173rd BIFAD Public Meeting
U.S. Government's Global Food Security Research Strategy: From Upstream Research to Development Impact
Tuesday, September 12, 2017
8:00 am–5:00 pm EDT
National Press Club, 529 14th Street, NW, Washington, DC
Video Accessible at: https://www.youtube.com/watch?v=ArolEzTMkWU&t=5865s (Part 1 of 3)

Welcome and Opening Remarks
BIFAD Chairman Dr. Brady Deaton opened the meeting by welcoming the live and webcast audience to the 173rd BIFAD Public Meeting. The meeting was held at the National Press Club in Washington, DC. There were 162 participants who registered for the live-stream of the event and 174 attended the event in person. Chairman Deaton began by highlighting the dual purpose of the event; the launch of the U.S. Government Global Food Security Research Strategy 2017-2021 and the public meeting of the Board for International Food and Agricultural Development (BIFAD). Chairman Deaton gave an introduction of BIFAD and its role in "providing linkage with land-grant universities," the CGIAR system, NGOs, and the private sector. The Chairman noted discussions with the recently appointed U.S. Agency for International Development (USAID) Administrator, Mark Green and the participation of USAID representatives at the public meeting.

Four BIFAD Board members participated, and they introduced themselves. They included:

- Dr. Pamela Anderson (on the phone), Director General Emeritus of the International Potato Center (CIP), West Palm Beach, Florida
- Dr. Gebisa Ejeta, Distinguished Professor, Department of Agronomy, Purdue University, West Lafayette, Indiana
- Dr. Waded Cruzado, President of Montana State University, Bozeman, Montana
- Mr. James Ash, Food & Agribusiness Group Leader, Husch Blackwell, LLP, Kansas City, Missouri

Chairman Deaton continued the conversation by acknowledging the Board Members who could not attend in person (Dr. Harold L. Martin, Sr., Chancellor, North Carolina A&T State University, Greensboro, North Carolina and Dr. Cary Fowler, Former Executive Director, Global Crop Diversity Trust, Rhinebeck, New York). The Chairman acknowledges the support received from the BIFAD Executive Director, Clara Cohen and from BIFAD Senior Counsel at APLU and Prof. Emeritus of University of Maryland, Mark Varner.

Chairman Deaton framed BIFAD's role as engaging in the process of research deliberation with the university community and USAID. First, helping convene a series of events for the Feed the Future Research Strategy in 2011 and again in 2016. The most recent was to participate in the web-based, public consultation process to revisit the research strategy. Over 400 people participated in the online consultation to provide insight on lessons learned and best practices. As a result, the newly launched strategy emphasizes global food security, reducing poverty among the most disadvantaged (particularly focusing on vulnerable families and women and children) as key targets. Chairman Deaton thanked everyone who participated in the online exchange. He closed the opening remarks by stating this is the most exciting time in higher education with the idealism, activism, and realism of the student bodies across the country through effective collaboration with USAID and other agencies of government that have been involved in that process.

Remarks from Dr. Bartuska, Acting Under Secretary for Research, Education, and Economics and Acting Chief Scientist, U.S. Department of Agriculture.

Dr. Bartuska began by highlighting the contributions from the university community, the federal government, and the private sector in developing the global food security strategy with partnerships being key to its successful implementation. USDA sees a critical priority is addressing the needs of the world of

2050 in terms of both global and domestic challenges. The new research strategy sets the stage for the future. It is based on whole of government research investments. Dr. Bartuska also acknowledged the role APLU has played in terms of Feed the Future as well as more recently in the Challenge of Change initiative as being a critical partner in moving the research enterprise forward.

Dr. Bartuska stressed that it is important to recognize how many global issues also have a domestic connection. She described four specific examples of international investments in wheat that have domestic relevance and complementarity including: 1) working on stem rust (Ug99) to genotype the pathogen at the USDA Cereal Disease Lab and have genetic resistance testing in East Africa, 2) collaboration with Ethiopia on a new wheat rust variant that emerged a few years ago, 3) containing wheat blast identified in Bangladesh, and 4) rapidly mobilizing expertise to address the fall armyworm outbreak in sub-Saharan Africa.

Dr. Bartuska also addressed USDA's investments in livestock research working with partners such as Virginia State University connected to the African Goat Improvement Network. USDA aims to move forward with a balanced portfolio building off successes of Feed the Future to now contribute towards the implementation of the USG's Global Food Security Research Strategy. She added that the most important aspect is the leadership we can provide by working in the U.S. and with other countries to build their local capacity to address these issues. She noted that it is important to recognize that global security is dependent on food security matters. The ability to destabilize and stabilize a country is closely tied to having quality food access and human health. Dr. Bartuska closed her remarks by stating that USDA looks forward to being part of the implementation of the USG's Global Food Security Research Strategy in continued cooperation with USAID and other partners.

Update on Global Food Security Act by Sean Jones

Chairman Deaton introduced Sean Jones, Senior Deputy Assistant Administrator, Bureau for Food Security, USAID. He thanked the participants and the Board Members of BIFAD for their continued leadership in their advisory role to the U.S. government. Mr. Jones also thanked the meeting organizers Tim Dalton and Kira Everhart-Valentin, from Kansas State University (KSU), and APLU. He recognized organizations that helped pull together the U.S. Government's Global Food Security Strategy, which is an interagency effort (including U.S. Department of Agriculture, the National Science Foundation, the National Institutes of Health (NIH), the Department of Energy (DOE), the U.S. Geological Survey, and others) that extends beyond the U.S. government to partners around the world to implement a comprehensive and cohesive approach to international research.

Feed the Future is delivering cost effective results. The Feed the Future approach views country ownership and partnerships as absolutely paramount and fundamental aspects of our work together. As a result of Feed the Future, 9 million more people are living free from poverty, 1.6 million households are free from hunger, and 1.8 million children are free from the devastating effects of stunting in areas where Feed the Future is implemented. Mr. Jones noted that continued progress is more urgent than ever and that there exist persistent pockets of increasing food insecurity.

The U.S. university community has always played an important role in tackling global food security challenges. The Global Food Security Act (GFSA), guided by the associated Global Food Security Strategy, continues to leverage investments in partner countries, the higher education community, and the private sector to reduce reliance on humanitarian aid, promote American prosperity, deliver results, and to build stability. Mr. Jones noted the situation in Yemen, Somalia, South Sudan, and Nigeria and highlighted the need for initiatives to bridge the gap between humanitarian and development action by building resilience.

Food security abroad also brings benefits to the U.S. economy as former aid recipients become trading partners, consumers of American innovation/technology, and development leaders in their own regions. Feed the Future supports policies that open trade in the agriculture sector, reduce corruption, improve the competitiveness of businesses, and increase foreign demand for U.S. products. The investments in research also protects the livelihoods of farmers and researchers in the U.S. from the work of 24 Feed the

Future (FtF) Innovation Labs supported by over 70 U.S. universities. Mr. Jones highlighted the Nelson Mandela Washington Fellowship, the Young African Leaders Initiative (YALI), the Borlaug Fellowship, and the USDA Borlaug Fellowship for developing future leaders and building lasting partnerships abroad.

One year into the implementation of GFSA, FtF is evolving. USAID coordinates 11 FtF partner agencies to implement a whole of government strategy and to incorporate findings from continuous evaluations and consultations. Twelve target counties have been identified: Bangladesh, Ghana, Guatemala, Honduras, Kenya, Mali, Nepal, Niger, Nigeria, Senegal, Uganda, and Ethiopia where U.S. investments have the greatest potential to achieve sustainable results in food security and nutrition. Efforts are currently underway to develop country plans, further incorporate evidence-based approaches, strengthen accountability, and upgrade indicators for performance monitoring. The new research strategy will help improve food security and nutrition in the face of complex and dynamic challenges.

U.S. Government's Global Food Security Research Strategy Overview by Nora Lapitan
Dr. Deaton introduced Dr. Nora Lapitan, Research Division Chief, Office of Agricultural Research and Policy, Bureau for Food Security, USAID. Dr. Lapitan began her presentation by thanking the Chairman, all of the BIFAD Board Members, the interagency partners, and U.S. government funding agencies. She also thanked the Bureau for Food Security, the Global Development Lab, and the team involved in drafting the research strategy.

Dr. Lapitan gave an overview of the global challenges the international community is currently facing. She noted that despite progress in several areas, there are currently 800 million people suffering from chronic hunger, 2 billion people affected by micronutrient deficiency, and 700 million people living in extreme poverty. In addition, she highlighted the challenge of a growing global population with estimates of an increase of 1 billion in 15 years and another 1 billion in 20 additional years totaling 9.7 billion by 2050 (with growth occurring disproportionately in Africa and Asia).

Food production will have to dramatically increase in the face of a changing climate and limited resources including land and water. Research is critical in achieving and sustaining long-term food security in the face of complex, dynamic challenges. Research provides new technologies that can drive productivity gains through transformative changes and breakthrough technologies such as the Green Revolution. Dr. Lapitan noted that the Green Revolution was built upon a long series of incremental scientific achievements. The next Green Revolution will similarly come from incremental advancements in the uses of big data, genomics, and high throughput technologies.

New strains of pathogens are a constant threat to food production and are borderless. Dr. Lapitan highlighted examples of research efforts that have prepared the global community to deal with emerging pests and diseases such as wheat stem rust and wheat blast. She noted how these research developments have mitigated potential significant losses of wheat producers in South Asia and Africa and help protect the US wheat crop valued at 10 billion dollars annually. The Global Food Security Research Strategy has built upon lessons learned from the implementation of FtF. One of the successes of FtF is that from 2011-2016, the strategy helped to develop over 900 innovations with 50,000 more innovations in the pipeline. Dr. Lapitan noted the role of the Global Performance Evaluation Review Team in ensuring a balance between upstream and downstream research while recognizing the need for greater cooperation between research and technology scaling up efforts.

