COLLEGE OF
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GAP REPORT®
GLOBAL AGRICULTURAL PRODUCTIVITY REPORT®

PRODUCTIVITY IN A TIME OF PANDEMICS

2020 Executive Summary

The Global Agricultural Productivity Report® (GAP Report®) is central to the mission of CALS Global in the Virginia Tech College of Agriculture and Life Sciences (CALS): to build partnerships, drive thought leadership, and create opportunities for students and faculty to serve globally.

In addition to producing this annual update on global progress toward doubling agricultural output through productivity growth by 2050, the GAP Initiative coordinates opportunities for collaboration and learning between its partners, the university, and stakeholders around the world.

Direction and input for the GAP Report and related activities are provided by the Virginia Tech Internal Advisory Group and the GAP Initiative Leadership Council. Members are acknowledged on the back cover.

OUR PARTNERS

The GAP Report brings together expertise from the private sector, NGOs, conservation and nutrition organizations, universities, and global research institutions. **Supporting Partners** provide financial support for the GAP Report and activities. They offer important perspectives on critical issues facing agricultural systems in the US and around the world. **Consultative Partners** contribute their knowledge of productive, sustainable food and agricultural systems, including the role of agricultural R&D and extension, natural resource conservation, human nutrition, international development, gender equity, and the needs of small-scale farmers.

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GlobalAgriculturalProductivity.org

Steensland, A. (2020). *2020 Global Agricultural Productivity Report: Productivity in a time of pandemics.* T. Thompson (Ed.). Virginia Tech College of Agriculture and Life Sciences.

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GLOBAL AGRICULTURAL RESILIENCE IMPERATIVE

Agricultural communities battle pandemic-scale pest and disease outbreaks every year. The health and productivity of people, livestock, and crops are all vulnerable. Food and nutrition security, livelihoods, and environmental sustainability are all threatened by these outbreaks. The Global Agricultural Productivity Imperative lays out some of pandemic-scale threats that must be addressed to ensure that we can sustainably produce food, feed, fiber, and bioenergy for 10 billion people in 2050.

PEOPLE

COVID-19 shutdowns will drive an additional 71 to 100 million people into extreme poverty and double the number of people at risk of acute hunger to 235 million.[1, 2]

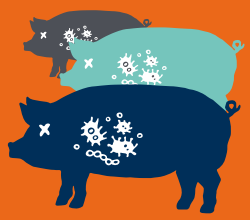
Infectious diseases transmitted by vectors, such as mosquitoes, are responsible for 700,000 deaths annually.[3]

5.9% of children under five are overweight and 21.9% are stunted (average global prevalence.)[4]

75% of new and emerging infectious diseases are transmitted from animals to humans, including the novel coronavirus causing COVID-19.[5]

LIVESTOCK

Avian influenza is carried across borders by wild birds. An outbreak first recorded in Canada in 2015 led to the deaths of 50 million chickens and turkeys in the U.S.[6]



China has lost 40% of its swine population in the past two years to an outbreak of African Swine Fever afflicting three continents.[7]

Peste des petits ruminants (PPR) is a highly contagious respiratory disease of goats and sheep, causing an estimated US $874 million in losses in Africa and South Asia.[8]

CROPS

20% to 40% of global crop production is lost to pests annually. Each year, plant diseases cost the global economy around US $220 billion, and invasive insects around US $70 billion.[9]

37% of the world's wheat production is at risk of potential epidemics of yellow, stem or leaf rust diseases.[10]

Fall armyworm destroys more than 18 million tons of maize annually in Africa, an economic loss of US $4.6 billion.[11]

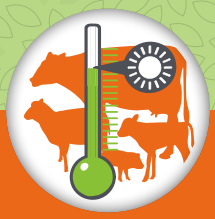
Banana Fusarium Wilt (TR4) is a soil-dwelling fungus with the potential to destroy entire crops and make land unsuitable for banana production for decades.[12]

A "small" swarm of desert locusts consumes the same amount of food in one day as 35,000 people. A "large" swarm can eat enough to feed 81 million people.[13]

CLIMATE CHANGE

Climate change compounds the risks of disease and pest pandemics, amplifying the need for urgent action.

Global temperature increases of 2-3°C would increase the number of people living in malarial climates by 3% to 5%, putting hundreds of millions of people at risk.[14]



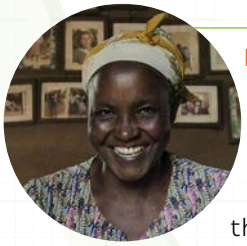
38 of the 65 diseases prevalent in livestock could increase with climate change.[15]

For wheat, rice, and maize, crop yield loss from pests will increase by 10% to 25% per degree Celsius of global surface warming.[16]

READ STORIES FROM THE FRONT LINES OF PANDEMICS >>>

PRODUCTIVITY IN A TIME OF PANDEMICS: STORIES FROM THE FRONT LINES

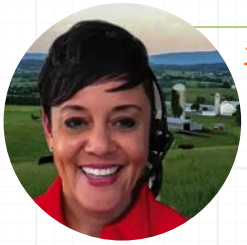
Pandemics are global challenges and require action and innovation at every level, from the smallest of smallholder farmers to global policymakers. In a film produced in conjunction with the 2020 GAP Report, *Agricultural Productivity in a Time of Pandemics: Stories from the Front Lines,* agricultural producers and experts share their experiences and challenges in improving their productivity, responding to pandemics, and adapting to climate change.



Hellen Wanijiko Wawero, Nakuru County, Kenya
I had a cow that was a local breed that was producing three liters of milk per day. I wanted to improve my productivity, so I bought one that produces fifteen liters of milk per day. There are diseases that need vaccines, now if we don't vaccinate, the livestock will be sick and die and you will not get money.

PJ Haynie, Haynie Farms, Virginia
We don't plow as my grandfather used to many years ago. We're in an area where we're very sensitive to the watershed. Our practices include no till buffer strips and vertical tillage. We try to do a lot of no-till planting when we can, you want to leave about 20 percent residue on top of the soil.

Cyril Clarke, Executive Vice President and Provost, Virginia Tech
It's really important to understand that there are inextricable linkages between human health, animal health, and the environment. About three quarters of emerging infectious diseases in people, like COVID-19, are actually derived from animals.



Jewel Bronaugh, Commissioner, Virginia Department of Agriculture and Consumer Services
This is not the time to exclude anyone from the table, when I think about the work of black and brown men and women, farmers and the contributions that they've made to agriculture, through their innovation, their heritage, their embracing our environment, the innovation and creativity is very important, but they need the opportunity to be at the table.

Chad Leman, Leman Farms, Illinois
Pigs don't recognize weekends and they certainly don't recognize pandemics, like COVID-19. We immediately realized that we have got to get pigs on different diets. We would have been struggling with what to do with 350-pound pigs, if we had not been able to incorporate different rations into our feed mill almost immediately.

Pushpa, smallholder farmer, Haryana State, India
I have been farming for 10 years. We grow tomatoes, onions, and other crops. Sehgal Foundation guided us to test our soil and made us aware of the right doses of fertilizers. You can see the difference in the onion crop on my field.

Alberto Salas, Specialist in Genetic Resources (retired), International Potato Center (CIP)
The potato gene bank will make sure we have material to be able to fight all the problems that may come and ensure the food security of humanity. It is a very important legacy.

CULTIVATING PRODUCTIVITY IN A TIME OF PANDEMICS

Agricultural productivity is not just essential for sustainably meeting the demands of a growing world. The technologies and practices that increase productivity can also be harnessed to cultivate resilience, especially to pandemics that can strike with little warning, with catastrophic results.

Agricultural productivity, measured as Total Factor Productivity or TFP, increases when producers use technologies and production practices that generate more livestock and crops from the same amount (or less) land, labor, fertilizer, machinery, feed, and livestock. TFP increases when large numbers of producers adopt technologies and practices that use inputs more efficiently to produce additional output. This can include precision mechanization, mobile agronomic advice, advanced seed varieties, healthier animal feed, and improved nutrient management or animal care practices.

