viability of more nutritious and healthy products.

   As part of FFAR efforts to build new partnerships and increase collaboration in this rapidly progressing area of agriculture, the Foundation will hold a convening event in fall 2017 with potential partners and stakeholders.

   FFAR is also pursuing research that investigates how changes in food systems not only empower consumers to purchase and consume more healthy food, but also promote the economic sustainability of local systems over time. FFAR is also interested in future research on how to influence consumer behaviors that increase consumption of healthy, nutritious food.

2. **Can you address how FFAR is working to address challenges for rural communities? If FFAR is not currently working in this space, what opportunities to you see for the future of FFAR to help rural communities?**

   Currently, FFAR does not have a specific program for rural communities, but rural communities will certainly benefit from a number of projects and programs that FFAR is supporting. For example, our Making My Plate Your Plate Challenge Area concentrates on food access and assuring nutritious food is available to all. One program that FFAR is developing within this area, called Tipping Points, will take a holistic approach to understanding food access programs and how best to achieve improved health outcomes, whether the intervention programs be in cities or in rural communities. Additionally, the vitality of farms is at the core of the Foundation's work, which provides for economic resiliency in rural communities.

3. **One of the highlights of the U.S. agricultural research framework is our cooperative extension system to disseminate information learned in the latest research to the people who need it most. Can you explain how FFAR plans on sharing information learned from research it supports with producers?**

Every research proposal that FFAR supports requires the submitter to describe how that research will address an issue for the food and agriculture industry. For research that is on the applied end of the spectrum, successful proposals involve producers in the research process and include a plan for quickly spurring results into application.

For example, the Foundation's National Cover Crop Initiative in partnership with the Samuel Roberts Noble Foundation is designed to generate new knowledge for farmers on the specific cover crops that will produce the greatest soil health, yield, and economic and environmental benefits for their specific land environments.

Researchers from the recently funded cover crop project will make improved cultivars commercially available to farmers as one of their primary objectives. Each of the five field-testing locations associated with the project will host a field day where farmers can learn about available cover crop germplasm as well as management of cover crops in their systems.

Several FFAR programs specifically take advantage of the cooperative extension system. For example, the Foundation's emergency pest and pathogen response program, Rapid Outcomes from Agricultural Research (ROAR), encourages applicants to work with the cooperative extension system to disseminate findings for preventing and mitigating pest and pathogen damage.

Later this month, FFAR will announce a new initiative to maximize on-farm efficiencies by finding ways to prevent crop loss and identifying potential new revenue streams for producers. Research will be conducted on-farm in partnership with producers to ensure practical, viable outcomes. In addition to publishing results in academic publications, the research team developed a communications plan to disseminate information to farmers and extension educations. Strategies include working with regional commodity groups to share information with members, targeting farming journals and popular press and presenting results at agricultural industry conferences.

Lastly, Dr. Rockey has met with Extension leadership through ECOP on numerous occasions including in June 2017 to expand our working relationship with this vital part of the agricultural enterprise.

4. **The FFAR was created to support both domestic and international agricultural research, can you describe how the FFAR is supporting international agricultural research?**

FFAR partners with international organizations and supports work that has international implications. On June 29, the Foundation announced the launch of the Crops of the Future Collaborative, a multi-million-dollar, international consortium that will fund research to accelerate crop breeding. The consortium brings together international companies and foundations to support research with global implications.

The Foundation is in the process of developing another similarly structured, international initiative focused on reducing post-harvest food loss and is expected to launch later this year. It will include research based in Africa, Asia, South America and the U.S.

Additionally, FFAR is partnering with another leading foundation to support research toward increasing the efficiency of photosynthesis. This research has the potential to reverse the plateau that research toward increasing crop yields has reached and significantly improve yields staple crops grown in the developing world. Research will be conducted both domestically and internationally. This project is ongoing and FFAR's participation is expected to be announced in 2017.

5. **Agricultural commodity groups could be great partners for funding FFAR research projects. Are checkoff dollars from commodity checkoff programs eligible to be used as non-federal matching funds?**

FFAR has formally partnered with state-level commodity groups to support research efforts including the Iowa Corn Promotion Board, Indiana Soybean Alliance, and the Indiana Corn Marketing Council. As you know, the Foundation for Food and Agriculture Research must match research investments with non-Federal funds. From our conversations with national-level commodity checkoff programs, some groups consider checkoff program funds to be federal while others do not. The Foundation is focused on supporting science that improves productivity and profitability for farmers and ranchers. As such, commodity associations and checkoff groups are natural and essential partners for the Foundation. However, currently only those checkoff groups that consider their funding to be non-federal are eligible to contribute matching funds to FFAR research.

Senator Kirsten Gillibrand

1. The **Foundation for Food and Agricultural Research is a unique institution that leverages public funds with private research dollars. In just the last two years, I have watched FFAR establish a board, form new partnerships, create investment priorities, and begin granting funds to researchers.**

Since FFAR has only recently started funding researchers and is still adding partners, can you tell us a bit about the demand for collaboration with FFAR and whether you think that additional support from the Committee is warranted?