A research and development pipeline has been developed as a centerpiece of the research strategy. The pipeline from basic, applied, to adaptive research involves many actors in the different phases including NSF, DOE, NIH, and USDA for basic research. In the applied research phase of the pipeline, efforts are made to take promising innovations to solve specific problems. Most of USAID investments are in applied research. Adaptive research further tests promising innovations in local regions done by USDA and USAID. Information from one type of research informs other research for other types of investments to connect to technology scaling and development programing. Through the research strategy, there is an emphasis on connecting the three phases of research through feedback loops from downstream activities to upstream research.

Dr. Lapitan provided an example of how greater coordination across US agencies can accelerate innovations and their applications. NSF funded the sequencing of the maize genome in 2009. Two years later, a technology also funded by NSF that made it possible to uncover polymorphisms and DNA variants at low cost applied to a wide range of species. In 2012, USAID funded the International Maize and Wheat Improvement Center (CIMMYT), Purdue University, other partners in Nepal, Bangladesh, India, Pakistan, and private companies (including Pioneer) to develop heat tolerant maize lines. Within three years of the project, the result was the release of improved, high yielding, heat tolerant maize hybrids that outperform the best commercial varieties in the region. These are now disseminated to seed companies and efforts are made to educate farmers of the benefits of the new maize hybrids. This technology has constituted a global public good that have benefitted maize breeding worldwide.

Goals of the U.S. Government's Global Food Security Research Strategy:

- Promote inclusive, sustainable agriculture-led economic growth,
- Build resilience among vulnerable populations, and
- Improve nutritional outcomes (especially for women and children), with a focus on reducing childhood stunting.

Three research themes of the U.S. Government's Global Food Security Research Strategy are:

- Research Theme 1: The development of technologies and practices that advance the productivity frontier to drive income growth, improve diets, and promote natural resource conservation.
- Research Theme 2: Technologies and practices that reduce, manage, and mitigate risk to support resilient, prosperous, well-nourished individuals, households, and communities.
- Research Theme 3: Improved knowledge and how to achieve human outcomes.

Dr. Lapitan closed her presentation by acknowledging the importance of international donors, the private sector, philanthropic organizations as partners critical in implementing the research. She urged the international research community to embrace purpose-driven research and to orient research efforts to support technology scaling as core principles as the Global Food Security Research Strategy. Dr. Lapitan also mentioned how difficult it is to measure and quantify the impact that has been generated from innovations coming from research. She highlighted the need to continue to improve whole of government indicators. She noted that 20 years ago, half of the developing world lived in extreme poverty. By 2015, the number was decreased by half. Since 2011, Feed the Future has lifted 9 million out of poverty and 1.8 million children living free from stunting. The UN Sustainable Development Goals (SDG) Goals are to eliminate hunger and poverty by 2030 and FtF will continue to contribute to those goals. She closed by stating that she hopes in 15 years, the international community will be able to look back and say: "What is now proved, was once only imagined." William Blake.

Question and Comments

- Comment from Dr. Pamela Anderson, BIFAD Board member: Dr. Anderson thanked everyone who participated in writing the strategy and stated that she was most excited about finding ways to accelerate the progress that has been made. She noted that the R&D community is often plagued by subject matter isolation, or 'silos,' and the new research strategy emphasizes integration and accountability. Now integrating productivity with resilience and nutrition. Instead of siloed pillars, the new research strategy aims to integrate them to accelerate the progress that has been made. In terms of accountability and a results framework - we now have a way to measure women's empowerment and indicators for measuring resiliency - the international research community should be held accountable and to learn from progress on these indicators.

- Question from Dr. Gebisa Ejeta, BIFAD Board member: What is the path forward in terms of how to mobilize all of the parties that have been involved and engagement with the other agencies and how can the university community get involved?
    - Response from Nora Lapitan: The next steps involve increased consultation and coordination among US agencies and their respective partners (who often have different stakeholders and priorities). The next steps also involve taking advantage of existing

inter-agency working groups, identifying opportunities to better coordinate of existing investments, and sharing information in monitoring and evaluation approaches to understand and communicate long-term food security impacts of research.

- Questions from the audience: An unidentified audience member asked about actual dissemination, how to get the research out to the last mile? How are the existing and emerging Feed the Future innovations going to reach the farmers who need them? Chairman Deaton commented that this is an issue that BIFAD and USAID staff have discussed and recognize as a priority. He highlighted the need for regional workshops, conferences, and an emphasis on knowledge sharing to achieve dissemination of the research innovations. Another question from an unidentified audience member included: What are some of the potentially disruptive issues that were discussed during the consultation process that were not included in the final strategy?

- Question from Julie Howard, Michigan State University, and former scientist with USAID BFS: Dr. Howard congratulated the team on the evolution of FtF and asked about technology scaling. How does the research strategy envision that as both a challenge and opportunity for better coordination within BFS and other parts of the agency?

- A question was submitted via the Internet from Lee Vought at Tufts University: Does food security mean 'farm to mouth' or 'farm to growth?'

- Comment from Rob Bertram: Dr. Bertram, Chief Scientist in USAID's Bureau for Food Security, highlighted three aspects of the new research strategy and priorities of moving into second phase of FtF: 1) The need to look to innovation and research processes for the latest and most relevant technologies to increase the upside potential and decrease risk to help drive investment at all levels, 2) Seed systems are going to be a priority moving forward as a conduit for improved genetic to reach farmers, and 3) Working with partners on access to better information that enables farmer choices and decision-making through digital technologies to bridge the gap between innovation and uptake.

Panel Discussion: Cutting Edge Science for Development
Chairman Deaton introduced Tim Dalton, Director of FtF Innovation Lab for Sorghum and Millet who led the panel discussion. Panel members included Jesse Poland, Director, Applied Wheat Genomics Innovation Lab, Kansas State University, Doug Cook, Director, Climate Resilient Chickpeas Innovation Lab, University of California, Davis, and Susan Lamont, Charles F. Curtiss Distinguished Professor of Agriculture and Life Sciences and Professor of Animal Science, Iowa State University and partner, Genomics to Improve Poultry Innovation Lab, Iowa State University. Tim Dalton opened the panel discussion by highlighting USAID's role in investing in strategic, upstream research to secure future advances in food production. He noted that USAID has shown great leadership in this area and has also invested in an important portfolio diversification strategy. Dr. Dalton highlighted that these investments will lead to a stream of outputs to solve complex problems into the future.

Jesse Poland, Director, Applied Wheat Genomics Innovation Lab, Kansas State University presented on Leveraging 'Big Data' for Wheat Improvement in Kansas and Around the World. He commented on current efforts to accelerate the breeding process and emphasized ongoing work with CIMMYT's wheat breeding program. He continued by giving an overview of the current state of wheat production. Wheat demand is expected to increase by 60% by 2050. With current varieties and management practices, wheat production and projected average yields will decrease 20% due to the impact of climate change. A 2% increase per year is needed to meet projected demands. Current gains have amounted to about a 1% per year.

Emerging diseases and nutrient scarcity are reducing protection, which can be increased through improved agronomic practices and breeding for new varieties. The breeding process is measured in genetic gains measured by year on year progress. This is a long process that takes 8-10/12 years in a breeding program to complete one cycle. The evaluation process for disease resistance, yield, and other

qualities requires the testing of 10s of thousands of candidates. To make the process faster and more efficient, the Innovation Lab is using prediction models using information from sites in North India, Pakistan, the middle of the US, and major wheat growing regions. Prediction models build off of billions of data points, wind speeds, sea temperatures, mathematical equations of physical process, and algorithms modeling to simulate possible outcomes. Prediction models are used to simulate yield and quality and use algorithms to calculate all of the genetic effects. Through the models, breeders are able to use well-established mathematical calculations of genetic effects to develop prediction models early on in the breeding process. As a result, scientists are now able to predict yield, quality, and disease resistance so that by the second year of the breeding process, they are able to fast-track the selection process.

The Innovation Lab's work is driven by big data using climate models from satellites and weather stations. The big data that is coming is the high throughput phenotyping and weather modelling that can be incorporated into crop prediction models. Current challenge in modeling is the need for increased human capacity in the field of computational biology. The infrastructure required to handle, store, and share big data and the human capital to manage those types of datasets are challenges. In developing world, there is a need to invest in capacity development in these areas to realize the value of predictive models.

Building prediction models can improve breeding programs in South Asia in the same way we do in the center of the United States. The different funding agencies that have really complemented each other in the work in this area include: the National Institute of Food and Agriculture (NIFA), the Kansas Wheat Commission, the Kansas Association of Wheat Growers, the Bill & Gates Foundation, and USAID. He also highlighted the work investments of NSF in sequencing the wheat genome and supporting the basic, enabling tools that have made this work possible.

Doug Cook, Director, Climate Resilient Chickpeas Innovation Lab, University of California, Davis. Approximately 20% of the world's population depends on chickpeas as their primary protein source. The Chickpea Innovation Lab's fundamental research upstream has been funded by NSF. Dr. Cook emphasized the role of "connected science" in bridging the gap between upstream research, applied science, outcomes, and value chains research. Connected science is more pragmatic and although it has components of "blue sky" research, it is more focused on directing the course of the research to outcomes in a way that is more similar to industry than what usually happens in academics. The idea of connected science is reflected in Global Food Security Research Strategy where there is an emphasis on leveraging the capacity and ingenuity of U.S. scientific community to bear on the challenges of global food security.

Chickpea is the world's second most important grain legume (excludes oilseed crops such as soybean and peanut). Chickpeas are a significant source of nitrogen protein for about 20% of world's population and is critical to food security in much of the developing world. Chickpeas enter into symbiosis with bacterium in the soil enabling the process of nitrogen fixation. Although chickpea is very important, it is a crop that has been under-invested in by the donor community resulting in stagnant yields and susceptibility to pathogens, abiotic stresses, insects, and microorganisms. Currently the productivity in the two largest consumers of chickpeas, India and Pakistan, is 25-50% lower compared to elsewhere in the world.