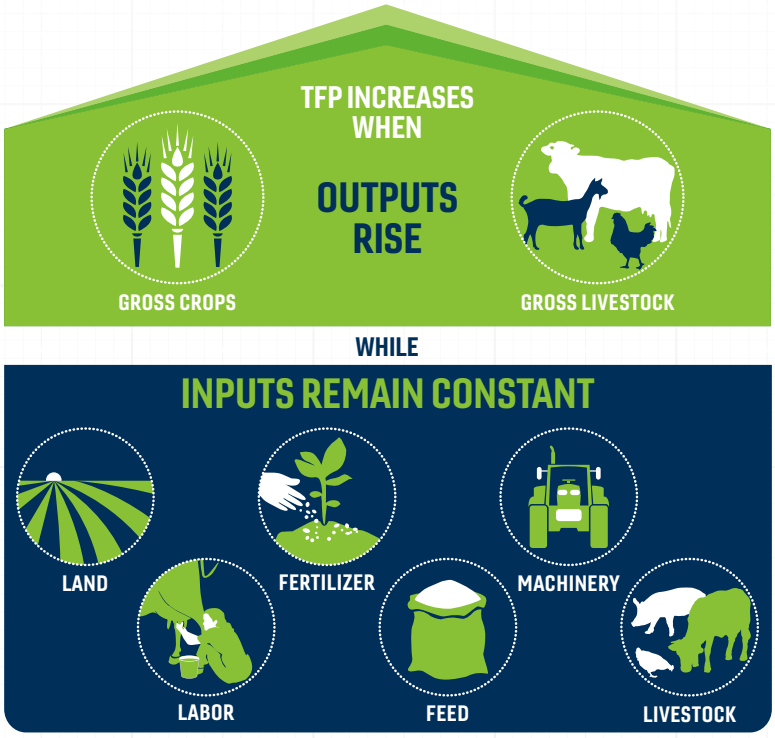
These tools also form a foundation for improving agricultural resilience. Resilience is about more than surviving a crisis. A recent review of the literature on agricultural resilience by the Organization for Economic Co-operation and Development (OECD) outlines **three capacities essential to resilience on the farm and for the agricultural system as a whole.**[17]

- The capacity to **absorb the impact** and cope with the immediate problems with minimal negative outcomes.
- The **capacity to adapt** during a crisis by changing farm or supply chain management to minimize the impacts.
- The **capacity to transform** production practices and supply chains to prevent and prepare for future crises.

Productivity-enhancing technologies and practices provide the tools, data, and know-how to absorb, adapt, and transform agricultural systems in a time of pandemics. For example, precision technologies provide producers with real-time data that can be used to track and isolate disease outbreaks in crops or livestock. As the world's attention turns to agricultural resilience, productivity growth needs to be at the heart of the conversation.

TFP is a ratio that measures changes in how efficiently agricultural inputs (land, labor, fertilizer, machinery, feed, and livestock) are transformed into outputs (crops and livestock.)

Figure 1: Total Factor Productivity Growth



ADDITIONAL APPROACHES FOR INCREASING AGRICULTURAL OUTPUT

LAND EXPANSION: Expanding the amount of land used to produce crops and livestock by converting forests and grasslands to agricultural production

IRRIGATION EXTENSION: Deploying irrigation systems to protect land against drought, improve yields, and permit multiple cropping seasons.

INPUT INTENSIFICATION: Increasing applications of fertilizer, machinery, labor, seeds, herbicides, animals, feed, and other inputs to produce more crop or livestock output on current agricultural land.

KEY MESSAGES

1 To sustainably double the amount of food, feed, fiber, and bioenergy needed for nearly 10 billion people in 2050, **agricultural productivity needs to increase at an average annual rate of 1.73 percent.**

2 According to the 2020 GAP Index, **TFP growth is below the target, growing at an average annual rate of 1.63 percent.** (See page 9.)

3 **TFP growth in low-income countries** continues its precipitous decline, growing at an **average annual rate of just 0.58 percent,** far below Sustainable Development Goal 2.3 to double agricultural productivity of smallholder farmers, many of whom live in low-income countries.

4 **Without significant increases in productivity and output,** low-income countries with rapidly growing populations will not have sufficient resources to grow or import enough food for their citizens, perpetuating cycles of hunger, malnutrition, and poverty.

5 While the recent outbreaks of **African Swine Fever in Asia and desert locust in Africa** are not reflected in the current data, the **impact on TFP in those regions will be substantial.**

6 **Technologies and practices that support productivity growth also support resilience.**[18] They provide tools and information agricultural producers need to absorb the impact of a crisis and adapt to the challenges it brings. (See page 7.)

7 With access to a variety of technologies, up-to-the-minute data, and strong social safety nets, **producers in the traditional productivity powerhouses in North America and Europe have distinct advantages in times of pandemics.** (See page 10.)

8 Policy and investment priorities for productivity and resilience include: increasing funding for agricultural research and development, expanding agricultural extension and farmer training programs, accelerating adoption of science-based and information technologies, strengthening the social safety net, and improving financial risk-management tools for producers. (See pages 14-15.)

9 **Strengthening human capital** (the skills, knowledge, and experience possessed by an individual or population) **and social capital** (the networks of relationships among people who live and work in a particular society) is critical for productivity growth and resilience. (See page 16.)

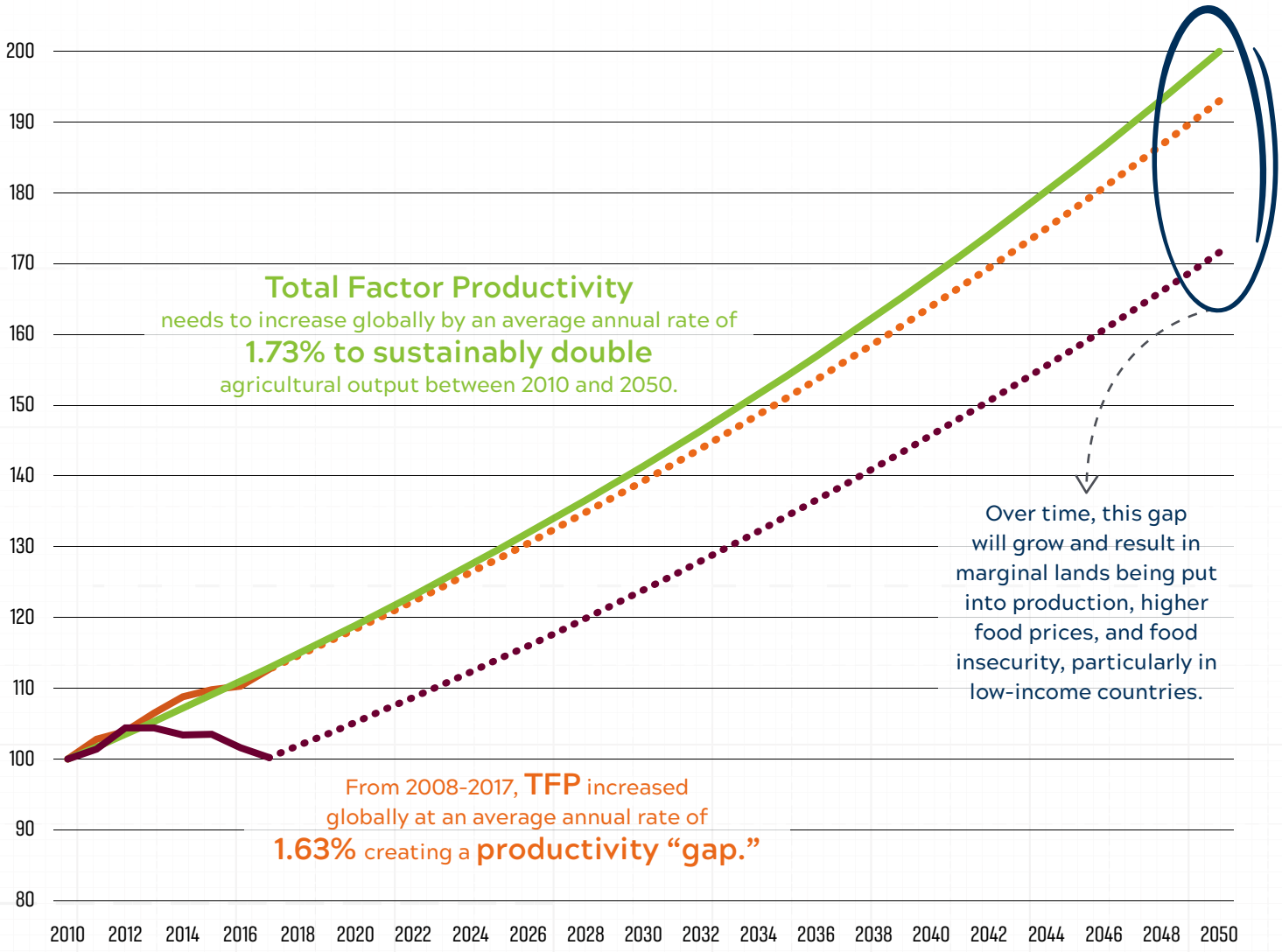
COVID-19 AND AGRICULTURAL PRODUCTIVITY

COVID-19 impacts on TFP growth are uncertain, nevertheless, there are areas of concern.[19] Travel restrictions and health anxieties have reduced the amount of agricultural labor available. As a result, fields have gone unplanted and unharvested. Disruptions to global and local supply chains are limiting access to essential inputs, such as fertilizer, especially for smallholder farmers.

