

AGRICULTURE AND APPLIED ECONOMICS PRIORITIES AND SOLUTIONS



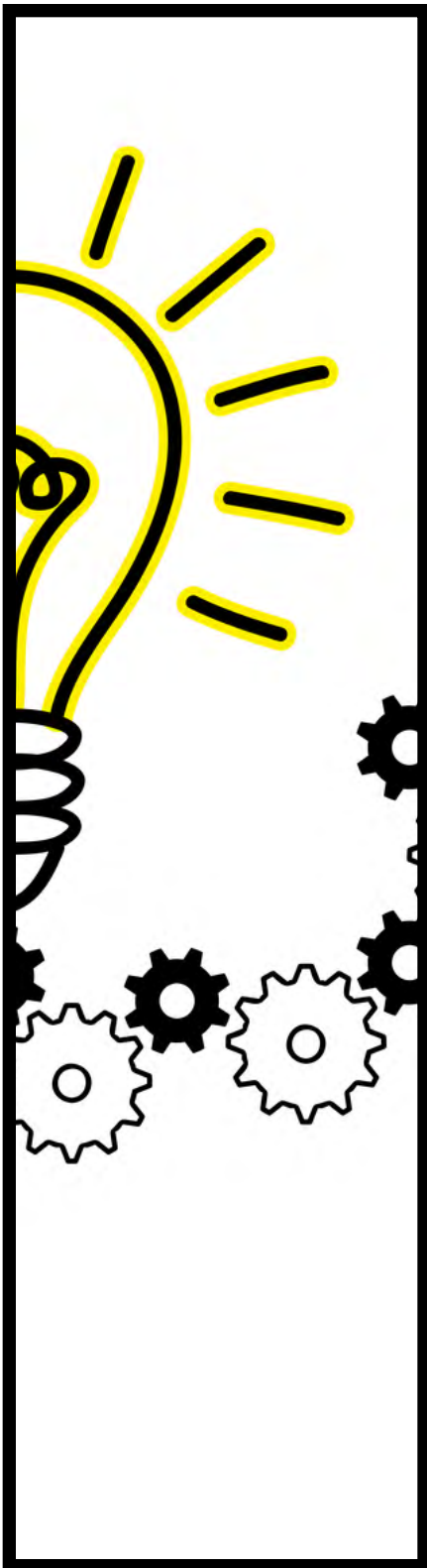
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The objectives of this project are to accomplish the following:

- *Identify overarching priorities* for agricultural and applied economics research and education to address society's challenges over the next decade.
- *Promote communication among agricultural and applied economists* about the priorities for developing new research projects, research methods, and curricula to meet the future needs of society.
- *Communicate to policy makers in Congress and federal agencies* about the key needs and priorities for research and education in agriculture and applied economics.
- *Articulate the unique role of agricultural and applied economists* in working with other disciplines to respond to the challenges facing society.
- *Identify the educational needs for future agricultural and applied economists* and develop new and innovative curricula to meet those needs.





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Thank you to William Nelson, Brian Mondragon Jones, Bonnie Fernandes and Chariese Walton.



Who Are Agricultural and Applied Economists?

Agricultural and applied economists play an important role in creating markets and mechanisms to efficiently allocate scarce budgets and resources.

Economic science related to human behavior, markets, institution and business structures can result in new ways of using or managing plants, animals, and even the environment, transforming risks into opportunities.

For example:

- Agricultural and applied economists work with nutritionists and epidemiologists to determine the effects of different diets on health and obesity and explain consumers' different food choices, given prices, food quality, and food environments.
- Economists work with animal scientists to project the impacts of new technologies that improve growth, reduce disease, increase farm profitability, and estimate what consumers pay for food, given new technology and policy.
- Agricultural and applied economists help farmers know the most profitable amount of fertilizer to apply, given prices and cost of application technologies.

Outcomes:

- Markets have successfully and cost-effectively mitigated the harmful effects of pollution in a manner that encourages innovation.
- Given a fixed budget for conservation, the profession has helped design a mechanism to allocate funding based on what farmers are willing to accept and the environmental characteristics of the land.
- Donations to food banks are now more effectively allocated across the country based on a market-based system.



Priority Areas



Cultivating economic development and trade policy for economic stability, growth, and equality



Understanding consumer preferences to enhance well-being



Ensuring growth and opportunities in the farm economy



Preparing the agricultural sector for a dynamic climate



Achieving nationwide food security to enhance rural and urban economic vitality



Enhancing natural resource and agricultural sustainability



Big data for advances in agricultural production, food supply, and meeting consumer demands



Advancing rural economic growth for a robust America



Building an American energy economy



Developing the solution supply chain by integrating innovation into the marketplace



Cultivating economic development and trade policy for economic stability, growth, and equality.