The Innovation Lab focuses on increasing the amount of diversity available for breeding in chickpea. The vast majority of the genetic and phenotypic diversity is left in wild varieties. Through NSF and Australian government funding, the Innovation Lab worked with Turkish partners and made the world's largest collection of wild progenitor species and the microbes (particularly important for nitrogen fixation). The result has been a 100-fold increase in available genetic diversity. Some of these traits include response to declining soil moisture, atmospheric drought, pest resistance, heat tolerance, and resistance to pathogens (i.e. fusarium wilt). The Innovation Lab is working to develop molecular tools to move these traits into crops and into farmers' fields. The long-term goal is to impact chickpea breeding for the next century.

Dr. Cook acknowledged partnerships and core funding for the program from USAID and other agencies including NSF (partly through USAID/NSF Partnerships for Enhanced Engagement in Research (PEER), national governments (Norway, Canada, Australia) including 6 million AUD from the Australian government, the CGIAR, the Global Crop Diversity Trust, and historical funding from the Bill & Melinda Gates Foundation (BMGF), private foundations including the Tata Foundation, and industry partners such as Mars and Nestle. The Innovation Lab works with partners in 9 countries, 25 partner institutions, and 27 partner laboratories.

Dr. Cook provided a case study involving the work with partners spanning from basic research to value chains in nitrogen fixation. Efforts were made to harness the microbes with funding from the NSF and sequenced 1,600 genomes of symbiotic microbes. A much higher range of genetic diversity was documented with over 20 species that fix nitrogen with chickpeas and are highly diverse organisms. How can this diversity be used to improve agricultural outcomes and can we improve inoculants through the use of better microbes? The focus is to now move to scaling new microbes in 200 mil package to treat 40 kg of seed and to conduct field level evaluation of the microbes to meet the needs of national agricultural programs.

Susan Lamont, Charles F. Curtiss Distinguished Professor of Agriculture and Life Sciences and Professor of Animal Science, Iowa State University and partner, Genomics to Improve Poultry Innovation Lab, Iowa State University. Her presentation was entitled "Animal Genomics to Enhance Food Security in Africa". Dr. Lamont began by introducing the Innovation Lab's focus on enhancing resistance to Newcastle disease virus and to heat-stress in chickens. The Innovation Lab leads a four-phase project that includes: 1) high-throughput genomic technologies to identify the genes (or genomic regions) that are associated with resistance, 2) development of an economic diagnostic kit that can be used for genetic selection on the African continent, 3) the validation of the kit, and 4) the development and distribution of a sustainable chicken breeding plan.

Dr. Lamont highlighted the benefits of improving animal production (particularly poultry) in Africa due to the portability of small livestock, the concentrated source of protein and nutrients they provide, the small amount of space required to rear poultry, the rapid regeneration interval, the accessibility and availability of the product in parts of the world without refrigeration, wide cultural acceptability, and women's empowerment. In terms of nutrition, eggs and chicken meat provide essential nutrients especially during the first 1,000 days affecting cognitive development. Poultry are a highly valuable trading commodity and often act as "living bank accounts" in periods of financial instability. Newcastle disease virus remains the number one disease constraint to breeding poultry in Africa. Within one week, Newcastle disease virus, can devastate 80% of a flock as it is highly contagious that can travel hundreds of miles. Some vaccines exist; however, in most developing countries, there is not the cold chain and proper storage capacity to enable the conditions required to distribute it.

A genomics approach to poultry research can improve animal health and production through not only sustainable improvements, but also reduced antibiotics use. The chicken was the first of all farm animals to have its genome sequenced in 2004. Local ecotypes have developed adaptations such as predator evasion, cultural preferences for taste and physical appearance, heat tolerance, and disease resistance that are not typically bred for in US commercial varieties.

Disease resistance in animals is controlled by many genes working together. The Innovation Lab identifies genetic selection criteria by studying Newcastle disease virus infected birds, taking periodic samples to identify the most resistant types of birds, and evaluating the genetic variation in order to associate the natural disease resistance variants to delivered improved response to the Newcastle disease virus. The Innovation Lab analyzes 500,000 genetic variants in each of the birds and works to mine the biological information to understand the genetic controls and systems for conveying disease resistance to the Newcastle disease virus. The goal is to develop more resistant birds - both for the US and for the global market.

Dr. Lamont continued by recognizing the role of several partners and donors including the USDA-NIFA Climate Change project, USDA, Hyline (through hundreds of thousands of dollars of in-kind contributions), and collaboration with the University of Cambridge to take a deeper dive on resistance to Newcastle Disease. Expected impact from the Innovation Lab includes tools for big data decision-making using existing biodiversity to improve disease resistance, human resources development in genomic and animal improvement, delivering enhanced poultry populations provided to small-holder producers, and improving poultry health and food security. Dr. Lamont also recognized the contributions of academic institutions including the University of California, Davis, Iowa State University, University of Delaware, Sokoine University of Agriculture and University of Ghana.

Questions and Comments

- Question from Pamela Anderson: For public sector breeding, what would be the most beneficial aspects from the private sector to pull from the private sector into our breeding efforts?
    - Response from Doug Cook: There are some areas where private sector won't be involved in and crops that don't have the monetization that generates incentive. In these areas, there is a decreased likelihood of having private sector partners. A challenge that exists is strengthening national breeding programs as a parallel to the development of the private sector for a number of crops.
    - Response from Susan Lamont: One of the things that make poultry attractive to this approach is that they are very scalable. Further, there are already companies in place that are interested in working with researchers. In the developing world, the scale and structure is different. There is a need to work at a level and scale that is appropriate in developing countries given the constraints of smallholder farmers.
    - Response from Jesse Poland: The US universities have big datasets but the private sector has access to even larger datasets in some species. There are valuable opportunities to train students and the next generation of scientists through collaboration with the private sector.

- Questions from unidentified members of the audience: Are there constraints at US universities for using big data for agricultural research that we should be aware of? Any thoughts on acceptability of genetically modified animals or crops in the developing world, how that is being addressed, and/or how that will have to be addressed in the future?
    - Response from Susan Lamont: For the Feed the Innovation Lab for Genomics to Improve Poultry, there is an emphasis on using genomic technology to identify what already exists in local populations and to use it to help to improve upon what is already there, not using genetically modified organisms.
    - Response from Doug Cook: For the Chickpea Innovation Lab, the emphasis is on pursuing opportunities as they are found, even if they might lead to a solution using transgenics. Several of the traits from the Innovation Lab potentially have transgenic outcomes.
    - Response from Jesse Poland: Regarding the Applied Wheat Genomics Innovation Lab more of the focus on optimizing traditional breeding process and would be considered outside of the sphere of transgenics.

- Comments from members of the online audience: Unidentified online audience members submitted the following comments: 1) the incredible importance of big data on improving wheat varieties, 2) a comment was made on the NSF PEER program influence and importance and 3) how healthy chickens improve women's empowerment is often overlooked.

Video Accessible at: https://www.youtube.com/watch?v=OTeIoi3a5jo (Part 2 of 3)

Panel Discussion: Practical Applications of Research Results

The panel discussion was moderated by Dr. Betty Bugusu, Director for Food Processing and Post-Harvest Handling Innovation Lab at Purdue University. The panel included Dr. Elizabeth Mitcham, Director, Horticulture Innovation Lab, University of California-Davis, Dr. Cynthia Donovan, Deputy

Director, Legume Innovation Lab, Michigan State University, and Dr. Karen Brooks, Director, CGIAR Program on Policies, Institutions, and Markets, International Food Policy Research Institute (IFPRI). Betty Bugusu began the session by introducing the Feed the Future Food Processing and Post-Harvest Handling Innovation Lab. The Innovation Lab concentrates on four key areas: developing technologies in dry storage, food processing, nutrition, and both upstream work and adaptive research. The Lab focuses on bringing technologies to scale and to the end users. Dr. Bugusu also noted how extremely important partnerships are in this part of the research continuum.

Elizabeth Mitcham, Director, Feed the Future Horticulture Innovation Lab, University of California, Davis. Dr. Mitcham presented "Lessons Learned from Scaling of Technologies". The Horticulture Innovation Lab works across the spectrum from seed systems to postharvest handling and marketing. From the beginning of the program in 2009, there has been an emphasis on addressing and reducing postharvest losses as well as innovative technologies. The Innovation Lab works with regional centers, with the private sector to develop entrepreneurship, and with marketing and communications of agricultural products. Dr. Mitcham then presented three examples of technologies from the Innovation Lab that focus on: 1) the drying bead technology, 2) the Dry Card Moisture Sensor and 3) the chimney solar drier.

The drying bead technology manufactured by Rhino Research originated with Dr. Kent Bradford at UC Davis to develop research to maintain the quality seeds after harvest. The drying bead technology uses a ceramic bead to absorb moisture, similar to silica gel but much more efficient. It works well with seeds and the Innovation Lab is looking at other potential applications for the technology. The drying beads have shown to have benefits in terms of food safety and the reduction of aflatoxins during food storage. In terms of lessons learned from scaling the technology, smallholder farmers had no interest in using the technology. Seed is paid for based on weight and if the product is dried efficiency, this results in lower incomes for farmers. The target audience was shifted to seed companies. The Innovation Lab is now working with companies in Bangladesh. The ultimate beneficiary will be smallholder farmers because they will be able to purchase better quality products. Funding is being sourced from Winrock International, the Feed the Future Asia Innovative Farmers Activity (AIFA) for distributors in Cambodia and later in Bangladesh.