It is clear that the global unemployment crisis created by efforts to contain COVID-19 is decreasing incomes and reducing per-capita food expenditures. However, the latest *Agricultural Outlook (2020-2029)*, predicts this will be a relatively short-term decline in demand.[20]

Population growth remains the primary driver of agricultural demand and the *Outlook* argues that the long-term trajectory of demand growth for agricultural products remains unchanged. While the rate of global population growth has slowed, the expected population in 2050 still hovers between 9 to 10 billion people. Focusing on increasing output through productivity growth remains as vital as ever, especially with the added pressures from pandemics and climate change.

2020 GLOBAL AGRICULTURAL PRODUCTIVITY INDEX



Sustainable Development Goal 2.3 calls for **doubling agricultural productivity of small-scale farmers by 2030.** Many live in low-income countries where the rate of TFP growth is declining rapidly.

Source: Current and projected TFP growth provided by USDA Economic Research Service (2020).

UNEVEN PRODUCTIVITY GROWTH RAISES CONCERNS FOR RESILIENCE

For chronically food-insecure countries, such as India, Pakistan, and Mexico, the Green Revolution of the 1960s and 1970s brought high-yielding seed varieties, irrigation, mechanization, and increased availability of fertilizer and crop protection products. (Figure 2, orange bar.) Widespread adoption of these technologies drove a surge in food crop production that saved hundreds of millions of lives.

As agricultural technologies and practices improve, producers of all scales use their inputs more efficiently and sustainably. With precision mechanization, farmers produce more crops with less land, labor, and fertilizer. With improvements in animal genetics, veterinary medicine, and animal care practices, farmers produce more meat, milk, and eggs using less feed and fewer animals. Advanced transgenic and hybrid seed varieties include traits for pest resistance and herbicide tolerance. Best practices for nutrient and water management protect the natural resource base, while increasing crop output.

As these and other technologies have been more widely adopted, Total Factor Productivity growth has become the largest source of **global** agricultural output growth. (Figure 2, green bar.) Yet, TFP growth is uneven across the world, with significant implications for the resilience of our agriculture and food systems.

In **high-income countries,** productivity growth has been the sole source of agricultural output growth since the 1980s (Figure 3.) Widespread adoption of advanced technologies has made these countries among the most efficient in the world. **The traditional productivity powerhouses in North America and Europe have distinct advantages in times of pandemics.** Advanced seed technologies, veterinary services and animal care, and accurate agronomic and market data, make it easier to adapt in a time of crisis. Government agencies in high-income countries have infrastructures for detection, management, and eradication of pests and disease

TFP — Gross amount of crop and livestock outputs per inputs of labor, capital and materials

Inputs/Land — Gross amount of fertilizer, machinery, feed and labor per hectare of agricultural land

Irrigation — Extension of irrigation to agricultural land

Land Expansion — Extending agriculture to previously forested areas or grasslands

Agricultural Output Growth Rate

Figure 2: Sources of Agricultural Output Growth: **Global**, 1961–2017

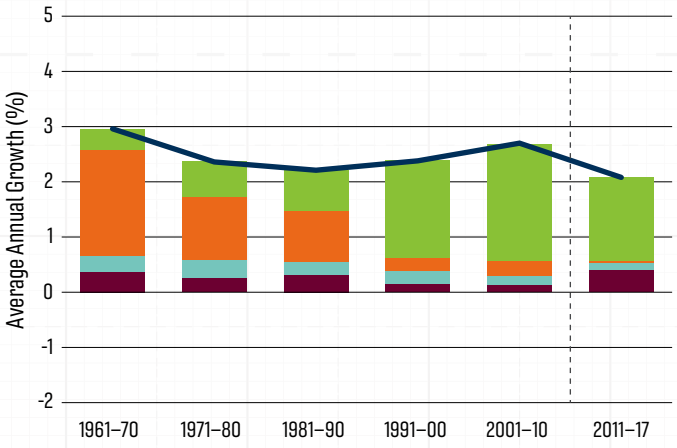
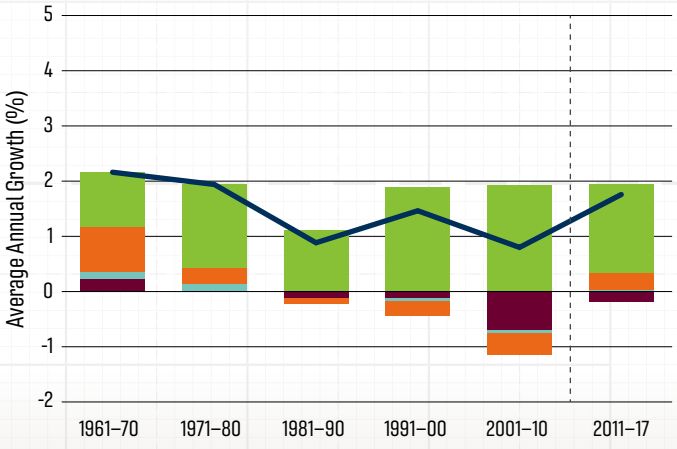


Figure 3: Sources of Agricultural Output Growth: **High-Income** Countries, 1961–2017



Source: USDA Economic Research Service (2020).

Figure 4: Sources of Agricultural Output Growth: **Upper-Middle-Income** Countries, 1961–2017

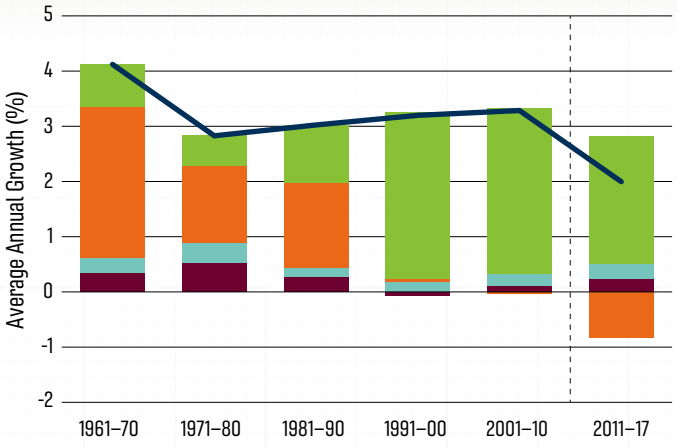


Figure 5: Sources of Agricultural Output Growth: **Lower-Middle-Income** Countries, 1961–2017

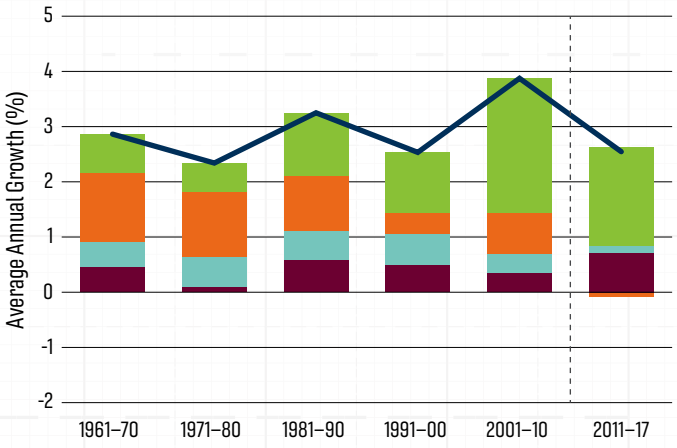
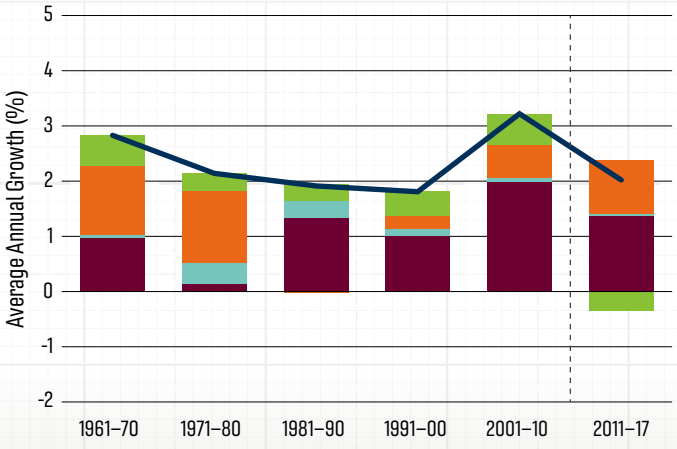


Figure 6: Sources of Agricultural Output Growth: **Low-Income** Countries, 1961–2017



Source: USDA Economic Research Service (2020).

outbreaks in people, crops, and livestock. Agricultural extension networks respond in times of crisis, and robust research systems develop preventative tools that keep pandemics at bay. Access to affordable insurance and financing, as well as safety net programs, enable producers to absorb the worst financial impacts of a pandemic-scale crisis.