International trade contributes to economic development by expanding economic opportunities, increasing commerce, and building human capital. International trade also plays an important role in development by capitalizing on the use of regional assets, meeting consumer demands, and enabling more efficient use of natural resources. It is widely acknowledged that international economic development and trade have the potential to advance quality of life and reduce social conflict. For many countries, trade is an important component of a development strategy, through both export and import activities.

Trade has been a source of growth in the U.S. agricultural sector, contributing to economic stability, reducing hunger, and lessening social inequality. The same is true for other major agriculture-producing countries around the world. Trade has driven increases in agricultural productivity through the development and eventual adoption of new technologies, among other factors. Facilitating this growth in productivity and the adoption of new technologies have been legal rights to the land, the availability of credit, the ability to manage risk, and intra-household sociological dynamics.

A coherent trade policy is essential to realize the benefits of domestic and international economic growth, poverty reduction, and food security. For example, agricultural trade in products has significant linkages beyond agriculture, bringing positive benefits related to employment and off-farm business activities. The specific agendas for promoting trade and economic and agricultural development will vary depending on a country or a region.

Challenge 1: Trade's winners and losers—It is becoming more important to identify the gains from trade, the losses that come from restricting trade, and the winners and losers. This information is needed to plan smooth transitions of resources from one sector (the loser) to another (the winner). Research is needed to document the policies that best facilitate growth in U.S. trade opportunities, identify the impacts of trade restrictions, and identify the winners and losers in trade policy. This research is valuable for developing trade policy and reducing economic volatility.





Challenge 2: Approaches to trade negotiations—Strategies for negotiating trade agreements are becoming increasingly complex and controversial. Research questions include: What new approaches to trade negotiations should be taken, particularly in regions where most agricultural trade involves developing countries? How are tariffs and non-tariff measures, including standards, regulations, labeling, and export restrictions, likely to affect trade relationships in the future? What are the advantages and disadvantages of bi-lateral versus multi-lateral trade agreements?

Challenge 3: Maintaining competitive markets amid drops in income—The macroeconomic outlook suggests the possibility of substantially slower global income growth and stronger dollar appreciation against the currencies of major U.S. agricultural markets and competitors in the future. Research questions include: What are the best methods for evaluating trade on a regional basis? How are specific sectors affected, and what are the costs of adjustment? What public policies are needed to overcome the impacts of low income, slow economic growth, and unequal income distribution around the world? Research can identify geographic locations where U.S. commodities and products possess a comparative advantage over competitors. This information can lead to improved strategic decision making by industry and the public sector.

Challenge 4: Options for reducing price volatility—Agricultural and food prices have been variable over the past decade. Research questions include: What is the impact of more volatile commodity prices (higher or lower) on agricultural development and trade strategies? How well do international and domestic food aid delivery programs address shortfalls in food availability? Research could help develop strategies to smooth food supply issues, ranging from locally-led food system innovation to increasing the availability of and access to non-local commodities and foodstuffs.

Challenge 5: Consumer demands and profitable food systems—Economic development in low-income and middle-income countries will shape the future direction of global food systems as populations and incomes increase and as changes in tastes and preferences for food and non-food items evolve more rapidly than in high-income countries. Research on the evolution of food systems in low- and middle income countries will identify the need for new technologies, products, and institutions to improve producer and consumer welfare and reduce rural and urban asymmetric impacts. Research on the impact of food systems on employment and productivity in specific industries and regions will help policy makers make more effective decisions about investment and trade policy.

Challenge 6: Trade's role in food distribution—Feeding the world's growing population will be a major challenge of the future. Research questions include: What are the most effective means of stimulating technical change, enhancing market participation, and building productivity within the small farm sectors of developing countries? In developing countries where natural resources are being depleted through soil, forest, and biodiversity losses, what can be done to improve natural resource management to enable and sustain productivity gains? How can private investment be combined with national or regional investment to promote economic development, encourage technological innovation, and expand community services?



Understanding consumer preferences to enhance well-being.

