October 2017

Feeding a Hungry World: How Kansas State University Is Improving Global Agricultural Production

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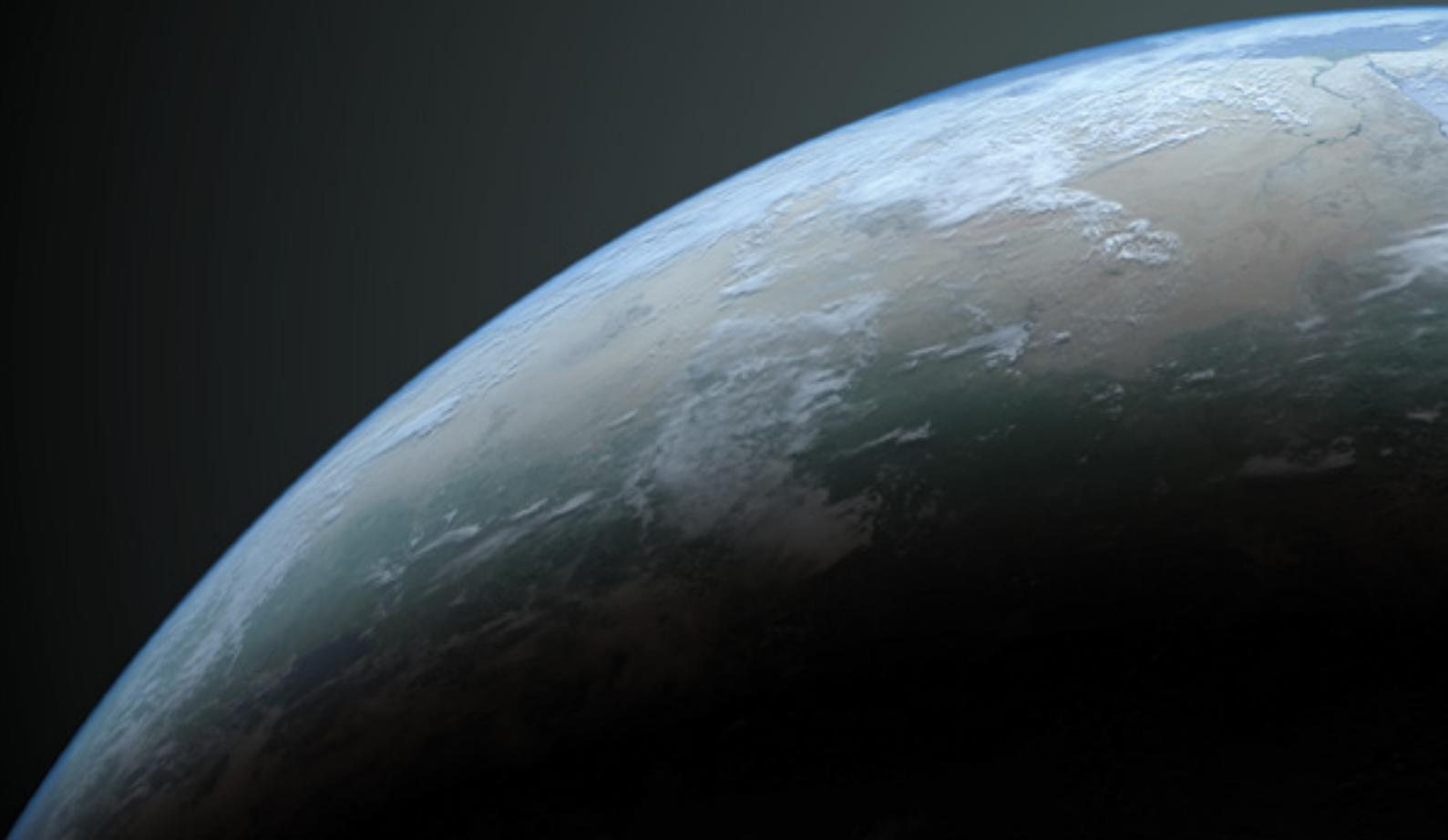## Recommended Citation

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By Pat Melgares

The world's population is expected to grow from 7.5 billion people today to nearly 10 billion by the year 2050. Experts predict that the world's farmers will have to produce as much food in the next 35 years as they have in the entire history of the world to feed everyone.

Kansas State University, a leader in global food systems research, is rising to the challenge through the Feed the Future program, the government's global hunger and food security initiative that is funded through the U.S. Agency for International Development. The program seeks innovations that will help feed a hungry world.

Of the 25 Feed the Future innovation labs, four are at K-State. Since 2013, K-State has received base funding and associated awards of more than $100 million to support projects in 15 countries, including high-tech efforts that use drones and satellites to scour landscapes from high above the Earth to gather plant data — including height, size of grain and more — to support development of new varieties and better nutrition.

Getting an accurate picture

Near the far northern tip of India, a steady buzz makes its way up and down rows of lush wheat fields.