TFP growth in the **middle-income countries** (Figures 4 and 5) is driven by a handful of countries, particularly China, India, and Brazil. Rapid adoption of improved technologies and practices, farm consolidation, and investments in agricultural research and farmer training have significantly improved productivity growth over the last few decades. While middle-income countries continue to show the highest rates of TFP growth, by country income group, growth is slowing down. The presence of advanced technologies and strong agricultural research systems supports resilience. Nevertheless, **there are significant vulnerabilities**, for example, underdeveloped or inefficient infrastructures for detection, management, and eradication of pests and disease outbreaks.

Producers in **low-income countries** are struggling to retain productivity gains (Figure 6.) The decrease in TFP growth for 2011-2017, is a disturbing trend. Low-income countries are highly vulnerable to crop and livestock pests and diseases, such as fall armyworm and East Coast Fever. These emergencies are compounded by chronic problems such as prolonged internal or external conflict, and high rates of food insecurity, malnutrition, and poverty.[21] **The presence of multiple short-term and chronic crises complicates efforts to improve productivity growth.** Agricultural research and innovation in and for low-income countries often prioritizes crisis management: seed technologies to address drought or pest outbreaks, for example. Agricultural extension and farmer training programs, which are critical for improving the productivity and resilience of producers, are significantly underfunded.

TFP TRENDS IN KEY COUNTRIES AND REGIONS (2001–2017)

Productivity growth varies widely, even within country income groups. Looking at TFP growth in key regions and countries provides an additional perspective on productivity trends. (Figure 7.)

Sub-Saharan Africa: Underinvestment in agricultural research and development and farmer training throughout most of the continent has left farmers with few options for increasing output.[22] With limited access to productivity-enhancing technologies such as mechanization, advanced seeds, fertilizer, and improved livestock breeds and feed, farmers are expanding crop and grazing lands at an alarming rate, with negative impacts on biodiversity.

India: With TFP growing at an average annual rate of 3.32 percent, India has benefited from significant investments in agricultural research and higher education.[23] Extending and improving the country's irrigation systems boosted productivity on already cultivated land. Increased access to mechanization services and improved seed genetics have reduced the need for agricultural labor.

China: The government has prioritized the consolidation of agricultural land, creating opportunities for greater efficiency, particularly in the wheat growing regions in northern China. Greater access to mechanization services and other inputs have reduced the amount of agricultural labor required, at all scales of production. Fertilizer use efficiency is also improving considerably.[24] The TFP impact of the loss of 40 percent of the swine population to African Swine Fever is uncertain but will likely be significant.

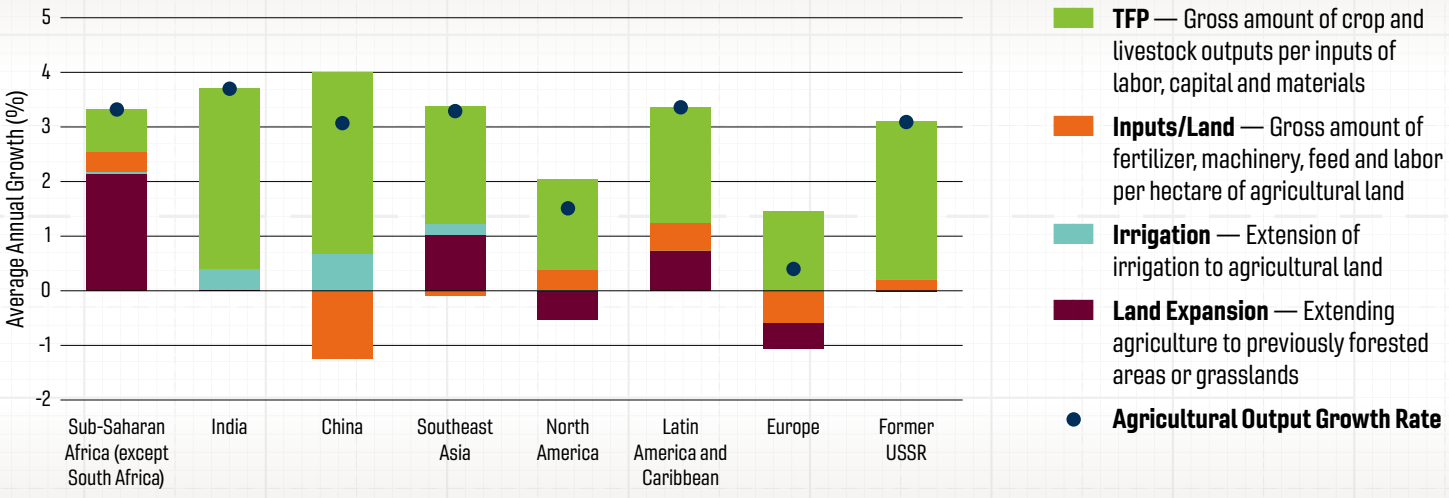
SE Asia: Increases in labor efficiency, thanks to adoption of new and improved technologies and practices, has driven TFP growth in the region.[25] Competition for land with urban areas has forced producers to maximize efficiency to increase output.

North America: The rate of TFP growth in North America has slowed to one to two percent annually since the turn of the century. The slowdown coincides with reductions in public-sector agricultural research and development investments – the cornerstone of TFP growth. The technology pipeline, including CRISPR-Cas and artificial intelligence, holds the potential to provide a TFP boost in coming years. Yet, questions remain about which technologies consumers will accept.

Latin America and Caribbean: Precision agriculture, advanced seed technologies, and improved livestock management systems have driven substantial TFP growth in feed grains and livestock production in countries like Brazil. Smaller countries, such as Guatemala, are using inputs and land more efficiently in fruit and vegetable production.

Europe: TFP growth is seen as a conservation strategy, resulting in less land and inputs used in production, but not an increase in output growth. Both output and TFP growth are strong in breadbaskets of the **former USSR,** particularly Russia and Ukraine. Following the economic reforms of the 1990s, large agro-holdings have increased efficiency by applying market-oriented agribusiness principles and practices.[26]

Figure 7: Sources of Agricultural Output Growth: **Key Countries/Regions**, 2001–2017



Source: USDA Economic Research Service (2020).

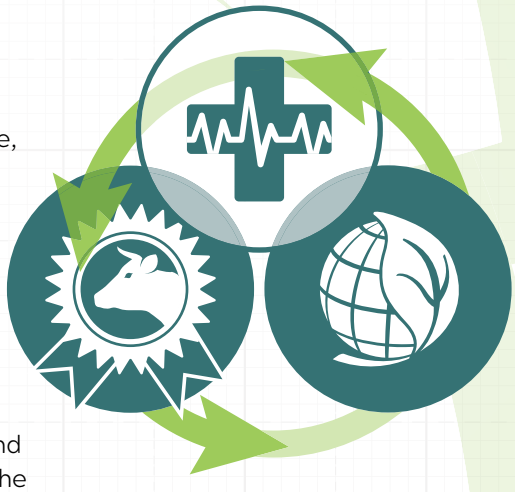
A RISK-MANAGEMENT APPROACH TO AGRICULTURAL RESILIENCE

Coronaviruses, such as the one causing COVID-19, are part of a "risk landscape" that threatens the health and productivity of the people, animals, and plants in our agricultural systems.

COVID-19 is not the kind of pandemic-scale outbreak typically associated with agriculture, yet its disruption of the supply chains for agricultural outputs and inputs is unlike anything in living memory. It is a stark reminder that 75 percent of new and emerging infectious diseases are passed from animals to humans. Coronaviruses, such as the one causing COVID-19, are part of a "risk landscape" that threatens the health and productivity of the people, animals, and plants in our agricultural systems. The Global Agricultural Resilience Imperative (see pages 4-5) is just a glimpse of the array of current and future risks to the world's agricultural systems and the people in them. Climate change will exacerbate the pest and disease threats, in addition to the threats it already poses to the sustainability of agricultural production.

A risk-management approach to resilience is well suited to the complexities of pandemic-scale challenges and climate change. It emphasizes proactive strategies, such as One Health, a widely adopted paradigm that acknowledges the symbiotic and complex interactions between the health and productivity of humans, animals, and the environment.