The DryCard Moisture Sensor is based on a simple technology embedded with cobalt chloride that changes color with relative humidity. The card is reusable and alerts the user when the product is dry enough for storage to prevent the growth of mold. The card costs $0.10 USD to produce and the product received a technology award at the All-Africa technology conference last spring. The Innovation Lab is now working to Identify partners in the developing world who can distribute and make available in local languages.

The chimney solar drier concept is an improvement on typical the solar driver. The chimney causes the airflow to be much faster. The chimney solar drier is still able to work in cloudy conditions and costs $60 USD to build. In Bangladesh, it costs $100 USD to produce. There is interest and acceptance of the technology; however, there is a now a need for a simple yet detailed manual to assist in the construction process. The Innovation Lab also is developing a video to instruct others how to construct and use the chimney.

Cynthia Donovan, Deputy Director, Feed the Future Legume Innovation Lab, Michigan State University. Dr. Donovan began by discussing the MasFrijol project, an integrated nutrition and productivity initiative in Guatemala. The project is the result of both upstream and adaptive research designed to feed into Guatemala mission's FtF strategy. The project worked with local partners and national research institutes in Guatemala supported by the USAID Guatemala mission. The result was the creation of a knowledge base that could be taken out to farmers through agriculture extension training and nutritionist training to achieve increased productivity and productivity. 25,000 households are engaged in getting improved varieties through the project. Innovative tools were used for communications were used for to target increased dietary diversity. The project targeted Guatemala's critical problem with stunting and incorporated communication strategies informing households of how beans can be incorporated into weaning foods and how dietary diversity can help prevent problems with stunting.

The Innovation Lab is also involved in integrated pest management work in West Africa based on cowpeas, a critical income and food security crop in the region. Biocontrol agents not readily available and 87% of farm households were using synthetic pesticides in Benin, which are dangerous when applied without protective clothing. The region is affected by 80% of losses due to pod-sucking insects if no pesticides are used. The Innovation Lab is developing an innovative package (SAWBO) involving the private sector engagement on the work on biopesticides and biocontrol agents. The key to the approach has been education and training of the farmers. The synthetic pesticides kill wasps, which also act as biocontrol agents.

The third example of the work of the Innovation Lab is a tool to measure photosynthesis that is driven by big data. The cost of the PhotosynQ Platform is 600 USD and measures not only photosynthesis, but also the metadata required to interpret the results. The tool is now being used throughout the US, Africa, and in Asia. The development of the tool was funded by the Bill & Melinda Gates Foundation, the Department of Energy, and the USDA.

Karen Brooks, Director, CGIAR Research Program on Policies, Institutions, and Markets, International Food Policy Research Institute (IFPRI). Dr. Brooks began by introducing the importance of the practical applications of policy-oriented research and gave an overview four research projects from the PIM portfolio. PIM uses four channels of influence including: 1) contributing to the global agenda setting, 2) helping agents and policy processes understand what the different choices are at the national and sub-national level, 3) work on the design of programs, and 4) work on capacity development.

The Government of Rwanda is developing their Fourth Strategic Plan for Agricultural Transformation for 2018-2022. IFPRI is working with the Government of Rwanda on quantitative models such as the social accounting matrix: a CGE model to look at models and sub-sector growth and the generation of jobs. The result of the work is the identification of a subset of Rwanda farm households with large-holdings that could be diversified, move into higher value products, and move into the export market. There is another large portion of households with very small holdings that require social protection. The models also show the importance of informal economy for generating jobs and opportunities for improvement.

In Ghana, the question that the government faces concerns issues of mechanization and increases in farm size. Governments are deciding whether or not to invest in tractors. IFPRI is advising governments not to become involved with the direct provisioning of machines/services, but rather to provide regular updates on the demand, facilitate exchange with other countries for trade opportunities, check import duties for spare parts, and fix the roads. These interventions have been proven to be more important than directly providing machines.

IFPRI is also involved in research on social protection focusing on Ethiopia's social safety net programs. Since 2006, IFPRI has been involved in conducting impact assessments by working with the Productive Safety Net Programme (PSNP) every two years. The assessments examine the level of transfers, wages, criteria for graduation, issues of timeliness of payments, and the impact of the program on childhood nutrition. The research findings demonstrated that although household nutrition improved, children nutrition and stunting rates did not. They found that messaging on child feeding needed to be embedded to improve child feeding practices (IYCF) and nutrition.

The final example was weather index-based insurance in India. The research found that the correlation between the assessed loss and actual loss incurred by farmers was not very accurate. IFPRI has been looking into alternative ways to assess the actual loss in the farmers' fields through the use of smartphones and working with farmers to take regular photos to determine loss. In the pilots, the correlation between loss and insurance payout has been higher with the picture-based insurance rather than the weather index-based programs. Now working with private sector to design products around this approach.

Questions and Comments

- Question from James Ash, BIFAD Board Member: Interested in seeing the synergies and impact between the Feed the Future Innovation Labs. How your work has affected the other Innovation Labs?
    - Response from Cynthia Donovan: We have been working with a lot of universities. Often leveraging resources and funding to ensure continued investments for US industry as well as the development work. These meetings and the ability to present some of the work and results of the Innovation Labs is important for sharing information and technology exchange between the Labs.
    - Response from Elizabeth Mitcham: We have a number of collaboration with other Innovation Labs including the Nutrition Innovation Lab funded by USAID and BFS. We installed and introduced the chimney drying and cool room storage. The Nutrition Innovation Lab in Bangladesh is looking at how they are making fruits, vegetables, and fish available at various times of the year by improving their quality and storage.

- Question from Pamela Anderson, BIFAD Board member: There has been some tension between US universities and the CGIAR system. Do you see this improving? The collaboration between the innovation labs and the CRPs and CGIAR programs. What can we be doing to make that integration better?
    - Response from Cynthia Donovan: We do have who are on the CRP design panels and were doing more to integrate work and activities with IITA and other CGIAR centers. The Legume Scholars Program has CGIAR scholars and researchers on the panel. Funding uncertainties undermine efforts for further collaboration.

- Questions/comments from unidentified members of the audience: The federal agencies that have over 100 million USD in research funding are obligated to spend 3% of that budget on Small Business Innovation Research (SBIR). Initially SBIR was set up for domestic funding but it could also work for international initiatives. USAID might want to consider looking at that program in terms of lessons learned for scaling and leveraging resources to make it active internationally.

Dr. Bugusu closed the session and reiterated the importance of partnerships and engagement. Purdue University is planning a scale-up conference in Sept 2018 to highlight best practices and lessons learned.

Applying Research to Emerging Threats

Dr. Rob Bertram, Chief Scientist, USAID's Bureau for Food Security, moderated and introduced the panel (en lieu of Pamela Anderson who was unable to travel due to weather conditions). Panel participants included Dr. B.M. Prasanna, Director, Global Maize Program, International Maize and Wheat Improvement Center (CIMMYT) and Dr. Barbara Valent, Distinguished Professor, Department of Plant Pathology, Kansas State University. Research equips us to be prepared for emerging diseases and risks. Dr. Bertram was provided with a statement from Pamela Anderson to open the panel discussion. People tend not to think about diseases that do not affect us directly. There are threats that emerge unexpectedly that can lead to catastrophic consequences for people that can change the course of history. Challenges of the work in these emerging areas include: identification of new threats, the emergence of known threats in a new area where the drivers and dynamics are not well-understood, lack of human and physical assets for preparedness, and a lack of finances to study and manage the threat.

B.M. Prasanna, Director of the CIMMYT Global Maize Program: Dr. Prasanna presented CIMMYT's work on drought and heat tolerant maize in the tropics and tackling the fall armyworm crisis in Africa. Maize is a major crop in the tropics that provides food and income to several million people. Out of 300 million metric tons, 90 million hectares are in the tropics. Maize feeds 200 million people in sub-Saharan Africa and is planted on 36 million hectares. Of the 22 countries with the highest maize consumption, 16 countries are in Africa. Yields in sub-Saharan Africa are very low at 1.8 t/h compared to worldwide averages of 5 t/ha, largely due to climate variability. Drought is a recurring theme in sub-Saharan Africa and the El Nino episode has rendered nearly 16 million food insecure in sub-Saharan Africa.

Breeding for drought tolerance has been ongoing for the past four decades at CIMMYT through extensive partnerships and stress phenotyping testing. CIMMYT has contributed to the development of more than 230 elite drought tolerant and elite disease resistant maize varieties (70% are hybrids). Southern and East Africa are moving towards hybrids while in West Africa, there is a lot of work to be done as more than 90% of maize area is open-pollinated varieties (OPVs). USAID and the Bill & Melinda Gates Foundation have invested strongly over the last ten years for drought tolerant maize. The estimated economic value of the increased maize production due to drought-tolerant varieties ranges from $162 million USD up to $328 million USD over the available commercial trends for each year, representing an incredible return on investment. The yield gap between popular, commercial varieties and heat and drought tolerant varieties is 3-4 t/ha. In some cases, CIMMYT hybrids yield almost double than most popular varieties (e.g. SC513). 30-40 year old varieties still grown in sub-Saharan Africa. In developed countries, varieties are typically grown for only 5-7 years before varietal replacement.

Efforts are now underway to map demo plots to farmer locations so that the demonstrations may reach women farmers with improved agricultural technologies more effectively. The mainstreaming of gender in maize seed value chains is also being pursued. The seed systems work aims to develop gender responsive to strengthen capacities of women farmers and to determine how new maize varieties can be developed and deployed throughout vast areas of production.

In South and Southeast Asia, maize growing areas are increasingly experiencing heat stress with an 11-15 million hectares of maize undergoing production declines. CIMMYT has responded by creating Heat Stress Tolerant Maize for Asia (HTMA) for dissemination in Faisalabad in Pakistan and Hyderabad in India. The project is made possible through partnerships between CIMMYT, Purdue University, Pioneer, national seed companies, and the national agricultural research system (NARS). U.S. agriculture benefits from these initiatives through the training of U.S. graduate students.