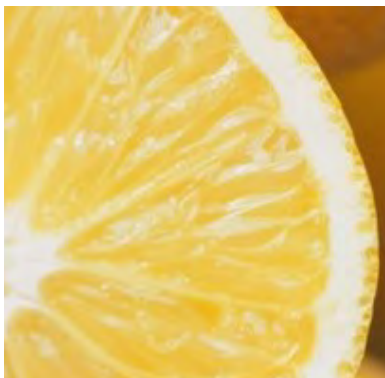


Consumer health is tied to *what people choose to eat* and their *accessibility to safe and healthy foods*. Obesity, which impacts more than one third of Americans, has grown rapidly in the United States compared to other countries (chart). The cost of obesity is significant—every year, the American public absorbs \$148 billion in related healthcare costs. The growth in obesity partially relates to how consumers balance enjoyment, health, sustainability, safety, and affordability in their food choices. For example, American consumption of fruits and vegetables products today is only one-fifth of what it should be for a healthy diet. What steps can be taken to advance consumption of healthy foods? Research by behavioral economists can inform approaches that generate greater purchases and consumption of healthy foods.

On the supply side, 48 million Americans become ill from foodborne pathogens each year. Related illnesses cost the public about \$15.5 billion in healthcare, productivity losses, and death. Food safety standards and practices inside the home, in the retail space, and along the food supply chain may advance methods that limit food safety issues in processing, delivery, and handling of food waste, while advancing quality. What are the most cost-effective methods?

These food consumption and supply challenges exist in a dynamic consumer environment. Consumers' food preferences, eating habits, and related demand are increasingly heterogeneous, following trends in demographics, values, preferences, new methods of informing consumers, and trust/mistrust of information. This presents food producers with the challenge of offering quality, safe, affordable, healthy food and designing appropriate supplies, processing, delivery logistics, and product information. These challenges have implications for food labeling, marketing, trade, and certification.

Perhaps most importantly, while significant investments in scientific research have been made, results are often inconsistent with consumer preferences. Agricultural and applied economists can help bridge that divide. They can evaluate how consumers balance trade-offs between their enjoyment of food, their health and safety, budgetary concerns, and other choice factors—they know the consumer and the marketplace. Economists are developing analytical tools to enhance understanding of consumer preferences and incentives to make healthy choices.





Challenge 1: Understanding how consumer preferences for characteristics affect markets. Economists can estimate the prices consumers are willing to pay for desired attributes in food, which will result in farmers using price data to select economically optimal cultivars. Economists can map attribute demands and work with plant breeders to develop valuable new combinations of traits appropriate to consumers' needs.

Challenge 2: Understanding a health food environment—Many factors affect these trade-offs, including the consumer's state of hunger, available information, and display of products in the marketplace. How does the food environment, including information and product displays and prices, affect consumer choices and health outcomes? What are the drivers of unhealthy eating? How does the organization of retail food affect food choices made by consumers? How do food retail companies make decisions such as where to source their food items and what foods to offer to consumers?

Challenge 3: Consequences of labeling—Many large retailers are using labels to appeal to the multiple values that consumers have related to their health and the health of their household. Economists ask questions like: How does the use of public versus private standards for labels and claims affect market outcomes? How can food-purchasing environments be modified to make an impact on the obesity epidemic?

Challenge 4: Ensuring food safety—Food safety protocol can be costly. What interventions can be used to create efficiencies in tracking and managing food safety issues? What are the tensions, price points, and logistical trade-offs of achieving an acceptable level of risk, quality, and processing efficiency? How effective are current and potential approaches to ensuring food safety?

Challenge 5: Food chain and food quality dynamics—Food quality and supplies in the marketplace are increasingly stratified by locale, income, and accessibility. Economists can quantify the costs and benefits between food waste and food safety, including how information affects food choice and consumption. How and where do food safety problems arise in the food system? What are the trade-offs between accessibility and affordability in achieving a safe, accessible, and nutritious food supply?

Challenge 6: Consumer demands and purchases—Consumers are increasingly demanding more sustainable food supply chains, and are seeking out information about labor practices and production management, as well as affordability and food quality. What are the characteristics of sustainable food systems that meet consumer preferences and internalize external costs and benefits? What are the costs/benefits of different food systems? What is the product demand and market feasibility associated with alternative production systems?

Challenge 7: Accepting innovation—Some consumers reject innovations in the food system. But these very advancements can address some of the environmental production, quality, and price standards that consumers seek. What factors influence levels of consumer trust in the food system? How can we overcome cognitive dissonance?



Ensuring growth and opportunities in the farm economy.



Over the last decade, because of robust domestic supplies, decreasing demand, and falling commodity prices, the agricultural economy has changed dramatically, going from a position of high commodity prices and strong net income to a situation of increasing financial stress. For 2016, net farm income is forecast to be \$71.5 billion, while net cash farm income is expected to drop to \$94.1 billion. Both measures are forecast to decline for the third consecutive year in 2016, after reaching recent highs in 2012 and 2013. Net farm income is forecast to decline by 11.5 percent in 2016, while net cash farm income is expected to be down 13.3 percent. The weakness of the crop and livestock sectors has caused cash-strapped producers to use working capital to meet immediate financial obligations. Farm land values have continued to decline and rental rates are beginning to decrease. The current condition is causing repayment situations to become more and more tenuous. Several supply and demand factors are driving this situation. The market is now facing a situation in which price responds to relatively small changes in production or energy price change.