ONE HEALTH: HEALTHY PEOPLE, ANIMALS, AND ENVIRONMENT



The One Health approach brings together experts in public health, agriculture, and natural resource management to identify strategies to promote better health and disease reduction. Rift Valley Fever (RVF), for example, is a zoonotic disease caused by a virus that is transmitted by mosquitoes. RVF outbreaks are common in sub-Saharan Africa following periods of heavy rain, when standing water allows mosquitoes to thrive. RVF afflicts animals and people, though its victims are not always symptomatic, making it difficult to trace and treat. By analyzing the human, animal, and environmental factors, researchers determined that vaccinating livestock was the most effective and affordable way to break the chain of infection.[27]

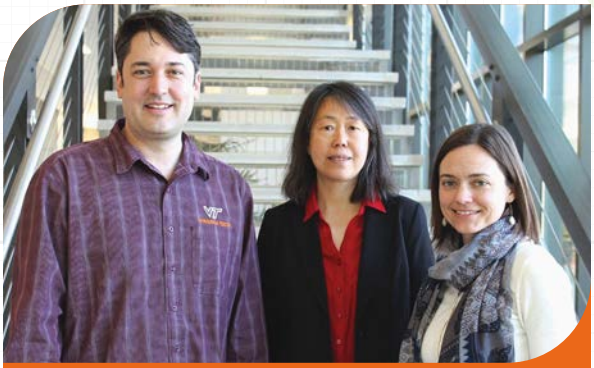


Photo credit: Virginia Tech

Virginia Tech researchers Roger Schürch, Kang Xia, Cassidy Rist, and Douglas Pfeiffer (not pictured) were awarded a US $1.4 million grant to undertake the economic and environmental impact assessments for BOHEMIA (Broad One Health Endectocide-based Malaria Intervention in Africa).

Virginia Tech researchers are part of a project that is taking a One Health approach toward malaria, the leading cause of illness and death around the world.[28] While there has been extraordinary progress against the disease during the past 50 years, eradication efforts have stalled. The project, called BOHEMIA (Broad One Health Endectocide-based Malaria Intervention in Africa), is distributing the drug ivermectin in a mass drug administration campaign for people and livestock in Tanzania and Mozambique. The Virginia Tech team will evaluate the environmental impact of the treatment, as well as any indirect economic benefits from improved health and productivity of people and livestock, due to the reduction in malaria incidences.

PRODUCTIVITY GROWTH: A "NO-REGRET" INVESTMENT IN A TIME OF PANDEMICS

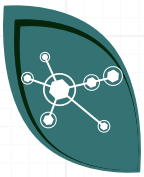
Total Factor Productivity is a measure of efficiency, but it is also a strong indicator of the capacity to manage risk. In the case of livestock production, for example, healthy animals are more productive animals. They generate more output per animal and need less feed, water, and other resources. Animal care practices to support productivity growth include vaccinations, protective housing, monitoring animals for signs of illness, isolating sick animals for treatment, and eliminating breeding grounds for disease vectors, like ticks. These same practices are essential to preventing and managing pandemic-style outbreaks of diseases, such as an avian flu or African Swine Fever.

The OECD report on agricultural resilience calls appropriate investments in agricultural productivity growth a "no-regret" strategy to strengthening resilience. The report recommends investments in, "the provision of information, education, infrastructure, and research and development," all of which are essential public goods advocated for in the GAP Report.[29]

These policy goals, explored in more detail in the online edition of the GAP Report, have benefits for producers, consumers, and the environment. These goals provide agricultural producers the innovations and knowledge they need to increase their output more efficiently, improve profitability, reduce waste and loss, and create opportunities for economic growth. These policies and investments protect productivity gains during times of crisis and ensure greater productivity in the future.

Invest in public agricultural R&D and extension services

Public sector agricultural R&D and extension services generate innovation and information that facilitate environmentally sustainable agricultural output growth, improve human health, and support a vibrant agricultural economy. Public-sector R&D generates the scientific knowledge that is translated into tools and information used to prevent and respond to pandemic-scale outbreaks. Agricultural extension systems, and other farmer training networks, deliver information that helps farmers evaluate their risk landscape, and take appropriate measures to prepare for and adapt to crises.



Embrace science- and information-based technologies and practices

Science- and information-based technologies and practices enable producers of all scales to manage environmental and economic risks by improving their sustainability, resilience, and competitiveness. Pests and diseases that attack and destroy crops and livestock are caused by complex pathogens carried by vectors that cross geographies with ease. They can also mutate, developing resistance to previous treatments. The next generation of scientific technologies, including CRISPR-Cas, will be vital tools for preventing and managing these pernicious threats. Biological crop protection technologies such as fungi, compliment conventional chemical approaches to pest and disease management. Sensor technologies and mobile agronomic information services are used at all scales of production to identify and control pest and disease outbreaks.

Improve infrastructure and market access for agricultural inputs and outputs

Efficient transportation, communications, and financial infrastructures, as well as affordable and equitable access to markets for agricultural inputs, services, and outputs support sustainable economic growth, diminish waste and loss, and reduce costs for producers and consumers. Improving transportation infrastructures would increase access to crop protection products and livestock vaccines for many of the world's farmers. Strengthening mobile communications networks is especially vital in pandemics, enabling large numbers of producers to receive up-to-the-minute information about outbreaks and how to respond. Affordable financial services provide a vital lifeline during crises, allowing producers to hold on to their most valuable capital assets, including land, machinery, and livestock.

Cultivate partnerships for sustainable agriculture, equity, and improved nutrition

Public-private-producer partnerships supporting agricultural development, equity, and nutritious food systems leverage public and private investments in economic development, natural resource management, and human health. Technology alone is not sufficient to strengthen productivity and resilience. Partnerships play an important role in strengthening human capital, a set of skills and knowledge possessed by producers and others in the agricultural value chain, that are essential in a time of pandemics. Likewise, social networks among people who live and work in a particular society provide many forms of support during pandemic-scale challenges.

Expand and improve regional and global trade

Forward-looking trade agreements, including transparent policies and consistently enforced regulations, facilitate the efficient and cost-effective movement of agricultural inputs, services, and products to the people who need them. Trade plays several important roles during times of pandemics. It brings food to places where food crops have been devastated by pests. Animal vaccines and crop protection products, such as pesticides need to be brought into impacted areas. Access to agricultural inputs, such as seed and fertilizer, helps farmers recover quickly following a crisis.

Reduce post-harvest loss and food waste

Reducing post-harvest losses and food waste increases the availability and affordability of nutritious food, eases the environmental impact of food and agricultural production, and preserves the value of the land, labor, water, and other inputs used in the production process. COVID-19 has underscored for many people around the world the critical importance of reducing food waste. When food was not as readily available in stores, many consumers realized just how much they were wasting and took measures to waste less. However, COVID-19 also saw a significant increase in post-harvest loss as a lack of agricultural labor and sluggish supply chains meant thousands of tons of food and livestock products never left the field or the farm.

PARTNERSHIPS FOR PRODUCTIVITY AND RESILIENCE

Partnerships are essential building blocks for human and social capital. They provide access to knowledge and tools that help individual producers improve their productivity, while strengthening the networks and community bonds that are essential to success, especially in a time of pandemics. Here, the Supporting and Consultative Partners of the GAP Report share stories of their work around the world. Full versions of these stories, and more, can be found on the website: **globalagriculturalproductivity.org**.

The icons with each story indicate which parts of the Global Agricultural Resilience Imperative (see pages 4-5) they are addressing: people, livestock, or crops.

Keeping farms running, while keeping farmers safe in Latin America

Photo credit: John Deere

The COVID-19 pandemic led to a drastic shift in the importance of virtual tools, as the world rushed to adopt and embrace remote work – including farmers.

Farmers at the medium- to large-scales who use complex machinery on their farms, however, depend on the in-person support from equipment manufacturers to ensure their machines operate optimally.

With safety measures like shelter-in-place and social distancing enacted in response to the pandemic, associates for manufacturers had to embrace virtual assistance for their clients. John Deere dealers in Latin America pivoted to a remote model, with measurable success.

Preparing for virtual services

Many dealers had been preparing for the growth in adoption of technologies like Remote Display Access, which enable dealers to remotely assist customers with optimization and setup to get the machine in the field to do the job.

John Deere dealers in Latin American locations have been establishing Operations Support Centers in their dealerships for several years. **A total of 71 Operations Support Centers have opened to provide centralized, proactive services to John Deere customers.** These dealers provide support using John Deere Connected Support™, which allows dealers to remotely monitor and proactively service machines.

When the COVID-19 pandemic hit, these centers were able to ramp up services, and several even offered free access to their Operations Support Center during the first part of the pandemic.