Armed with sophisticated, multispectral cameras no larger than your back pocket, an unmanned aerial vehicle — a drone — zips through the field collecting images that will give researchers and wheat breeders important information on how to improve crops.

This is not your grandfather's agriculture. It's 21st-century innovation, something that K-State's Jesse Poland knows well.

As director of the university's Feed the Future Innovation Lab for Applied Wheat Genomics, Poland is helping lead projects in India, Pakistan, Bangladesh, Mexico and the U.S., bolstered by a $976,000 grant he received last year from the U.S. Department of Agriculture and the National Institute of Food and Agriculture.

"We've done some work with push carts and ground vehicles, but right now we are primarily focused on the unmanned aerial vehicles, using different types of cameras and then photogrammetry approaches to extract plant information from those flights," said Poland, assistant professor of plant pathology.

Researchers with the Feed the Future Sustainable Intensification Innovation Lab tour maize and pigeon pea intercropping field trials in Babati, Tanzania.

K-State graduate student Daljit Singh leads the high-throughput phenotyping efforts in India for the Feed the Future Innovation Lab for Applied Wheat Genomics.

"It's 'big data' science where we have massive data sets, and we evaluate tens of thousands of candidate breeding lines and varieties," he said. "We study how all those genetic differences combine together to make a better-yielding, more heat-tolerant, more disease-resistant wheat variety."

The result of this work is more — and better — food because the images can provide important information about a plant's growth, susceptibility to disease and more that help researchers improve the plant's resilience over time.

The global community has made great strides in improving food security over the past few decades, said Jagger Harvey, director of K-State's Feed the Future Innovation Lab for the Reduction of Post-Harvest Food Loss.

"A lot more people have been lifted out of poverty globally — about a billion people," Harvey said. "More recently, the global agricultural and international development community has been focused on quality and safety of the food. We're getting a lot more information about things that, despite having sufficient food, could really be impacting people, stunting children's development, and overall keeping people and communities and nations from realizing their full, vibrant potential."

Doing more with less

At K-State's Feed the Future Innovation Lab for Sustainable Intensification, director Vara Prasad is working with researchers at the University of California-Davis and Stanford University who are using remote sensing and geospatial tools through Google Earth to map the landscape in the specific countries where the lab has projects.

The term "sustainable intensification" is becoming fairly common in the agricultural industry. It refers to growing more food on the same land base while also protecting the air, land and water that feeds that land.

"To efficiently use water and nutrients, we need to look at site-specific management, and that means understanding the landscape and then selecting the crops that are good for your landscape," said Prasad, a university distinguished professor of agronomy.

David Lobell, a professor of earth system science at Stanford, is leading a project funded by Prasad's lab to map maize fields and yields in Tanzania. His work is part of the Geospatial and Farming Systems Research Consortium at UC-Davis that will feed information from outer space to help scientists on the ground improve food production.

"U.S. agriculture will benefit from the same technologies we are testing in Tanzania, particularly the ability to combine multiple sensors to rapidly map crop performance at a very high resolution," Lobell said.

Good for the world, good for Kansas

K-State's Tim Dalton, director of the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet, says bringing value back to the United States and many other areas of the world is the basis for international research.

In the early 1980s, the sugarcane aphid was causing problems in southern Africa. U.S. researchers worked to develop germplasm resistant to the aphid, which then was the key solution 10 years later when the greenbug aphid attacked sorghum in the Texas High Plains and parts of Oklahoma.

"The thing that makes it really interesting is that we estimate a benefit of about $750 million in 2015 dollars to U.S. producers because of this one research finding," said Dalton, a professor of agricultural economics. "It's very easy to show both internationally and domestically that there have been more benefits than costs. When I did some calculations last year, there was slightly over $1 billion invested in federal support programs for international research. So that one benefit to producers covers about three-quarters of the cost."

More recent calculations by Dalton show a global net benefit of $4.6 billion over 42 innovations generated by the labs and their precursor, giving a benefit to cost ratio of 4.5 to 1.

Harvey's postharvest loss lab has also seen evidence of a high potential return on investment. He is leading a project to study toxins that are produced by fungi, known as mycotoxins, which frequently develop in such crops as corn and peanuts. One in particular, aflatoxin, is estimated to contaminate as much as a quarter of the global food supply, putting 4.5 billion people at risk, he said.

A recent study from Michigan State University indicated that U.S. corn production losses due to aflatoxin can reach $1.6 billion in bad years;

K-State Professor Jesse Poland, right, and members of the research team at the Borlaug Institute for South Asia discuss high-throughput phenotyping methodologies on-site in Ludhiana, India.

K-State's Jesse Poland, left, and Daljit Singh, right, tour trial plots at Punjab Agricultural University.

in normal years — years when the environment is not so conducive to growth of mold, according to Harvey — corn losses due to aflatoxin are about $52 million.

"It varies a lot from year to year," Harvey said. "In some places like Kansas, we can have some problems with it, and in a bad year, it will be worse than others. But in some of the countries we're working in, it tends to be a problem every year. In surveys of toxin exposure in some of these countries, we're finding that a lot of people are being exposed to it."