Fall armyworm is well-known in US and Brazil; however, it is a new and major threat in Africa. The initial infestation spread from 1-2 countries and is now known in 30 countries as of May 2017. The fall armyworm is a powerful migrator and is also fast-breeding. This results in significant damage to the maize crop equivalent to an estimated economic loss of $3 billion to $13 billion USD for 2017-2018. In April 2017, the Alliance for a Green Revolution in Africa (AGRA) and the Food and Agriculture Organization (FAO) convened a stakeholders meeting to formulate an action plan to tackle the fall armyworm challenge. Today, there is a need for a strong association with US universities and EMBRAPA for lessons learned that can be tailored to African conditions. A comprehensive strategy is needed that includes monitoring and surveillance, the use of biological controls, transgenic resistance, and cropping systems. CIMMYT's fall armyworm work i funded by USAID, the Bill & Melinda Gates Foundation, and the Department for International Development (DFID).

Barbara Valent, Distinguished Professor, Department of Plant Pathology, Kansas State University. Dr. Valent is an expert on rice blast disease that is now starting to attack wheat. Wheat blast was first seen in Brazil in 1935. Rice blast is the most serious disease of rice. Wheat blast started 30 years ago with a short history, but the disease had extreme intensity. With support from USDA NIFA, Dr. Valent started working on wheat blast nine years ago. The project began in January 2009 in close partnership with scientists with the USDA Agricultural Research Service (ARS). The project also benefited from close partnerships with South American institutions, EMBRAPA, a wheat growers collaborative in Bolivia, and Capeco, a wheat growers association in Paraguay. A second grant was received for 2013-2017. The project continued to work with the original collaborators and expanded to other partners including the Kansas Wheat Commission and universities (the Ohio State University, University of Kentucky), and private sector companies such as Heartland Plant Innovations (owned by Kansas Wheat) and BioTrigo, a Brazilian wheat growing company. As the disease moved to Bangladesh in 2016, the project began collaborating with CIMMYT.

For the US, there two potential routes for infection: 1) wheat strains from South America (wheat blast is a seed borne fungus) and a different population of the fungus identified that affects turf grass. These are the most closely related strains to the wheat population in South America. Turf grass strains in the US

has potential to infect wheat in the US and cause serious problems. Wheat blast is difficult to contain. Head blast is the major symptom of wheat blast; one spore can kill the entire wheat head. Under many environments, resistance plus fungicides don't work. Wheat blast has potential enormous impact on grain trade. The fungal spores are seed borne, and if it occurs early, no seed is produced. If the infection occurs late, the seed becomes infected, and you won't see it. Movement of grain shipments can transport the disease.

Wheat blast also has a huge potential to surprise the US. In August 2009, it destroyed 30% of the wheat harvest in Brazil. Wheat heads emerged that were already infected by the disease. In Bangladesh in February 2016, unusually warm, rainy conditions resulted in wheat blast that affected 15% of total wheat area in Bangladesh. Wheat blast can have up to 100% losses in affected fields. Following blast-like symptoms in India, a rapid response was mobilized working with CIMMYT and the Bangladesh Agricultural Research Institute (BARI) used genomics to identify the fungus as one of the most aggressive strains from South America.

In the US, the wheat blast resistance screening is happening at only two labs with biological safety level (BSL) 3: Kansas State University and the USDA ARS Foreign Disease-weed Science Research Unit in Frederick, MD. A collaboration with a growers group in Bolivia was established to understand wheat blast in its native environment and to executive two field tests per year.

Accomplishments of the Blast Integrated Project (BIP):

- Most of the US and S. America germplasm is susceptible. There is little to no resistance. The project, scientists have located resistance translocation fragment that gives partial control.
- Resistant varieties from S. America have been identified, and the gene that is responsible for resistance has been identified.
- There is a recognized need to go to wild wheats to find more sources of resistance.

Early fungicide treatments can help but training and disease surveillance are critical. Climate suitability and disease forecasting studies can also prevent losses. More of us need to work together to find more resistance and understand the disease better at look at sources of resistance in wild varieties. Due to wheat blast, Brazil has stopped growing wheat in the El Dorado region. Some areas in Bolivia have been taken out of production. Production in Bolivia was reduced from 62,000 (62,763) in 2016 to 14,000 (14,238) in 2017. Wheat is a 10 million USD business in the U.S. 40% of U.S. wheat area is at risk with ½ of U.S. soft red winter wheat (grown in the southeastern United States) at risk. Funding for the BIP came from USDA NIFA.

Questions and Comments

- Comment from Pamela Anderson, BIFAD Board member: There is a need to look at opportunities to invest in improved diagnostics and international partnerships. There is a lack of investment in epidemiology. There is a need for global diagnostic and surveillance networks, something critical for the international community to address in terms of how to make diagnostic tools more useful in real-time.

- Comments from Gebisa Ejeta, BIFAD Board member: Sometimes in developing economies, emerging threats can have discouraging effect on investing in research.
    - Response from B.M. Prasanna: We have learned a lot from tacking maize lethal necrosis (MLN). It is complex as it is a combination of two viruses and it is not only spread by insect vectors but also through contaminated seed. It affected our operations and we could not send germplasm from Kenya - which is an endemic country - with our Southern Africa partners or even with CIMMYT because of the possibility of disease being spread through research. Through the germplasm base, we conquered this challenge through the release of 9 hybrids with MLN resistance in Kenya, Uganda, Tanzania, and Uganda with 17 more in the pipeline which could potentially replace obsolete varieties. We also stopped the migration of MLN from Eastern Africa to Southern and West Africa by creating a community of practice. We really need to strengthen the global surveillance

capacities. The transboundary threats and increased trade will escalate the problem significantly and we need strong regional and local capacities.

- Comments from unidentified members of the audience: An important but more subtle impact of disease on agricultural production is that it removes farmers from the system. The decline in production causes farmers to switch crops once they experience loss. Also a need for increased investment in discovery and curation of wild crop relatives.
    - Response from Rob Bertram: This is an area for intensive collaboration between U.S. universities, the CGIAR centers, and national research partners to access and screen the germplasm in more environments where things we haven't experienced yet and do not know could still be there.

Video Accessible at: https://www.youtube.com/watch?v=xJHSY_v28_w **(Part 3 of 3)**

Panel Discussion: Federal and State Investments in Agricultural Research
Dr. Deaton welcomed the participants to the afternoon session and introduced the start of the panel. The session was moderated by Dr. Gebisa Ejeta. The panelists included Dr. Rob Bertram, Chief Scientist, USAID's Bureau for Food Security, Dr. Diane Okamuro, Science Advisor, Office of International Science and Engineering, National Science Foundation, Dr. Catherine Ronning, Program Manager, Biological Systems Science Division, Office of Biological and Environmental Research, U.S. Department of Energy, and Dr. John Floros, Dean of Agriculture, Research and Extension, Kansas State University. Dr. Ejeta opened the panel by acknowledging the US federal agencies and the various actors contributing to synergies and partnerships in agricultural research as being well-represented at the meeting and he thanked them for their participation. The food security agenda has the capacity to concentrate investments and maximize synergies.

John Floros, Dean of Agriculture, Research and Extension, Kansas State University. Dr. Floros began by addressing why Kansas State University (KSU) has been interested in competing for Feed the Future Innovation Labs and what are some of the benefits as an institution and to the U.S. as a country. Kansas is the number one wheat producing state, number one sorghum producing state, the number three in terms of the production of livestock, combined with some very extreme issues with water scarcity. KSU also has a history of doing systems work to maximize outputs through sustainable intensification. KSU leverage areas of its expertise and past performance to compete for five of the Innovation Labs and was successful in being selected for four out of the five. KSU currently has the wheat genomics, sorghum and millet, postharvest loss reduction, and sustainable intensification. The four labs partner with 24 other US university and 24 foreign universities, 47 private sector partners, 10 US NGOs, 8 other Innovation Labs, and 49 other international organizations.

Through the Sorghum Innovation Lab, researchers have estimated that the improved quality of new sorghum varieties has resulted in $360 million USD additional earnings to the sorghum industry producers in the U.S. The fact that KSU has four Innovation Labs, the university has been able to hire better quality staff and improve the university's reputation in the areas of agriculture and food. PepsiCo is now investing in KSU to produce sorghum based products for the American market that would not have happened if didn't have the international work and partnerships. A private donor is giving $8-10 million USD in land and funds to produce a research farm for the sustainability work led by KSU as a result of the combination of expertise in sustainable intensification and the Innovation Lab.

Aflatoxin is a huge issue in the U.S. The U.S. corn industry incurs between $50 million USD to $1.7 billion USD of losses annually because of aflatoxins. The losses are more significant under optimal conditions. Research in India allows KSU to pursue the research under optimal weather conditions in the field, which will ultimately help U.S. farmers and consumers. Another benefit that has come to KSU has come due to the long history of working on food safety research and international agriculture, a new biosafety level 4 facility is now being built. It will be the only level 4 facility in the U.S. and will be built in Manhattan, Kansas.

Diane Okamuro, Science Advisor, Office of International Science and Engineering, National Science Foundation. NSF supports fundamental research in all sciences and engineering. NSF provides funding for projects that focus on plants and plant processes, data tools and resources, and the training of emerging scientists. NSF's most relevant contributions would be most relevant in addressing research thematic areas 1 and 2. Research Area 1: Investing in technologies and practices that advance the productivity frontier to drive economic growth and Research Area 2: Technologies and practices that reduce, manage, and mitigate risks to support resilience, prosperous, well-nourished individuals, households, and communities.