Community-led solutions grow crop yield and capacity to mitigate risk for Indian smallholder farmers

During the COVID-19 pandemic, India's lockdown and lack of public transportation led to a labor shortage for the winter crop harvest, generating waste and stress for smallholder operations.

In addition, this particularly vulnerable group is more likely to struggle with the impacts of climate change. Climate change may lead to a decrease in yields for India's major food crops by as much as 10 percent by 2035.

One way to mitigate risk is through improved agronomic expertise. While rural villages may lack resources, they have strong communities and motivated leaders. In 2008, Mosaic, The Mosaic Company Foundation, and S M Sehgal Foundation teamed up to create the Krishi Jyoti project, which addresses agricultural productivity through community-led solutions.

continued on next page

Community-led solutions (continued)

Krishi Jyoti, or "enlightened agriculture," equips smallholder farmers with improved agricultural inputs and practices. This initiative improves quality of life through its community-led transformation efforts focusing on three primary drivers: agriculture, water management, and education. These all-encompassing efforts reduce risks by contributing stability to the community and its farmers.

By the numbers, more than **60,000 people including 7,000 smallholder farmers** in the past **12 years** have benefited in **85 Indian villages** covering over **20,000 acres,** with an average crop **yield increase of 18-35 percent** in wheat, mustard, pearl millet, and cotton. Some growers have even seen crop yields increase by 45 percent.

Farmer income has increased, ranging from **US $63 to US $360 per hectare** due to increased productivity. Over 50 percent of farmers continue to use the best practices and knowledge gained from the program.

Photo credit: USDA

Virginia Tech researchers using genomic advances to help save soybeans from billions in losses by pathogens

Adopted from "Saving Soybeans," in Retaking the Field Volume 5 by the Supporters of Agricultural Research (SoAR) Foundation. The Virginia Tech College of Agriculture and Life Sciences is a member of FedByScience, a project of the SoAR Foundation.

The **total value of the U.S. soybean crop was US $41 billion** in 2016, according to the American Soybean Association. However, the valuable crop is heavily impacted by root and stem rot diseases caused by oomycete pathogens, fungal-like microbes that cause highly destructive plant diseases and plague almost every type of row crop grown.

Oomycetes, which contain hundreds of species, along with other plant pathogens, are **estimated to cost billions of dollars in crop losses annually.** A particular type of oomycete, *Phytophthora sojae*, is one of the most disruptive pathogens in soybean fields across our nation.

The United States Department of Agriculture funded a multi-disciplinary team of researchers to combat oomycete diseases. Virginia Tech led the challenge in collaboration with 19 universities including Michigan State University, University of Georgia, Iowa State University, and others.

This consortium used genomic information to better understand the disease's prevalence and to produce new tools to mitigate its impact. More recently, new tools to decode oomycete genomes were recently reported by Virginia Tech's David Haak and John McDowell. **They proved that combining two generations of genomic sequencing technology has immense advantages.**

Using first-generation technology, it takes one-and-a-half years and around US $2 million to sequence the *P. capsici* genome. **By combining technologies, it takes just nine days, costs only US $1,000, and can sequence 100,000 times more information in roughly 1.5 percent of the time.** Using these genomic advances opens the door to developing new diagnostic tools, identifying genes for breeding disease-resistant soybeans, and managing the pathogen. Preliminary estimates by agricultural economists suggest that these and other tools to fight oomycetes could generate billions of dollars in savings globally.

Silage program aims to sustainably boost dairy productivity in Kenya

Kenyan farmers produce more than five billion tons of milk per year, the most in Africa. Optimizing diets of livestock improves the efficiency and environmental impact of livestock production. Making silage can also help farmers overcome seasonal feed shortages and avoid dry-season shortages of fodder.

Corteva Agriscience™ is piloting a two-year dairy silage initiative in Kenya that aims to bring these benefits to 50 emerging farmers and 5,000 smallholder farmers while also helping improve the productivity of their cows. In partnership with Land O'Lakes, Corteva will also work to connect these farmers, a majority of whom are women, to a market.

The emerging farmers, defined as those having 30 or more milking cows and 20 to 60 hectares of land, are located in the target regions and districts of Nakuru, Kericho, Kiambu, Eldoret, and Nyeri. Corteva is facilitating access to capital for land preparation, harvesting, and ensiling equipment. They are also coordinating farmer training on the right time to harvest, harvest processing prior to ensiling, and the correct way to make the silage.

Corteva has in-country forage testing capabilities they can use to better understand the quality of forage. Complete forage testing will help demonstrate to farmers the impact of the silage program, and will benefit both commercial and smallholder farmers.

Over time, some commercially-oriented smallholders with adequate land may be positioned to produce their own silage. In these cases, access to capital will be required as will training on production and post-harvest handling. These efforts aim not only to increase farmer profitability, they help farmers further improve their productivity sustainably.

Photo credit: CIAT

Photo credit: Bayer Crop Science

Better Farms, Better Lives — Responding to COVID-19

While COVID-19 has rocked economies and disrupted lives all over the world, it hasn't done so equally. For **smallholder farmers, who farm 10 hectares at most,** there is little room to absorb the shock of a disruption. Yet, they **feed as much as 80 percent of the regions where they live and work,** and so much depends on their productivity.

To assist smallholder farmers in Asia, Africa and Latin America who are facing additional challenges resulting from COVID-19, Bayer Crop Science, through its societal engagement activities and new "Better Farms, Better Lives" initiative, is providing up to **two million smallholder farmers seeds and crop protection inputs as well as assistance with market access and support for health and safety needs.**

Bayer's hope is that the Better Farms, Better Lives initiative will result in resiliency for smallholders and ensure this current health and economic crisis does not turn into a hunger crisis. Knowledge and training with new products and sustainable practices, connections with markets to ensure fair prices, and financing to provide access to cash at key times of the year are longer-term offerings. This project is also making a point to focus on women, who make up no less than 40 percent of smallholder farmers–and growing. Women have historically had less access to resources than male farmers.

Photo credit: Smithfield Foods

Biosecurity measures protect from the crippling African Swine Fever

African Swine Fever (ASF), a highly contagious, incurable and fatal viral disease that affects hogs, has killed hundreds of millions of animals in Asia, Europe, and Africa in the past three years.

In response, Smithfield Foods, Inc. is enhancing its already robust biosecurity procedures, taking notable steps to protect its farms from the virus. **Strong biosecurity measures** that keep animals safe and healthy on farms are not only vital to business – they also **support efforts to help feed a growing world population, provide jobs in local communities and help sustain other businesses** in the global agricultural supply chain, such as corn and soybean farming.

Smithfield's biosecurity policy covers the animal production process at individual farms, as well as the movement of vehicles, animals, personnel and equipment between these facilities.

Employees and visitors must "shower-in" and change into clean clothing before entering all sow farms and must also "shower-out" prior to leaving. In addition, equipment and supplies delivered to sow farms, as well as vehicles, must be disinfected prior to being allowed inside the farm complex.

An ASF risk analysis in Poland and Romania revealed that people entering the farms and what they bring with them were the biggest risk factors. In Poland, the company has banned bringing any food onto the farm and arranged for a catering company to provide lunch to team members.

Combatting the invasive fall armyworm in Africa

Fall armyworm first appeared in Africa in 2016. Capable of feeding on more than 80 plant species, the quick-moving pest threatened the agricultural productivity and food security of farmers and their families throughout the continent.

In Ghana and Tanzania, **ACDI/VOCA** worked to combat fall armyworm by implementing two projects for the U.S. government's Feed the Future initiative, funded by the **United States Agency for International Development.**

Feed the Future Tanzania Nafaka II Activity collaborated with the Tanzanian government and International Institute of Tropical Agriculture to train agricultural extension officers and village-based advisors in tracking and managing fall armyworm outbreaks. They then cascaded the training to **71,500 smallholder farmers.**

As part of a Ghanaian government taskforce, **Feed the Future Ghana Agricultural Development and Value Chain Enhancement (ADVANCE) II Project** provided guidance on the recommended timing, dosage, and plant stage for applying pesticides, which informed the national response framework.

Pesticides, public awareness campaigns, and field trial demonstration plots helped curtail the invasion of the fall armyworm. By 2020, the threat was manageable in many parts of Africa, especially where strong buyer-seller relationships and market incentives for pesticide use existed.

Photo credit: ACDI/VOCA

Biofortified staple crops reducing the risk of malnutrition during pandemics

The COVID-19 pandemic is a stark reminder that people everywhere need good nutrition to be resilient in the face of health threats and to lead productive lives.