At the same time, opportunities abound for the sector if these constraints can be addressed. The agriculture sector of the United States has and continues to evolve through major transformations with increasing labor efficiency, mechanization, technological change, more purchased inputs due to greater specialization, and an increase in contracting and biological revolution. New market opportunities are arising in response to dynamic domestic and international consumer preferences. In this changing environment, farmers must consider producing new crops, using new technologies and management approaches, and changing production patterns.

Challenge 1: Agricultural market issues—There are increased macro and micro economic risks in the global marketplace. Trade agreements, exchange rates, and regulatory issues have become more difficult for farmers to anticipate. Laws make it difficult for financial institutions to work with producers that are under financial stress—innovation in institutions financing production agriculture is hampered.

Researchers can evaluate how the current situation in agricultural markets will affect the financial positions of U.S. farm businesses and lenders, as well as real estate. Researchers and extension agents can work with farmers to coordinate financial decision-making in ways that will help farmers to position their businesses for success. Research on the tradeoffs of regulation is warranted. High quality data, statistics, and analysis can help farmers better manage increasing macroeconomic risk in a global food system.





Challenge 2: Financial risk management—Risk management is a growing fraction of the farm safety net, which includes subsidized crop insurance, price loss coverage (PLC), and agriculture risk coverage (ARC). Researchers can address questions such as: Is this the best way forward for this type of marketplace and economy? Is the current farm safety net (crop insurance and commodity programs) adequate and sufficiently targeted to reduce risk? What is the best way to evaluate risk on a farm-by-farm basis? What decision-making tools and skills do farmers need to make the best decisions for their farms and the economy?

Challenge 3: Positioning for positive trade—The global population is expected to increase to more than nine billion by 2050. Supplies from North and South America will have increased demand. Trade mechanisms will be important in moving food and fiber from regions with excess production to regions of less production. Researchers can consider such questions as: What does agricultural trade contribute to the U.S. and global economies? What options are there to break down barriers to trade, maintaining its benefits? What strategic opportunities exist for American farmers and supply chains to form multilateral and bilateral trade agreements? What role will additional infrastructure play in facilitating international trade? How can the U.S. maintain a comparative advantage in the production of agriculture-based products?

Challenge 4: Future farmers—Establishing a successful farming business requires capital or equipment and operating expenses and either rented land or an owned acreage. Many beginners find that one or more of these resources can be severely constrained. Research is needed to determine where future farmers will come from and what public policy alternatives would facilitate the entry of young entrepreneurs into farming. What sources of start-up financing are available to young farmers? Are there tax reforms/incentives that can be established that would decrease the financial risk to starting a farming operation?

Challenge 5: Farm labor—Farm labor and/or mechanized innovations are both important contributors to the financial well-being of the farm. Researchers can consider such questions as: What role does temporary labor play in agriculture? What is the trend and future for mechanization in farm production? What are the benefits and tradeoffs of this trend? How is it distributed? What contribution does immigrant labor make to agricultural production? How would hired agricultural labor be impacted by public policy regarding visas, etc.? To what extent can the sector expect investments in mechanization to be a large part of the future of the farm?

Challenge 6: Health insurance—Farmers buy insurance in the small group market or individual insurance markets, or they have health insurance through off-farm employment. Research is needed to determine what types of health insurance markets are needed to keep America farming.





Preparing the agricultural sector for a dynamic climate.



The world is experiencing increased global temperatures, changing precipitation and weather patterns, altered surface water flow, and more frequent climate-related disasters. Agriculture is already being affected and will continue to be affected by more such events in the future. Extreme events like droughts, hail storms, and floods will result in greater economic losses. Farmers and agricultural economies worldwide have been and will be affected by shifts in agricultural productivity, increased yield volatility, rainfall changes, altered water seasonality and volume, and increased incidence of pests and diseases. Such changes will influence the stability of commodity markets, levels of market prices, farm incomes, consumer purchasing power, and regional food and water insecurity. Countries with important agricultural production in coastal areas will also be affected by sea level rise.

Agricultural and applied economists are researching the economic impacts of climate change, the nature of the effects of current and future changes, and the likely economic consequences of various mitigation and adaptation strategies. They look at changes in management practices, consider human choices and market behavior, and then evaluate the implications of possible responses and related trade-offs. Economists also consider direct and indirect impacts of policies that mitigate and adapt to climate change.