You mention in your testimony that becoming a self-sustaining Foundation is a core part of the five-year plan. FFAR will clearly need support while it works towards independent funding but could you tell us about that plan and how FFAR will self-sustaining?

The innovative FFAR model as defined in the initial authorization only works if the Foundation continues to receive financial investment from Congress. If FFAR does not bring funds to the table, the Foundation loses its leverage with partners. The ability to leverage FFAR funds is the draw.

With that said, FFAR is working to solidify our reputation as a neutral, trusted funding partner for innovative agricultural research. Looking to the future, FFAR expects that our demonstrated success will attract non-Federal support from philanthropists who understand the gravity and importance of the food and agriculture challenges we face, and see the Foundation's ability to bring partners together to address those challenges.

FFAR is continuing to build on short-term successes, having built a credible, nimble organization with a low operating cost of five percent, established research priorities, and launched a giving program. With a strong baseline for future success, FFAR is now exploring ways to generate revenue from IP and seeking major gifts. Further detail is outlined in response to Question 2 from Chairman Roberts.

2. **We depend on pollinators for nearly $24 billion dollars of agricultural production each year, much of it in specialty crops. Honeybees contribute $15 billion dollars and native bees and wild pollinators account the remaining $9 billion dollars. Pollinators have suffered greatly over the past few years from exposure to pesticides, parasites, disease, habitat degradation, and decreased forage quality.**

   I know the Pollinator Health Fund is one of FFAR's major initiatives. Can you tell us about the fund, some of the partner groups, and what research you expect to see supported by the initiative?

   The Pollinator Health Fund is an exciting investment in the health of our nation's pollinators and one that will yield results that are applicable both domestically and internationally. The Foundation has committed $10 million to the Fund. The current research focus is on four areas:

   1. **Understanding Multiple Interacting Stressors:** No single factor is responsible for pollinator losses. Pests, pathogens, land use, agrochemicals, nutrition, and environmental changes are just a few of the factors affecting pollinator health. The Foundation is funding studies that take into account these interacting stressors.
   2. **Best Management Practices and Their Application:** Best management practices guide beekeepers, growers and land managers on how to improve the health of pollinators. While there are many sets of best management practices available for pollinators, very few have been scientifically vetted through applied research studies to ascertain which practices are best, under what circumstances, and with what expectation of pollinator/colony survival and productivity. Pollinator projects will be interdisciplinary, accounting for the biological, social and economic dimensions of efforts to improve pollinator health and engage private partners to test practices in real world situations.
   3. **Technology Transfer:** The technology that could improve the health of managed and native pollinators ranges from improved agricultural machinery to novel pest control strategies to selectively bred lines of parasite-resistant bees. The Foundation will fund two lines of inquiry: 1) the promising technological advances that are ready to move from the preliminary research to the at-scale field testing phase and 2) high-risk projects that have minimal preliminary data but potential for great impacts on pollinator health. Projects will involve industry partners with an interest in taking developed technologies to market plus social and economic analyses of adoption potential for the new technology.

4. **Outreach and Education:** Everyone from home gardeners to commercial farmers can improve pollinator health through individual actions. Activities like planting pollinator gardens in urban areas, training future pollinator taxonomists, and coordinating land management activities with beekeeping schedules can impact pollinator health. The Foundation seeks to promote innovative outreach and education projects that reach new demographics and communities to raise awareness around pollinator health and encourage the adoption of activities that promote pollinator health.

FFAR issued a competitive, public call for pre-proposal applications in February 2017 and is currently reviewing final proposals invited in June 2017 from approximately 40 research teams. The portfolio of successful proposals will address pollinator issues across the country's geographic regions and diverse cropping systems, including pollinator-dependent commodities as well as pollinator-independent commodities with impacts on pollinator health. The Fund will devote considerable resources to high-intensity agricultural areas that present major opportunities for improvement of pollinator health.

The Foundation will notify successful grantees and matching partners in late 2017 and expects partners providing matching funds to include community groups, universities, non-profit organizations, conservation groups, and businesses.

FFAR expects to award up to $5 million through this initial program, which is half of the Foundation's commitment to the initiative. FFAR will formulate future Pollinator Health Fund strategies in 2018.

Senate Committee on Agriculture, Nutrition, and Forestry
Agricultural Research: Perspectives on Past and Future Successes for the 2018 Farm Bill
June 15, 2017
Questions for the Record
Mr. Steve Wellman

Senator Debbie Stabenow

1. The witnesses today have all painted a great picture of the importance of research to all sectors of agriculture, however I am concerned that countries like China, India, and Brazil are overtaking the United States in terms of total invest in Ag research. How can farmers and ranchers best communicate the importance of public investment into agricultural research and the need for additional resources?