For smallholder farming families and other vulnerable populations in low- and middle-income countries, nutrition deficiencies can be particularly debilitating, threatening these families' health, livelihood, and ability to withstand shocks, including pandemics.

HarvestPlus and its partners address this by getting micronutrient-rich, biofortified varieties of staple crops on the plates of these farming families and other vulnerable populations.

In Colombia, 13 percent of children under five are stunted (low height for their age.) Zinc plays an essential role in maintaining optimal childhood growth and a healthy immune system. HarvestPlus released the first hybrid variety of zinc maize in the country in 2019, offering an opportunity for additional nutrition and income for the country's coffee farmers.

Such health-boosting varieties of maize are aimed at resource-poor families or rural communities who rely on staple crops for much of their diet because they can't afford to eat nutritionally diverse diets.

Developed by HarvestPlus and the International Maize and Wheat Improvement Center (CIMMYT), **the hybrid variety of zinc maize contains 28 percent more zinc than non-biofortified maize.** Arepas (corn cakes) made with this new hybrid can be considered a good source of zinc, since the daily consumption of a zinc-biofortified maize arepa would provide up to two times more zinc than those made with commercial maize.

By enhancing the micronutrient content of staple crops such as maize, regular consumption improves nutrition and health, giving consumers further protection from risks like viral outbreaks.

Photo credit: Tanager

Adapting to a pandemic to serve India's smallholder farmers

In Uttar Pradesh, Tanager's five-year Shubh Mint Project – supported by Mars Wrigley, Symrise, and GIZ – works with 25,000 smallholder mint farmers in Uttar Pradesh. With corporate partners, Tanager works to increase adoption of good agricultural practices for production of mentha arvensis – a mint variety grown for oil – to improve the livelihoods of farmers, their families, and communities. The project also established an inclusive, traceable, and sustainable mint oil supply chain for Mars Wrigley.

When COVID-19 hit, farmers in the program experienced a slight impact on mint oil yields, especially in areas newer to the project. Fearing a demand slowdown with limited market activities, movement restrictions, and cash availability, Tanager conducted a rapid phone assessment to determine the farmers' most pressing needs.

After the rapid assessment, farmers received (and continue to receive) regular phone calls to share updates on the status of their mint season. To date, every farmer received an average of eight contacts during COVID-19 to check in on farm status, with priority given to contactless engagements.

Tanager's ongoing work to help farmers access a diverse and nutritious diet is also important for maintaining health – particularly critical in the midst of a pandemic. As part of the Shubh Mint project, Tanager uses Self-Help Groups to encourage households to adopt the use of kitchen gardens to improve household nutrition, provide advice on starting and managing their gardens, and on-going support as the gardens developed.

Bringing drought monitoring and early warning systems to the Middle East and North Africa[30]

While drought cannot be stopped, it can be forecasted and its impacts substantially reduced. The Daugherty Water for Food Global Institute (DWFI) at the University of Nebraska is helping countries in the Middle East and North Africa (MENA) region predict future drought and devise drought mitigation plans for implementation.

The project delivers new insights, management plans, and drought resilience strategies at the national and local levels to reduce drought impacts on the food supply and on the quantity and safety of the water supply in vulnerable communities.

During the past year, DWFI updated its GloDET spatial datasets adding 2018 and 2019 to the database, and continues to work toward its goal of real-time evapotranspiration (ET) mapping. ET represents daily crop water use and can be used to determine the amount of plant stress. If remote sensing shows that a plant's ET is decreasing while its temperature is increasing, it can be a sign that the plant is stressed by a lack of adequate water and can be an early indicator of drought.

In the future, the daily ET product can be used to extend the estimation of the Evaporative Stress Index, used in drought detection and early warning. According to the FAO, this type of proactive monitoring is effective in enhancing the resilience of communities and their capacity to cope with drought.

Taking virus detection out of labs and into farmer fields in Africa[31]

Potato and sweetpotato farmers lose up to 60 percent of their yields annually to crop pests and diseases. Finding ways of managing sweetpotato viruses is a priority at the International Potato Center (CIP), **which has disseminated nutritious varieties to more than 6.5 million African households since 2010.** With recent breakthroughs in scientific research and the spread of technology, Africa's sweetpotato farmers may soon benefit from tools which could revolutionize disease control.

Whereas human immune systems create antibodies to destroy viruses, plants have simpler defense responses that chop up a virus's genetic material–ribonucleic acid (RNA)–when it enters a cell, hindering its ability to cause damage. In crops like sweetpotato, viruses accumulate and pass from one generation to the next in planting material, diminishing the yield of each successive harvest.

CIP virologist Jan Kreuze pioneered the use of genetic sequencing and reassembly of the RNA fragments from a plant's anti-viral response to identify the sweetpotato viruses that infect it. Kreuze led a field study that analyzed tissue samples from 1,168 sweetpotato plants in farmer fields across 11 African countries, identifying more than 15 viruses, some previously unknown.

Kreuze's team used the data to develop models to predict where specific viruses are likely to be found and how climate change will affect their distribution. Using a technology known as a LAMP assay, they identified genetic markers to develop a diagnostic field test for three common sweetpotato viruses. The assay is vital because infected plants are often asymptomatic, which complicates detection. In trials at four different sites in Kenya, the assay was 100 percent accurate, and both faster and cheaper than laboratory-based methods.

Foodborne disease education reduces food safety risks for consumers and producers in Peru

Photo credit: Purdue Center for Global Food Security

In Peru, the economic losses from foodborne diseases annually is estimated to be US $500 million. Peru is one of the few countries in the Americas categorized in the World Health Organization subregion stratum "D," with known high child and adult mortality resulting from foodborne disease. Campylobacter spp., norovirus and non-typhoidal *Salmonella enterica* are responsible for the majority of foodborne disease in this sub-region.

In late 2018, a group of researchers at Purdue University, led by Amanda Deering and Haley Oliver from the Food Science department, began a project aimed to improve food safety in the Arequipa region of Peru.

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Foodborne disease (continued)

The food safety group has worked closely with faculty and students at the National University of Saint Augustine (Universidad Nacional de San Agustín, UNSA), on a capacity-building program on food safety extension that can be available to local farmers.

The Purdue group has had success in sparking interest among farmers in Arequipa. During the trainings, the group has learned that local farmers have a greater awareness about chemical contaminants in crops than biological contamination, such as pathogenic bacteria.

Additionally, one of the group's surveys identified that **61 percent of local farmers use fresh manure as a soil amendment for their crops,** which include fresh produce. This is a clear example of lack of awareness about the risk of bacterial contamination and consumer foodborne illness with the application of fresh manure to fertilize crops that are eaten raw, including produce.

Photo credit: Sasakawa Africa Association

COVID-19's impact on agriculture systems in Africa

The Sasakawa Africa Association (SAA) conducted an assessment on the impact of COVID-19 on African food systems in June 2020. The survey was conducted virtually with key actors across the agriculture value chain, and covered the countries in which SAA operates: Ethiopia, Mali, Nigeria and Uganda (SAA focus countries); as well as Benin, Burkina Faso, Malawi, Mozambique, Sierra Leone and Tanzania.

Results of the assessment showcase the negative impact COVID-19 is having across the agriculture sector, including on productivity, delivery of extension services, and food security. A total of 433 respondents were surveyed. Key findings from the focus countries include:

- **Nigeria:** 88 percent of farmers surveyed cannot access their farms.
- **Mali:** 92 percent are expecting poor crop productivity this season.
- **Uganda:** 83 percent of farmers surveyed have not received any extension services since the beginning of the pandemic in March.
- **Ethiopia:** 75 percent believe the pandemic will affect their food security.

The survey also showed that teaching and learning processes of the universities and agricultural colleges has been significantly reduced, with a far-reaching impact on the overall education cycle and increased food and nutrition insecurity in Africa.

New app gives grain farmers access to data to increase productivity and mitigate threats in Mexico

New tools developed by CGIAR centers are narrowing the digital divide for smallholder farmers – equipping them with insight to be more productive and risk-tolerant.

Maize and wheat growers in Mexico can receive the results of agronomic analyses and site-specific recommendations on how to increase productivity and adopt more sustainable farming practices directly from their mobile phones.

Arming farmers with personalized recommendations and insights enables them to make informed decisions on sustainably increasing their productivity, which in turn buffers farmers from risk. A more productive farmer is better equipped to manage uncertain seasons of fluctuating business cycles and climate change.

This is possible thanks to a new Android and iOS application called AgroTutor, developed by the International Maize and Wheat Improvement Center (CIMMYT), the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), and the International Institute for Applied Systems Analysis (IIASA).