With its focus on basic research, this allows the NSF to fund projects that are both risky but with a high potential of return on investment and impact. An example of this ability to fund innovative and risky projects was leveraged into a joint program between NSF and the Bill & Melinda Gates Foundation to support the Basic Research to Enable Agricultural Development (BREAD) program with an initial investment of $24 million USD over five years. BREAD was able to support research to address key constraints faced by smallholder farmers in the developing world. The aim of BREAD was to support novel, transformative, basic research at proof of concept stage (rather than its application or development). Over five years, five competitions were held for various funding opportunities such as full proposal competitions, prizes, and early concept grants for exploratory research (ECERs). In the first three competitions, BREAD provided support for 24, three-year projects totaling over three million USD covering topics ranging from vaccines for livestock, pest management, adaptation to environment/drought, haploid lines for breeding, support for the development of low-cost genotyping, and soil management. Successful projects were leveraged and funded by USAID and the Gates Foundation.

The National Plant Genome Initiative (NPGI) established in 1998 by an act of Congress to understand the structure and function of genes of plants. The guiding principles of the NPGI are: 1) the long-term program governed by 5 year plans generated with community input, 2) all resources (including data, germplasm, and software) are openly accessible to all and 3) the federal efforts should be coordinated by an interagency working group - the Interagency Working Group (IWG) on Plant Genomics consisting of representatives from the NSF, DOE, USAID, USDA, NIFA, ARS, Forest Service, NIH, and the Smithsonian Institute. The accomplishments of NPGI include: capacity building, community building, toolkits, databases, education and outreach, and fostering international collaboration and PPPs.

Catherine Ronning, Program Manager Biological Systems Science Division, Office of Biological and Environmental Research, U.S. Department of Energy. Dr. Ronning gave a brief overview of the Office of Science. She emphasized that historical investments have paved the way for the development of a domestic, sustainable energy for bio-energy. The Office of Biological and Environmental Research aims to build predictive, systems-level understanding of genome-enabled biology in an integrated and multidisciplinary manner. The Office supports the genomic science program including the bio-energy research centers with the goal to provide fundamental research on biofuels and oilseed crops for bio-products.

Dr. Ronning also leads a joint program with NIFA for Plant Feedstocks for Bioenergy initiated in 2006 in an effort to leverage the DOE's capabilities in sequencing with USDA's expertise in crop development. The program has evolved to incorporate lingocynostic crops such as switchgrass, sorghum, and model crops such as brachypodium, as well as oil seeds. The aim is to develop sustainable crop varieties that can be grown on marginal land with few inputs. There is also a program in biosystems design, which takes advantage of genome editing technologies for increased photosynthetic capacity, increased oil and bio-product production, increased abiotic stress tolerance, and new and improved for the sustainable production of biofuels and bioproducts. Dr. Ronning is the Program Manager for the program in sustainable research for bioenergy. The goal of the program is to understand plant-soil-microorganism interactions and how they influence plant productivity. The aim is to be able to put to use to develop new cultivars.

The Computational Biosciences Program within the Genomic Sciences Program uses the DOE systems knowledge base (still being developed) as an open software and data platform for predicting biofunction.

The serves as a platform with tools that a user can use to compare different datasets and ask questions and to design experiments based on what they find and serves as a platform for sharing results and methods. The Joint Genome Institute (JGI) mission is to serve the scientific community to develop understanding bioenergy and the environment. Sequencing DNA is no longer a bottleneck, but the challenge is in analysis and phenotyping traits. The JGI increases functional assignments in addition to the genome sequencing to help with these efforts.

The work of the Office is broadly applicable for all sorts of plants in the US and internationally. The Office also collaborates with the high-risk, high potential research led by the DoE through two programs, TERRA and ROOTS using high-throughput phenotyping for sorghum. DoE providing sequencing information and computation facilities. Then use to provide tools that will ultimately go out to the breeder. Focus on energy sorghum but applicable to other types of sorghum as well. The Office is focused on bioenergy issues, basic science, and the results are applicable across the board to agriculture in general. All data and software produced by the programs led by the Office is freely available to the scientific community.

Rob Bertram, Chief Scientist, Bureau for Food Security, USAID: At USAID, the resource levels for research are relatively lower compared to other agencies. USAID's resources are directly linked to the Global Food Security Act. One of the big accomplishments of FtF has been putting agriculture and nutrition back together to give it a human face that has been important for the understanding of these investments for Congress and the American people.

Research for development and USAID pursues purpose-driven research, but this does not imply that the Agency is limited to only downstream and applied research. There is overlap with the other agencies and other phases of research. The university community actors are integrators receiving funding from multiple agencies and are linking with the NGO and private sector. Innovation Labs enable an entrepreneurial approach to partnerships on the ground for integration. The ability to draw on and pull together other investments offers major benefits for US. Some examples of collaborative research include the wheat blast and stem rust work and how USAID enabled the USDA Cereals Disease Lab at the University of Minnesota to double its greenhouse size so that it can take on a global mandate, which ultimately made US farmers more secure. This was an example of a synergy between foreign assistance effort and a US focused agricultural research investment.

Dr. Bertram discussed another example of collaborative research efforts for scuba rice, a flood-tolerant rice variety developed with support from the Bill & Melinda Gates Foundation and the International Rice Research Institute (IRRI). The research was originally developed at UC Davis through funding from NIFA and NSF. The NSF PEER program enabled collaboration between developing country researchers and U.S. agencies/universities. Several of the Innovation Labs were initially developed out of the BREAD program. USAID is working with the International Wheat Yield Partnership with the British Biotech Science and Research Council, DFID, USDA, and CIMMYT for longer term work to help put the needs of the developing world at the table when wheat research needs are being discussed. Dr. Bertram continued by providing several examples of agricultural research alignment with international and domestic priorities

Questions and Comments

- Question from the Chairman Deaton: Are there some possible new coalitions emerging in areas that align with the policy interests of those states with federal agencies?
    - Response from John Floros: Absolutely, a lot of states will benefit from this type of work and it could be leveraged with state funding for positions for faculty, staff, etc. Support could also be provided for some of the activities with the Innovation Labs. KSU has very strong collaboration with state non-for-profit groups.

Panel Discussion: Leveraging Private Sector Innovation

The panel was opened by moderator James Ash, BIFAD Board member and Food & Agribusiness Group Leader, Husch Blackwell LLP. Panelists included Geoff Graham, Research Vice President for Global Plant Breeding, DuPont-Pioneer, Tim Lust, CEO, National Sorghum Producers, and Mark Edge, Director of Collaboration for Developing Countries of Monsanto. Mr. Ash began the discussion by highlighting the

critical role of leveraging private sector innovation plays in moving foreign agricultural assistance moving forward. One of the key benefits the US can bring is the depth and breadth of scientific information from both the private sector and from universities. One of the key contributions the U.S. can make is the depth and breadth of agricultural research both from the university community and the private sector. The U.S. is unique in the amount of resources it has to support agricultural research initiatives.

Geoff Graham, Research Vice President for Global Plant Breeding, DuPont-Pioneer. Underlying principles of breeding is the same 20 and 30 years. The biggest difference is the size and scale of technologies however the principles are the same. Through hybrid maize varieties, corn production in the U.S. has gone from 20 bushels per acre has gone to a national average of 162 bushels per acre. As a sustainable and long-term project in innovation, it is remarkable that a crop with that level of productivity that in the 1920s only yielded 20 bushels to what it is today.

Since then, Pioneer has continued to work in PPPs. Henry Wallace worked with the Government of Mexico to develop the CGIAR system starting with CIMMYT. Pioneer has continued to work with CIMMYT to develop gene editing technologies for MLN in Africa. In terms of leveraging technologies and ideas, North America has long history of developing crop productivity is not often recognized as much as it should be. Small incremental steps can add up to make a tremendous difference and can be applied to other geographies. The hardest part is often working around processes and people to take innovation to products. How do we forcibly think about strategies of partnerships to bring ideas into a marketplace? Policies are difficult to manage, however clear policy guidelines can be used as roadmaps to make it very easy for partnerships to be developed.

Doug Cole, Director of Marketing and Communications, J.R. Simplot. Simplot processes potatoes for fast food restaurants. Simplot uses introgenics to turn down the traits already in potatoes such as silencing the ability of cut potatoes to turn brown. This is achieved by silencing an amino acid called asparagine resulting in 70% less asparagine. This is both a sustainability and a health trait. The generation two version contains two additional traits: disease resistance from a wild potato species and sugar control (allows for sprout suppressant during cold storage) in white russet potatoes. About 40% US potato crop is exported, 60% of that is in frozen form. Simplot participated in a USAID project called the Feed the Future Biotechnology Partnership for Potato with Michigan State University for leaf blight resistance, not only for the U.S. market, but also for developing country markets (Indonesia and Bangladesh).

Tim Lust, CEO National Sorghum Producers: Today, we have a tremendous opportunity to work together to leverage resources to answer farmers' problems. Using the double haploid technology, Pioneer has worked with the National Sorghum Producers to greatly change the private industry. Pioneer has invested billions of dollars to develop this technique and processes. Sorghum has the potential to have double haploid technology later and benefit from those technologies. Genetic gain in sorghum has truly been untapped for many years. An International Sorghum Conference will be hosted in April and is an important way we can work together and take sorghum breeding technology it to the next level.

In terms of challenges of working together in public private partnerships, sorghum is a small crop and an untapped commodity. The number of scientists that are focused on the problem is relatively small. It is important to try to make sure that we are not duplicating efforts. There is a lot of ability to complement each other. For example, West Africa phenotyping can tie in very well with phenotyping with DoE and with phenotyping. A lot of things can happen but only if they tie together and focus on what they are really good at and what they can do well.

Mark Edge, Director of Collaboration for Developing Countries of Monsanto: Mark Edge began his presentation by emphasizing that collaboration is central to the work that Monsanto does. Monsanto is heavily invested in plant breeding and agronomy even more so than biotech. Monsanto's key areas of focus today are in crop production, precision agriculture, big data, and digital tools. Monsanto is aiming to address the question of what do farmers need and what is the technology we can use to make their products better.