Challenge 1: Overcoming climate challenges to food security and water supplies—Increasing temperatures, melting glaciers, lessening snowfall, and increasing variability in weather patterns will further increase crop/grassland yield variability, in addition to, regionally, changing river flows and rates of groundwater depletion. This, in turn, will likely lead to higher food prices and increased water competition, which will exacerbate local and regional food and water insecurity. Research by agricultural and applied economists evaluates the global, regional, and local nature of these impacts, including effects on agricultural supply chains, logistics, risks faced, human food and water security, livestock herds, water resource competition, resource inefficiencies, and—working with other scientists—the potential for resource-based conflicts.

Challenge 2: Means to understand and manage risk—Farmers, agribusinesses, insurers, and consumers may be hesitant to adopt or accept risk reduction strategies or management approaches. For example, a) lenders may be reluctant to extend credit for new better climate-adapted agricultural ventures, b) risks may make enterprise shifts the best management option, and c) enhanced risk may alter the need for and design of insurance schemes. Research is necessary to develop new policies, management, enterprise choice, and insurance approaches that manage risks associated with increasing weather and crop/grassland yield variability.





Challenge 3: Trade and infrastructure needs in a changed market—Trade relationships are changing and will need to continue to change as agricultural production shifts geographically. Nations that lose productive capacity will be interested in importing food and agricultural products. Importing countries may become net exporters. Shifts in the location of production will create demands for new or altered supporting infrastructure, processing, transport, etc. Research is necessary to observe current shifts in production, forecast future shifts, and understand their implications in terms of commodity scarcities or newfound abundance and implications for policies, infrastructure, and business operations.

Challenge 4: Elucidating costs of action and inaction on climate change—The cost of reducing greenhouse gas emissions, a driver of climate change, is closely tied to the cost of energy for consumers and many businesses. The implicit costs of addressing and reducing emissions and adapting to climate change are not obvious to public institutions or the private sector. Often, unintended consequences of policies or the lack thereof have the potential to produce large negative economic consequences for certain societal groups or regions. Research by agricultural and applied economists can help private decision makers and public policymakers understand the consequences of actions before the fact, enabling them to factor such consequences into their decisions and become aware of the costs and consequences of current/past actions under evolving climate change.

Challenge 5: Partnerships for data and statistics—With dramatic changes occurring in agricultural production regions, costs, yields, irrigation demands, and natural resource use around the world because of climate change, data that tracks these changes will become even more important. Research that helps institutions prioritize data collection and assesses the value of new data collection efforts is necessary.

Challenge 6: Supporting evidence-based policy—Money is always scarce, and responsible levels of mitigation and adaptation investment must consider the effect of those actions and of diverting funds. Applied economists identify both costly climate change challenges and the benefits and costs of actions to limit emissions or better adapt farming practices, as well as the costs that will ensue if less money is spent on traditional investments, like education.

What results can we expect?

Work by agricultural and applied economists will help to document and project climate change implications and develop adaptation responses for highly vulnerable areas, and identify needs for and evaluate mitigation actions designed to limit future climate change. Work on climate change impacts will extend our understanding of human and ecosystem costs, as well as identifying the vulnerabilities that most need an adaptation response. Policies must be cost-effective means of reaching goals, while addressing conditions that vary spatially and temporally.



**Achieving
nationwide
food
security to
enhance
rural and
urban
economic
vitality.**



The Great Recession led to a dramatic increase in food insecurity—or the uncertainty of having, or being able to acquire, enough food because people had insufficient money or other resources. These rates of food insecurity have persisted. Nationally, the rate of food insecurity has risen from over 10 percent in 2000 to nearly 15 percent in 2011. In 2015, over 42 million, or 13.4 percent, of Americans were food insecure. The negative health consequences and health care costs associated with food insecurity are cause for the urgency in addressing this problem.

National statistics mask a great deal of heterogeneity in food insecurity rates across the U.S. This can be seen in Figure 2 for 2014, which has information on estimated food insecurity rates for all counties. In some parts of the country, especially the Upper Midwest and the Northeast, in the main, food insecurity rates are lower than the national average. In contrast, there are pockets where rates of food insecurity are especially high, including in the Mississippi Delta, Appalachia, and poor Southern counties. Reflecting the challenges facing those living on American Indian Reservations, there are isolated counties throughout the country with very high rates. Researchers observe a similar pattern for households with children. Some counties, especially along the Texas-Mexico border, have rates above 40 percent. Furthermore, substantially higher rates of food insecurity are found in households with children in comparison to households without children.