Harvey said aflatoxin is a potent carcinogen and can cause death after short-term, high-concentration exposure.

"We're taking a systematic approach in our program," Harvey said. "In every country we work in, we have national leaders in research and in government who we're often engaging as the implementers of the project. We've established labs to improve the capacity for these national leaders to address this problem locally. The long-term goal across USAID programs is to empower local systems so that such programs are no longer needed.

"Until we can equip these countries to monitor and then have a safe way to dispose or use it as feed or decontaminate it, it's going to continue to be a problem."

Diversification a must

Prasad's lab is working with partners who have established weather stations in several countries, giving scientists the ability to match growing patterns with weather data. They are using drones to identify stress tolerance in crops and irrigation patterns in large fields. They are also studying the best ways to mix crops and livestock on the same land.

"We are trying to help farmers diversify so that they not only minimize the risk of farming, but also have a diversity of foods in their diet," Prasad said. "Diet diversity is the key to nutrition. If you're only producing cereals in your subsistence farming, then you're eating only rice, or only wheat or only maize.

"There needs to be more focus on nutrition, rather than just getting the calories. You can get the calories easily from any of the cereal base. For good nutrition, you really need diversification — you need the protein, you need the fat, you need the micronutrients."

In July 2017, the World Food Program reported that 20 million people in four African countries would suffer from starvation within a few months. The United Nations called the situation the worst humanitarian crisis of our time.

But in a world where technology can help produce more food for more people, and put more money in local economies, U.S. researchers and the work they do can provide some relief.

"As a very blessed country with a lot of resources, there comes the equal responsibility to take that to the benefit of the rest of the world," K-State's Poland said. "A number of countries, especially ones that have been defined in the Feed the Future initiatives, are really in a state of current or imminent food insecurity. That represents hundreds and hundreds of millions of people in these target regions who are at or maybe just a step above subsistence-level farming and household nutrition.

"An obvious benefit of doing this work is to take agricultural innovations that can help these countries and these people to develop into more productive economies and increase their food security and their standard of living." k

The sun sets over a wheat field in Ludhiana, India, where researchers from the Feed the Future Innovation Lab for Applied Wheat Genomics are conducting a field trial.

Easy to prepare sorghum- and millet-based products provide important nutrition to consumers while creating new income and market opportunities for entrepreneurs.

K-State Professor Jesse Poland, graduate student Daljit Singh and Indian researcher Uttam Kumar test the Phenocart 2.0 at the Borlaug Institute for South Asia in Ludhiana, India.

A Senegalese woman prepares millet couscous in her home. Millet is a staple crop to millions of people across West Africa and beyond.

By creating microenvironments that encourage better germination and plant establishment, seedballs present exciting new possibilities for millet farmers in West Africa who struggle to establish a successful stand in the harsh Sahelian climate.

U.S. researchers are conducting studies to compare hermetically and traditionally stored chickpeas in Ethiopia. On the left are chickpeas that have been hermetically stored; on the right, traditionally stored chickpeas heavily infested by insect pests.

FEED THE FUTURE INNOVATION LABS AT K-STATE

The U.S. Agency for International Development established the Feed the Future Innovation Labs program to harness the capacity of U.S. land-grant institutions, other universities and the private sector to improve global food security.

Feed the Future, along with the new U.S. Government Global Food Security Strategy, seeks to promote inclusive growth of agricultural economies, increase resilience against shocks and improve health and nutrition in Feed the Future countries. K-State officials say the university's four innovation labs are contributing to these goals in major ways.

Here is an overview of the four labs currently housed at K-State.

Sorghum and Millet

k-state.edu/smil

- Funded in 2013 for $13.7 million base; $10 million in associated awards.
- Focuses on improving the productivity, disease resistance, agronomy and economic value of sorghum and millet.
- Focus countries are Burkina-Faso, Ethiopia, Mali, Niger and Senegal.
- Will be seeking a second five-year funding cycle in July 2018.

Applied Wheat Genomics

k-state.edu/wheat-innovation-lab

- Funded in 2013 for $5 million.
- Focuses on developing heat-tolerant, high-yielding and farmer-accepted wheat varieties for South Asia.
- Focus countries are Bangladesh, India and Pakistan.

Sustainable Intensification

k-state.edu/siil

- Funded in 2014 for $32 million; $18 million in associate awards.
- Focuses on developing practices for producing more food and nutrition on the same land base while protecting natural resources.
- Focus countries are Bangladesh, Burkina-Faso, Cambodia, Ethiopia, Senegal and Tanzania.

Post-Harvest Loss

k-state.edu/phl

- Funded in 2014 for $8.5 million; $15 million in associate awards.
- Focuses on improving global food security by reducing postharvest losses in long-term storage crops, such as grains, oilseeds, legumes, root crops and seeds.
- Focus countries are Bangladesh, Ethiopia, Ghana and Guatemala.
- Has received an additional $3 million for projects in Nepal, Honduras and Afghanistan.