Public private partnerships are only going to be able to address by changing the productivity of smallholder farmers, not a traditional focus of large private sector entities. Our challenge is to find those collaborations that look at millions of farmers and hectares and look as opportunities and turn into business opportunity and improvement of productivity of agriculture. Monsanto has several successful examples of working with smallholder farmers with cotton for example. The technology involved in improving cotton has resulted in dramatic change in developing countries. Monsanto focused on the smallholder farmers and focused on getting technology tools to them.

Digital technologies and agronomic information is another focus of Monsanto. The goes is to get integrated systems working together and to see how smallholder farmers can be good customers. The opportunity of working with smallholder farmers requires a 10 to 15 year horizon. Normally, multinational companies are not very good at laying those foundations. USAID, national governments, have a very good ability to do this type of work. In these areas, we are able to see the synergies of cooperation. How can Monsanto reach out to resources that do think long-term? What technologies exist that we can do together that will be beneficial for us? For business, we always have to answer to investors and to the Board of Directors. What is the return on investment?

How to get technologies to the farmers? One answer is to develop technologies that we may not use ourselves. An example of this is the development of cassava resistance to brown streak virus through the VIRCA project. Cassava is not typically a crop that Monsanto is interested in, but the technology transfer is an opportunity. DT cow pie is another example as well as the Water Efficient Maize for Africa (WEMA) project that has been in place for 10 years. Drought tolerant maize and insect resistant maize working together with 9 NARS is funded by the BMGF and USAID. Taking a long-term view, we are getting better at getting products into farmers' hands. Drought tolerant and insect resistant maize hybrids will be available in South Africa. Confined field trials showing good suppression of fall armyworm. There is a need for help from many different stakeholders for technology to be adopted by smallholder farmers in Africa to be able to find synergies building off of our core competences. We also know that smallholder farmers need finance but that is not our core competence. We have to stay with what we know how to do. The private sector needs to learn so much from the public sector about how we can interact and be proactive in sourcing those technologies that will be of benefit to farmers.

Questions and Comments

- Comment from James Ash. It is not well communicated how much the private sector looks for ways to support food security in developing countries, so thank you for each of your company's efforts in this area.

- Question from Pamela Anderson: The private sector has access to great datasets. There is a need to get students interning in these companies to get training on computational analysis. How do we push harder for public and private sector breeding in the other crops outside of wheat and maize to drive the genetic gains in alternative crops?
    - Response from Mark Edge: Monsanto is participating with IITA on cowpea breeding funded by the BMGF. Monsanto has knowledge on processes and advanced ways of working with technology to work with IITA as a pilot project to see what are the ways Monsanto can build capacity and engage in a meaningful way. The most valuable aspect of that partnership for Monsanto is learning to work with local partners in developing countries i.e. Nigeria. It is also a people development opportunity for Monsanto employees to be involved in these projects. Monsanto is interested in being more proactive in seeking partnerships and opportunities to work with development agencies.

- Question from Chairman Deaton: There are great opportunities for regional collaboration and partnerships with mixes of universities. Could some assessment of that model be useful for global collaboration moving forward?
    - Response from Geoff Graham. Phenotyping is the single biggest expense for DuPont-Pioneer. How do you deploy the right technologies to address the cost of phenotyping? The private sector does not have that much more technology for phenotyping, but the

scale is different. The private sector builds into the next generation of ideas much earlier than the public sector.
    - Comment from Mark Edge: Deployment of new products is one of the strengths of the private sector. Seed companies often do not know how to do foundation seed. The Bill & Melinda Gates Foundation has started a grant to fund a standalone foundation seed business for maize in Africa.

- Question from the Gbola Adesogan, Director of the Feed the Future Innovation Lab for Livestock Systems: Is there any ongoing work looking at improving the digestibility of crop residue and protein content rather than just from the human consumption aspect?
    - Response from Geoff Graham: The focus of DuPont is on the traditional commodity piece. Focusing on silage as an industry, there is a lot of room for improvement. The biggest challenge is how to deploy a system in different regions. This is an emerging area of discovery for the private sector.
    - Response from Mark Edge: There is a lot of research that goes into animal livestock feed improvements. There has always been a problem if you focus on those things, you end up compromising on yield. The new technologies i.e. CRISPR/Cas9 and targeted genome editing is going to open up a new realm to make these sorts of changes without having negative yield impacts. There are huge opportunities to work across the boundary of grain for animal and human consumption to unlock the potential of improving quality without having negative impact that you normally have from traditional breeding.

Questions and Comments - End of Day

- Questions from the in-person audience: (Ed Buckler from USDA ARS): Tremendous opportunities in the genome editing technologies to deliver niche products, but how do we make new varieties customer acceptable?

- Comment from an unidentified in-person attendee: During the meeting, we heard very little about fruits and vegetables (mostly staple crops). The issue of smallholder farmers with land holdings of 0.7 hectares or less, staple crops won't be the answer for improving dietary diversity. Nutritional outcomes not taken into consideration nearly as seriously as we could have.

- Question from the online audience: There is a contrast between the topics we heard today and some of the other areas in the Global Food Security Research Strategy, such as nutrition, soil health risks, socio-economics, etc. Is the research agenda broader than the selected topics presented here today?
    - Response from Chairman Deaton: We are listening very carefully to the comments made today to incorporate into the advisory role BIFAD plays for USAID.
    - Response from Nora Lapitan: The research strategy does describe areas of sustainable intensification, natural research management, and other areas. Nutrition and nutrition sensitive agriculture has been elevated in importance in this research strategy. Research Theme 3 emphasizes systems research into how we can improve nutritional outcomes.
    - Response from James Ash: Fruits, vegetables, and nuts are also important for food security, but addressing hunger is prioritized and a more varied diet is another level up.
    - Response from Pamela Anderson: The integration of efforts when working across research, development, and implementing partners is important; however, most of today's discussion was focused on productivity. Although nutrition and resilience are in the research strategy, we did not discuss these areas today.

- Comment from Jonathan Lynch, Director of the Feed the Future Innovation Lab for Climate Resilient Beans: Chickpeas and legumes are also consumed as vegetables, people eat them as pods/immature seeds, and as leaves. Legumes are part of the system of nitrogen fixation and provide the nutritional benefits even though it is a grain.

- Comment from Elizabeth Mitcham, Director of the Feed the Future Innovation Lab for Horticulture, University of California, Davis: Dr. Mitcham reminded the audience of the challenge of postharvest losses and that studies have shown that only 5% of agricultural research and development is invested into postharvest technologies.

- Comment from Jagger Harvey, Director of the Feed the Future Innovation Lab for the Reduction of Postharvest Loss, Kansas State University: Dr. Harvey commented on the need to build capacity in the countries we are working with. There are some have great facilities such as the Biosciences eastern and central Africa-International Livestock Research Institute (BecA-ILRI), but also opportunities to build the human and institutional capacity. We should take every opportunity to empower local partners in order to have a sustainable impact. We should challenge ourselves to make sure we empower the national partners so that they can address many other problems into the future.

- Comment from Moffatt Ngugi, Agricultural Development Officer, USAID/BFS: Urged audience members to think of every country as "developing". We should not discuss agricultural development with this false binary of developing/developed. Even in countries in North America and Europe, there are still areas for advancement.

- Comment from an unidentified in-person audience member: In terms of reaching the last mile farmers, do we really understand fully the process of extension? Has there been a research agenda of how to improve extension in addition to how to create the technologies?
    - Response from Chairman Deaton: The question of extension has come up and there has been one study that has been undertaken on the topic, but it is an issue that has not been resolved and warrants further attention.

- Comment from Patrick Webb, Independent Science and Partner Council: We need to focus much more on the future where diets are changing and dietary patterns are changing dramatically and rapidly around the world. Focus needs to be on how to improve dietary quality on every consumer in the world and the need to have dietary diversity. Need to focus on quality of diets and integrate our research and activities

- Question from the online audience: (Matthew Blair, Research Associate Professor, Department of Agricultural and Environmental Sciences, College of Agriculture, Human and Natural Sciences, Tennessee State University) Will there be a New Food Crops Lab and whether or not it could be managed by an HBCU as the lead institutions? Also, what will the role of MSIs and the 1890s land-grants be for the new iterations of Feed the Future? Matthew Blair also commented on the opportunity for a Resiliency Lab focused on New Heat Tolerant Crops (e.g. amaranth, lima bean, mung bean, and sweet potato) that would be pertinent to most of the countries recently announced as priority locations, especially in Africa.
    - Response from Chairman Deaton: BIFAD has called to attention of the new administration the issue of minority-serving institutions and the continued role that we expect them to play in the evolution of the new research agenda.

- Question from the online audience: (Florence Dunkel, Montana State University): How is the wealth of indigenous knowledge being considered in the new research strategy?
    - Response from Chairman Deaton: There has not been enough discussion on this point. NIH commissioned one study in Africa looking at potential HIV traditional knowledge. That was a rigorous study that was undertaken.
    - Response from Doug Cook: Project with the Ethiopian Institute for Biodiversity on chickpea germplasm looking at 1,000 genotypes, conducted farmer surveys to capture the functionality of the landraces. As they begin to be replaced with improved varieties, you remove the products of long co-evolution. Will lose lots of innovations if we take the simple strategy of planting the best performing genotypes we find elsewhere.

- Comments from Twitter: Congressman Jeff Fortenberry of Nebraska commented that this week is Feed the Future Week. The Postharvest Loss Innovation Lab was impressed by the numbers about partnerships and leveraging shared by KSU, a key theme of this meeting. Brenda Dawson at UC Davis highlighted Rob Bertram's question about scuba rice.