In recognition of the problem of food insecurity in the U.S., Congress has authorized an extensive food assistance safety net. The Supplemental Nutrition Assistance Program (SNAP) has been in place for over fifty years. Eligibility for assistance is based on household income and assets. The central goal of SNAP is to alleviate food insecurity, and multiple studies have demonstrated that it does so. While SNAP is much larger than other food assistance programs, both the National School Lunch Program (NSLP) and the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) also lead to reductions in food insecurity. In total, these programs represent an investment of \$100 billion in U.S. government funds.

Agricultural and applied economists have researched the determinants of the problem and the effectiveness and implications of SNAP to alleviate food insecurity. Researchers are beginning to look at how the emergency food system—e.g. food pantries—address the needs of vulnerable populations. If the problem is to be solved, its causes must be revealed and corrected. Once a more complete understanding of these consequences is acquired, proactive programs can be developed to break the cycle and reduce the future impacts of food insecurity.





Challenge 1: Measuring the distribution of food insecurity within a household—Food insecurity measures are generally defined at the household level rather than for everyone in the household. Some recent work has utilized measures that include questions about food insecurity specifically for children. As we gather data, child-specific responses can lead to new insights into the food security status of each individual member of the family.

Challenge 2: Food distribution and food security—The U.S. has an advanced food distribution system that has made possible lower food prices than are found in other high income countries. One consequence of this is that food insecurity rates are lower than they otherwise would be. Research is needed to determine how to further improve the distribution system. For example, one could examine how the regulatory process impedes the distribution of food from farm to food stores. Or, for example, analyses of how the food distribution system could do a better job of reaching underserved areas, especially in rural areas, are worth pursuing.

Challenge 3: Coping mechanisms and trade-offs—To be food secure, low-income households may be deprived in some other dimension of well-being. For example, seniors may be foregoing prescription drugs to feed themselves and other members of the household. Research questions include: What types of coping mechanisms do low income and other households employ to avoid food insecurity? What are the impacts and tradeoffs of these mechanisms? Do these coping mechanisms have unintended effects on health and well-being?

Challenge 4: Sustained high levels of food insecurity among American Indians—As seen in Figures 2 and 3, counties with American Indian reservations have substantially higher rates of food insecurity than neighboring counties. Similar patterns can be seen in counties with higher proportions of African-Americans or Hispanics, but can generally be explained by income or family structure. This is not the case for American Indians. Why are the food insecurity rates of these populations so high? Research is needed to explore how effective policy can be constructed.

Challenge 5: Maximizing SNAP efficiencies and outcomes—Although SNAP has been successful at reducing food insecurity, benefit levels of many SNAP participants are too low to eliminate their food insecurity altogether. Given that the SNAP benefit formula has not fundamentally changed since 1979, there is the question of whether changes to this formula could raise more households into food security. This research could consider budget neutral proposals and proposals that distinguish among SNAP recipients by level of need.

Challenge 6: Private-public partnerships—Alongside public food assistance programs, there is a substantial private food assistance network in the United States. This network comprises food banks and the tens of thousands of agencies they serve. These food banks receive food and distribute it through food pantries, soup kitchens, and residential shelters. Approximately 46.5 million people were served in 2013. Research on the impact of these private food assistance programs needs to be documented so that we can see how such programs may intersect with public programs.

Challenge 7: Food security and health outcomes—The direction of the food insecurity-health nexus is not always clear. What is the causal relationship between food insecurity and health outcomes? Future research using longitudinal data with the appropriate econometric techniques should address these causality issues.



Enhancing natural resource and agricultural sustainability.



Farmers and ranchers around the world rely on natural resources (land, soil, and water) to produce a wide variety of commodities for food, fuel, and fiber. Ultimately agricultural productivity, worldwide food security, safe water supplies, energy availability, and the quality of our environment all depend on how well we manage the use of these natural resources. The natural resources used by these farms and ranches also provide other ecosystem services, such as wildlife habitat, cleaner air and water, and flood control.

According to leading economists, world food production needs to double by 2050 if we are to feed an anticipated nine billion people on diets with adequate protein. The world will also need more fiber for clothing and biomass for bioenergy. Globally, farmers and ranchers cultivate or use about 40 percent of the earth's ice-free land for raw material production. Most arable land is already in use; agriculture needs to continue boosting productivity on that land rather than expanding onto new, less productive land. As a leading agricultural exporter, the United States faces great opportunity. But to seize that opportunity in a sustainable way, policies are needed to protect the soil, water, air, and biotic resources that underpin the productivity of our agriculture and the quality of life of our nation.