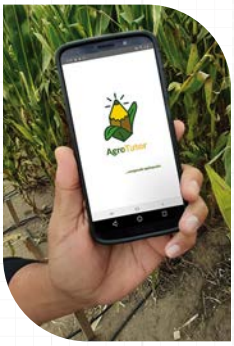

Photo credit: CIMMYT

AgroTutor delivers tailored information to farmers, such as historic yield potential, local productivity benchmarks, windows of opportunity to perform specific agronomic tasks, recommended agricultural practices, and commodity price forecasting.

The use of sophisticated data analysis systems is common in almost every field and industry, including agriculture, but have rarely been accessible or adapted to serve the needs of smallholder farmers.

FILLING THE GAPS: ESSAY ABSTRACTS

The GAP Initiative editors invited scholars and experts to submit essays based on their research about strategies for filling the "gaps" for productivity, sustainability and resilience. Below are abstracts of their work, with full versions available on the GAP Report website, globalagriculturalproductivity.org.

Building Inclusive and Empowering Agrifood Systems for Resilience

Authors: Laura Zseleczky based on Malapit, H. J., Meinzen-Dick, R. S., Quisumbing, A. R., & Zseleczky, L. (2020). Women: Transforming food systems for empowerment and equity. *2020 Global Food Policy Report*. pp. 36-45. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/9780896293670_04).

Agricultural communities face a range of shocks from animal disease and crop pest outbreaks to natural disasters, political conflicts, and health crises such as COVID-19. Women are often particularly vulnerable to such shocks given constraints they face in terms of access to information, household decision-making power, control over assets and resources, time burdens, and much more. Enabling agricultural producers to recover from shocks and mitigate the risks of future threats requires technologies, practices, and policies that ensure women's participation and access to benefits but also their empowerment to make strategic life choices. Necessary steps toward more inclusive agri-food systems include 1) increasing women's decision-making power and control over resources and assets within households and communities, 2) raising women's voices in key processes such as market negotiations, research, and political processes, and 3) including and considering women's needs and preferences in the design of programs and institutions. By building more inclusive and empowering agricultural production systems, communities can better withstand crises and bounce back stronger, with benefits not only for women but for all of society.

Florida Agriculture Faces the Economic Impact of COVID-19

Authors: Martha King, Farm Foundation; Abby Durheim, University of Nebraska-Lincoln

In this essay we review the impacts of COVID-19-related market interruptions on the Florida agriculture industry. Through interviews with academic and industry leaders in the agriculture sector we explore unique perspectives on the direct impacts to the Florida agricultural sector in 2020, and consider the work that needs to be done to ensure greater efficiencies, develop alternative markets, and promote safety and flexibility in the labor market. Further, we evaluate the impact of timing on produce sales and planting forecasting under conditions of uncertain demand. For more than eight decades, Farm Foundation has provided an objective, non-partisan home for open and healthy conversations and debate among food and agriculture leaders. Perspectives gained are the keystones of generating innovative options to address evolving issues like agricultural productivity in a time of pandemic.

Markets for Nutritious Foods: What role for the agricultural sector in market-based approaches to nutrition in Mozambique?

Author: Jessica Agnew, Center for International Research, Education, and Development (CIRED) , Virginia Tech

Given that, globally, more than two billion people suffer from deficiencies in micronutrients that are essential for human health, there is a need to identify ways to scale the distribution and demand for nutrient-rich foods, particularly among low-income populations. The potential for agricultural productivity to contribute to nutritional outcomes has long since been acknowledged. In recent years, the recognition of individuals as net food consumers has led to an increased focus on the biofortification of staple crops, a shift in agriculture-nutrition policies, and promotion of food safety. The agricultural sector also plays a key role in the availability and affordability of naturally nutrient-rich foods that play an essential role in high-equality diets. However, the potential the agricultural sector to support the success of market-based approaches to nutrition, particularly in the promotion of a variety of naturally nutrient-rich foods, has been largely unexplored. Using data collected from four urban markets in the northern Mozambican city of Nampula, this essay examines the nature of weekly consumer food purchases and the ways the agricultural sector might support increased demand for a variety of naturally nutritious foods. It concludes with exploring the potential synergies between innovation in agricultural productivity and agri-food value chains and market-based approaches to nutrition. Research at this intersection will be especially important in the face of threats to food security resulting from crises such as the COVID-19 pandemic, to ensure that consumers reliant on markets have access to the foods that are essential for reducing micronutrient deficiencies.

Extension and Advisory Services: Supporting Communities Before, During, and After Crises

Authors: Benjamin Grove, Global Programs, College of Agriculture and Life Sciences and Virginia Cooperative Extension, Virginia Tech; Thomas Archibald; Agricultural, Leadership, and Community Education, Virginia Tech; Kristin Davis, International Food Policy Research Institute (IFPRI)

Extension and Advisory Services (EAS) providers are important partners for communities to prepare for, respond to, and recover from shocks such as natural disasters and human, plant, and animal disease and pest outbreaks. EAS providers work long-term in communities to equip people with knowledge, skills, and technical resources to improve their livelihoods. EAS are provided by various actors including governments, nongovernmental organizations, private sector entities, higher education institutions, and other organizations. EAS often serve in bridging roles connecting resources from numerous actors operating in communities and are valuable conduits of information during shocks.

EAS are seen as key partners in helping communities rebuild and strengthen food systems after the initial shock, given their long-term work horizons. There are numerous examples of EAS responding to crises around the world, such as HIV/AIDS, Ebola, Avian Influenza, malaria, and, more recently during the current COVID-19 pandemic. During COVID-19, EAS have undertaken an unprecedented shift to virtual and distanced programming as daily life has been disrupted through restrictions on movement and gatherings. EAS agents have been challenged to modify program delivery and remain effective in serving their clientele while navigating this new landscape. In this essay we explore examples of EAS supporting communities before, during, and after crises, and discuss implications for future EAS work, including considerations of lessons learned during the COVID-19 pandemic response.

Technology Adoption for Improving Agricultural Productivity in Sub-Saharan Africa

Authors: Tom Thompson, CALS Global, College of Agriculture and Life Sciences, Virginia Tech; Tashi Gyatso, Virginia Tech

Agricultural productivity in Sub-Saharan Africa (SSA) continues to lag behind the rest of the world. Here, we briefly review the status of adoption of technologies that have potential to boost productivity–irrigation, mechanization, genetically-improved crops, and digital technologies. No more than five to six percent of SSA cropland is irrigated, despite the continent's vast reserves of renewable and non-renewable water. Increasing irrigation may hold the greatest promise for increasing agricultural productivity and production in SSA. Recent trends suggest that small-scale "farmer-led" irrigation is on the rise in SSA. The lack of farm mechanization continues to challenge many SSA farmers. Recent innovations, including equipment-sharing schemes, are beginning to make a difference. Nevertheless, mechanization costs are still a barrier to most SSA farmers. The large majority of SSA farmers do not use improved seeds created through conventional breeding, hybridization, genetic modification, or gene editing – and thus are not able to take advantage of improvements in crop stress tolerance, adaptability, and other traits. Several African countries have or soon will revise standards to allow genetically modified crops, a promising trend. Science-based policies and effective seed systems, both formal and informal, can give farmers to improved seeds. The number and usea of agricultural digital applications in SSA are increasing rapidly, along with availability of internet and mobile devices. They hold promise for improving farmer information about weather, markets, pests, and more. There is no one solution to increasing agricultural productivity in SSA; this will require improved access to multiple inputs, supportive government policies, and well-functioning supply and value chains.

Open Access to Genetic Sequence Data Maximizes Value to Scientists, Farmers, and Society

Authors: Jim Gaffney, Independent Consultant; Redeat Tibebu, University of Minnesota

Over the last 20 years, genome sequencing has become increasingly faster and affordable, with genome sequences of thousands of species - plants, animals, insects, bacteria, viruses – now curated in multiple, open access databases available to all scientists worldwide with internet access. The open access database system, as it stands today, offers fair and equitable sharing of Genetic Sequence Data (GSD), promotes sustainable use of biodiversity, while also contributing to conservation of biological diversity. Yet this free and unencumbered access to GSD may now be threatened by policy-makers looking to regulate and monetize GSD in the hopes of creating more "fair and equitable sharing of benefits from the use of genetic resources". Unencumbered, open access to GSD contributes directly to improved breeding programs, more vibrant seed systems, greater agricultural productivity, and greater resilience of crops and farmers in the face of changing environmental conditions. We ask that policy makers and politicians move with great care and caution when considering regulation and monetization of GSD, beyond what currently exists for international sharing and partnering of GSD. Public research and emerging economies have the most to lose if GSD is further controlled, especially if the global scientific community is not consulted.

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