As individuals and through farmer and rancher associations we can communicate the need for increased funding for public research to policy makers and the media. We can collaborate with Universities to demonstrate positive results and benefits from past research projects. Organizations such as Supporters of Agricultural Research (SoAR) can also be helpful providing information on how public investment in ag research has and can benefit the U.S. agriculture sector and eventually the U.S. consumer.

Over the past year, SoAR has initiated two broader campaigns aimed at communicating clear, easy-to-understand results from research funded by USDA NIFA and the Agriculture and Food Research Initiative (AFRI). This campaign known as 'Retaking the Field' brings farmers and scientists to Capitol Hill and to science reporters in Washington so that they can explain in practical terms the relevancy of agriculture research. From this Retaking the Field series, articles have appeared in the New York Times, the Washington Post and in various media outlets throughout the Midwest.

More can be done especially in terms of how USDA communicates the value of agriculture research. The last AFRI synopsis was published after fiscal year 2015. USDA's information technology and website can be modernized and made more user friendly like some of the other federal research agencies namely those of the NIH which communicate in real-time research awards by Congressional district and the practical outcomes of that research.

2. Mr. Wellman, you list a number of conservation practices on your farm including "contour terraces, no till farming, cover crops and nutrient management such as grid sampling plus variable rate application of nutrients and seed are implemented." Over time, have you noticed that these practices have made your crops more resilient to adverse weather relative to your neighbors? If so, would you support policy that would recognize the reduced risk from these conservation practices through a lower premium or other incentive related to crop insurance?

These conservation practices have been implemented over several decades on our farm. Most of these practices are common place in my area and used by the vast majority of farmers. Over this time, several government cost sharing programs (e.g. cost share for design and building terraces, the Conservation Stewardship Program (CSP)) have been available and used to implement some of these practices. The cost sharing helped get the practices introduced and demonstrate their value to farmers. I believe each practice has helped measurably improve conservation of our resources while increasing our production. A financial incentive for implementing practices such as these definitely speeds up the rate of farmer/rancher adaptation. CSP has been helpful, but due to funding restrictions it hasn't reached nearly as many producers that have expressed interest. A broader based program could be a way to dramatically increase producer participation of implementing beneficial practices. The crop insurance program is such an important risk management tool for producers, I hesitate to involve it with this type of incentive program. We certainly would not want to create obstacles for farmer participation in the crop insurance program.

3. With an aging farmer population, agriculture needs to attract more young people, and our colleges and universities can help do that. Young people can help transform the agricultural industry by applying new technologies and new thinking. What are the greatest challenges for getting students at colleges and universities engaged in agricultural science programs and going into careers in agriculture? What are the greatest gaps in our current agricultural education programs? Can you describe the job prospects for students graduating with degrees in agricultural sciences?

From the standpoint of agricultural research, a concern of mine and one that I have heard expressed by university faculty and leadership is agriculture research is terribly underfunded, meaning grants are small and the length of the grants are short. Because of this, university agriculture deans and ag-related leaders encourage students to look at other scientific arenas which have funding to do their studies. USDA research funding ranks well down the list of prospective research funding after many other federal agencies and even non-government sources. This concerns me because if students are encouraged to look outside of agriculture research to pursue funding for research interests they may never come back to agriculture and will pursue education and careers in fields outside of the agriculture industry.

Connections between industry and college programs need to continue and be funded so these students will want to further their education in agriculture, which will guide them to careers in either ag-related companies or back to the family farm. Family farms continue to benefit from those who go into other ag-related fields and share that information with their family who still operate the farm or when they come back to join the family business.

Agricultural science graduates will have numerous opportunities when looking for full-time employment. The impact of science and research on farming and ranching continues to grow at a fast pace. It seems the discovery and implementation of new

technologies plus advancements in scientific knowledge happened faster each year. Ag businesses, universities, farms and ranches will all need educated employees.

Senator Sherrod Brown

1. Soybeans are one of the most important crops in my state and as you know, when prices are flat, every bushel counts. We have seen significant gains in yields over the past several decades—that is due in part to the research that has been undertaken by ARS. Can you explain to the Committee what USDA funded research has meant to your industry and Ohio farmers?

USDA research has powered several value-added opportunities for soybean farmers across America. Examples include low-linoleic soybeans and soybean oil which improve the nutritional profile of foods, the growing use of biodiesel to fuel professional truck drivers moving 80% of our economy and even the foam now used by large automobile manufacturers is made from soybeans.

Specifically, a recent USDA AFRI grant combined with funding from farmer check off dollars allows a multi-disciplinary team of researchers from 19 universities to develop new diagnostic tools and pathogen control strategies to treat one of the most disruptive pathogens in soybean fields.

It is difficult to determine which public research has benefitted farmers. The following question needs to be asked; Are the results of public research quickly and effectively distributed to those of us in production agriculture? Communication between those conducting the research to the farmers who implement the results of such research needs to be improved. Producers should be invited to participate early on in the research process so the end results are actually practical and applicable to the farmers and ranchers.

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