Economic research plays a key role. Market prices let consumers communicate to producers what, how much, and how to produce. But some shared natural resources lack markets. For these cases, economic research can identify what citizens are willing to pay and can design market-based ways to communicate demand for environmental quality to producers. For existing public programs, economic research can identify cost-effective ways to meet goals for boosting productivity and protecting natural resources. Finally, economic research can evaluate sustainability policies to ensure they are cost-effective. To advance economically and environmentally sustainable agriculture in the United States, we need to meet five broad research challenges in which economics plays a key role.

Challenge 1: Ensuring that voluntary adoption of sustainable farming practices is cost-effective—Some existing conservation programs pay farmers for sustainable practices without estimating the environmental benefits, which vary from place to place. The right amount to pay farmers to provide these environmental benefits also varies from place to place. Research is needed to answer such questions as: What policy designs foster voluntary adoption of sustainable farming practices that meet society's needs at the lowest cost? Economic research can inform the design of smart, spatially targeted policies that generate the biggest environmental bang for the conservation buck.





Challenge 2: Evaluating cost-effectiveness of conservation programs—The United States spends billions of dollars annually on policies intended to conserve natural resources, enhance productivity, and cope with climate change. Evaluating how effectively those expenditures achieve their objectives ensures that public funds are well spent. Research is needed to answer such questions as: How cost-effective are our current sustainability policies at achieving their goals? Where can we save or productively re-allocate taxpayer dollars?

Challenge 3: Market-based water policy—Americans will need more clean water for drinking, fishing, and swimming in years ahead. Market-based policy has the potential to achieve more productivity from scarce water and more cost-effective water quality enhancement. Economic research can answer such questions as: How can we use surface and ground water most efficiently, especially where it is scarce? What are cost-effective, voluntary ways to protect public water quality from nutrients lost from farm fields or trapped in soils and water bodies? How can we enhance private sector initiatives certifying sustainably produced crops and livestock?

Challenge 4: Alleviating weather risks—More extreme rain and temperature patterns are shifting the locations where and how crops and livestock thrive best. Economic research can answer such questions as: What are the economic impacts of changing weather patterns on crop yields and associated environmental benefits? What market-based approaches could efficiently slow the rate of change in weather patterns? What are the best policies to help farmers and consumers adapt to weather risks?

Challenge 5: Making smart producers even smarter—Mobile computing devices are making just-in-time, field-specific advice available to farmers and ranchers. Complex economic and environmental decision-support models are ripe for adaptation for use in mobile devices. These models draw upon scientific knowledge from many fields, including meteorology, agronomy, animal science, and economics. Research is needed to answer such questions as: How does predicted crop and animal production change in response to weather? What inputs and management practices can be used to make profitable decisions during changing circumstances? How will predicted crop yields, livestock production, and associated environmental quality vary in response to management?

Bottom line

U.S. agriculture is vital to meeting a growing global population's demand for food, fiber, feed, and fuel. Meeting those needs presents U.S. farmers and ranchers with promising new opportunities. But changing weather patterns and rising population mean that U.S. agriculture faces formidable but surmountable challenges to sustain its natural resource base and the environmental quality enjoyed by the nation's citizens. Ensuring a sustainable future will call for smart decisions and cost-effective policies based on sound economic research in tandem with biological and technological research.





Building an American energy economy.



Economic activity fueled by research and innovation in the biological sciences (i.e., the bioeconomy) is a rapidly growing segment of the global economy that may provide substantial public benefits. If done carefully, bioenergy and bio-products developed through the bioeconomy can help achieve energy efficiency goals while adding economic value to the United States agricultural sector. Bioenergy and bio-products can lead to switching the economy away from fossil fuels to cleaner renewable energy sources and reducing reliance on carbon-intensive inputs such as chemical fertilizers and pesticides, as well as increasing the availability of bio-products that are low carbon.

Bioenergy and bio-products rely on a diverse mix of feedstocks, technologies, and outputs. These processes are in various developmental stages, and they differ from each other in their carbon implications and land footprint. The use of renewable resources such as wind and solar should also be explored, and synergies between renewables and agriculture production processes better understood.

The specific energy challenges the agriculture sector faces that warrant research and development include the following:

Challenge 1: Evaluate the economic and environmental implications of reducing the energy footprint of agriculture, and promote energy conservation and efficiency. Identify the economic viability of (potential) alternative technologies that can reduce the agriculture energy footprint, and identify and expand production processes that better utilize the feedstock employed by the energy sector (e.g., develop processes that use waste) and yield an increase in economic value to the agriculture sector.

Challenge 2: Better understand synergies between renewable energy and agriculture. Identify how the use of renewable energy in agriculture can generate added economic value to farmers.