Chairman Deaton concluded the meeting by highlighting the transdisciplinary evolution we are seeing and the need for multiple disciplines to be engaged in addressing the problems we are seeing in the world today. That has been re-emphasized in the meeting today and the need for policy outcomes not just dominated by one discipline. It is a powerful issue in universities and is extremely exciting to our undergraduates because they can see the opportunities and are communicating with colleagues worldwide through social media. The responsiveness and openness of USAID and the passage of the Global Food Security Act has brought us where we are today. Today, we have seen potential of many areas that we can follow through in greater depth. Dr. Deaton thanked BIFAD members for their participation. Dr. Deaton thanked the organizers and members of the public. He also thanked APLU's leadership and Peter McPherson for bringing his past experience as a former USAID Administrator and Under-Secretary of Treasury has a background that has enabled reaching out to our universities in new ways that will keep us moving forward. He thanked all participants for their contributions and fruitful discussions.

Acronyms

BARI	Bangladesh Agricultural Research Institute
BFS	Bureau for Food Security
BMGF	Bill & Melinda Gates Foundation
FtF	Feed the Future
CIMMYT	International Maize and Wheat Improvement Center
PEER	Partnerships for Enhanced Engagement in Research
SDG	Sustainable Development Goals
SUA	Sokoine University of Agriculture
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDA ARS	USDA Agricultural Research Service

Resources

U.S. Government Global Food Security Research Strategy 2017-2021

Link to BIFAD Presentations: https://www.dropbox.com/sh/lzk5pswyqbna0yt/AAAAigCTdYbV1-hWmcC5WBdaa?dl=0

AIARD White Paper: SMART Investments in International Agriculture and Rural Development: http://www.aiard.org/aiard-publications.htmlhttp://www.aiard.org/aiard-publications.html

Appendix 1: In-person Participants

First Name	Last Name
Haley	Ahlers
Gary	Alex
Sabrina	Amburgey
Daniel	Bailey
Jacqueline	Bass
Rob	Bertram
Jack	Bobo
Betty	Bugusu
Dena	Bunnel
Robert	Burdick
Dylan	Butler
Diana	Caley
Michael	Carter
Jennifer	Cisse
Kerry	Clark
Neville	Clarke

Timothy	Close
Clara	Cohen
Douglas	Cook
Katharine	Coon
Genevieve	Croft
Ryan	Crow
Karelyn	Cruz
Timothy	Dalton
Cynthia	Donovan
Andrew	Drozynski
Janie	Dubois
Karen	Edwards
Hillary	Egna
Karen	Exel
Amer	Fayad
Meredith	Fensom
Katie	Garcia
Aniruddha	Ghosh

Jerry	Glover
Bram	Govaerts
Noubia	Gribi
Elaine	Grings
Scott	Habrun
Joseph	Huesing
Bronwyn	Irwin
Ashley	Juengling
Ahmed	kablan
Terra	Kelly
William	Kisaalita
Gretchen	Knoth
Gabriel	Laizer
Nora	Lapitan
Sean	Lawrie
Shivaun	Leonard
Carole	Levin
Anna	Lewis

Vern	Long
Josue	Lopez
Jonathan	Lynch
Barakat	Mahmoud, PhD
Grant	Malmberg
Aideen	Mannion
Mywish	Maredia
john	mccormack
Michael	McGirr
Erin	McGuire
Jan	Middendorf
Elizabeth	Mitcham
Rangaswamy	Muniappan
Timothy	Ng
Moffatt	Ngugi
Caitlin	Nordehn
Dan	Northrup
Lindsay	Parish

Andrew	Paterson
Elisabeth	Paymal
Jesse	Poland
Tracy	Powell
Vara	Prasad
Carl	Pray
Angela	Records
Tim	Rendall
James	Rhoads
Lorraine	Rodriguez Bonilla
Catherine	Ronning
Jeannie	Rose
Micah	Rosenblum
Christopher	Rozell
Nadine	Sahyoun
Laura	Satkowski
Erica	Schmidt
Susan	Schram

Jordan	Sellers
Dan	Silverstein
Rebecca	Skipp
Anika	Smith
Matt	Stellbauer
Paul	Tanger
Toshiko	Tanuma-Weiner
Will	Thompson
Dr. Margaret	Udahogora
Martha	Van Camp
Akhila	Vasan
Daniela	Vega
Chris	Vincent
Patrick	Webb
Alex	Winter-Nelson
Eric	Witte
Hailu	Wordofa
Huaijun	Zhou

DeAndra	Beck
Kulvinder	Gill
Binam	Iyob
Reid	Hamel
David	Leege
Thomas	Thompson
April	Thompson
Jenna	McCarthy-Anderson
Julie	Howard
Jerry	Hagstrom
Ed	Keturakis
Michelle	DeFreese
Lori	Rowley
Hillary	Egna
Erik	Pederson
Eleanor	Morefield
Michael	Johnson
Mary	Dingley

John	Bowman
Eddy	Aparicio
Edwina	Wambogo
Hanan	Saab
P. V.	Sundareshwar
Jagger	Harvey
Susan	Lamont
B.M	Prasanna
Barbara	Valent
John	Floros
Geoff	Graham
Mark	Edge
Karen	Brooks
Douglas	Cole
James	Ash
Waded	Cruzado
Gebisa	Ejeta
Brady	Deaton

Shanaz	Waise
Mark	Varner
Otto	Gonzalez
Olfat	Sheikomar
Melissa	Day
Bob	Rabatsky
Paul	Koch
Cathy	Phiri
Sheila	Roquitte
Andrew	Bisson
Tom	Thompson
Ed	Buckler
Mathew	Blain
tyrell	Kahon
Kira	Everhart-Valentin
Karen	Duca
Nat	Bascom
Christopher	Strock

Kerry	Clark
Steve	Brown
Tim	Lust
Lily	Bork
Hina	
Sarah	Marshall
Philip	Steffen
Ann	Bartuska
Sean	Jones
Diane	Okamuro
Ruth	Hortenia
Gbola	Adesogan
Dave	Hoisington
Julie	MacCartee

Appendix 2: Online Participants

Shereen	Abdelaaty
David	Ader
Hayley	Alexander
Hayley	Alexander
Alejandra	Arce Indacochea
Joshua	Ariga
Joanne	Arsenault
Fayrouz	Ashour
Innocent	Awasoom
Edward	Baars
Ranajit	Bandyopadhyay
Amrit	Bart
Amrit	Bart
Deanna	Behring
Deanna	Behring
Ranjana	Bhattacharjee
Jean-Claude	Bizimana
Caroline	Boules
Lauren	Broccoli
Gary	Burniske
Shari	Bush
Ty	Butler
Liana	Calegare
Lauren	Carter
Anais	Castagnola
Paige	Castellanos
Jack	Chang
Mubelwa	Charles
Jose	Cisneros
Nicolas	Cook
Paul	Cotton
Karelyn	Cruz
Kamisha	Curtis
Bill	Daniels
Kenton	Dashiell
Brenda	Dawson
Melissa	Day
Walter	de Boef

Jesus	De Los Santos
Karin	Dillon
Steven	Duke
FLorence	Dunkel
Rana	El Hattab
Olaf	Erenstein
Don	Evans
KATE	FEHLENBERG
Kevin	Fitzsimmons
Kari	Flores
Tee	Ford-Ahmed
Tee	Ford-Ahmed
patty	fulton
Cibeles	Garcia Burt
Madeleine	Gauthier
Tom	Gill
Maria Veronica	Gottret
Shoshana	Griffith
Lina	Ha-Stone
Melissa	Hambly-Larios
David	Hansen
Emir	Hardy
Marriel	Hardy
Shauncey	Hill
Don	Humpal
Sophie	Javers
BORA	JEAN MARIE
Michael	Johnson
Merrill	Jordan
laureline	josset
Bakirya	Judith
Tyrell	Kahan
Ed	Kaleilau
Kokeb	Kassa
John	Kennelly

indra	klein
Ben	Kohl
Ben	Kohl
Matthew	Krause
Vijesh	Krishna
Edye	Kuyper
Erastus	Kyalo
Kendall	Lamkey
First Name	Last Name
Mark	Lawrence
Matthew	LeBreton
Nina	Lilja
Kathryn	Lincoln
Kate	Lincoln
Gillian	Locke
Michael	Machala
Ram	Mannan
Skye	McDonald
Keenan	McRoberts
Ali	Mitchell
Ali	Mohamed
Kyle	Murphy
Richard	Nader
Latha	Nagarajan
Moffatt	Ngugi
Esther	Ngumbi
Ly	Nguyen
Jennifer	Nielsen
Patrick	Norrell
Godwill	Okoro
Gregory	Ormsby Mori
Lawrence	Oroma
Sylvester	Osagie
Michela	Paganini
Chris	Pannkuk
Katherine	Patterson
Namita	Paul
Ana	Pavlovic
Gad	Perry
Thomas	Pesek
Leroy	Petersen
Cathy	Phiri

Barry	Pittendrigh
Suzanne	Poland
angga	pradesha
Hillary	Proctor
Namande	Prossy
Jennie	Rabinowitz
Patrick	Rader
Pablo	Ramirez
Po	Rin
Terry	Roe
Donna	Rosa
Micah	Rosenblum
James	Rowland
Abby	Rubley
Alex	Russell
Tess	Russo
Sandra	Russo
Michael	Rust
Bethany	Rutledge
Eugenia	Saini
Cynthia	Sandoval
adam	schrecengost
Blen	Shewaye
Brad	Shurdut
Elizabeth	Sibale
Pauline	Simmons
Ricardo	Soto Nolazco
Janice	Stallard
Tara	Steinmetz
Barbara	Stoecker
Faith Bartz	Tarr
Deepa	Thiagarajan
Rohan	Tikekar
Emily	Urban
William	Vu
Jon	Wakeman
Michael	Weber
Nicole	Webster
Beth	Weeks
Christina	Weng
Daniel	White
Bryce	White

Irvin	Widders
Judith	Williams
Stephen	Wood
Jim	Yazman
Virginia	Zaunbrecher
Margaret	Zeigler