Challenge 3: Identify the economic and environmental benefits and costs of using bioenergy. Identify the supply chain paths through which advancements of the bioeconomy can travel in order to significantly decarbonize the U.S. economy, such as, for example, identifying economically viable market structures that employ carbon-negative technologies that harness the biomass ability to sequester carbon, producing “ready to burn” liquid fuels for cars and planes made not from oil but from renewable biomass and waste. Also, investigate the implications of tight oil and shale gas for the development of bioenergy technologies, and assess the benefits of using these abundant fossil resources.





Challenge 5: Improve our ability to measure the impact of the bioeconomy and its possibility for generating economic value while resulting in more sustainable processes. Measuring the various effects of the bioeconomy will require a detailed understanding and monitoring of product flows and, in some cases, the use of big data. This effort should aim to provide information about the economic and environmental impacts of the proposed processes and how the discussed advancements can contribute to economic development and employment.

Challenge 6: Estimate the consequences of alternative policies aimed at facilitating economic growth in the U.S. while fostering more sustainable use of biomass and yielding more sustainable agricultural practices. Identify and better understand the economic determinants that influence the carbon implications of the bioeconomy and the role that technological development and policies play in achieving synergies among fossil fuel displacement, climate change mitigation, and energy security.

What are the multidisciplinary research, data, education, and training implications of this challenge?

Energy involves multiple disciplines and should be studied in the broader context of development and the environment. The study of energy should incorporate the basic specifications of the technology (e.g., biological, chemical, or physical characteristics of the technology) and use economic models to understand the implications of introducing the technology. While building on big data, the effect of alternative energy sources and manufacturing processes and the implications for climate can be better understood. By integrating science into our economic models, the agricultural and applied scientist can better understand the implications of introducing bioenergy and bio-products.



Big data for advances in agricultural production, food supply, and meeting consumer demands



In the next decade, big data will transform the agricultural and food economy. “**Big data**” consists of large, diverse, complex, longitudinal, and/or distributed data sets generated from modern technology, including sensors, click streams, etc. Big data can be described in terms of **volume, velocity, variety, and veracity**. **Big data analytics** uses **big data** to generate useful information, providing valuable, and previously impossible, insights about business efficiency, markets, resources, and consumers. **Big data analytics** may provide unprecedented policy and decision-making insights by simultaneously capitalizing public and private sector data resources relating to water conservation, soil health, weather patterns, food safety risks, the adoption of technology, production approaches, resource management, consumer behavior, and the food supply chain. Agricultural and applied economics finds that big data will change the landscape and state of data accumulation, storage, analysis, visualization, transferability, and security.

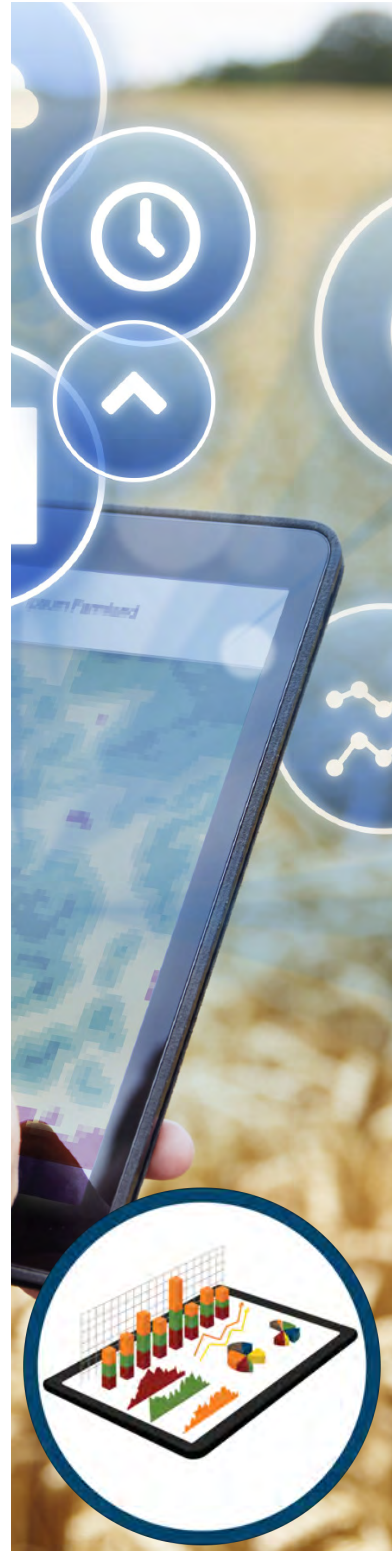
Big agricultural data are generated at the intersection of geospatial technology, field production information, weather and climate patterns, and the marketplace. Big agricultural data analytics can evaluate practices, farm profitability, and risks of crop loss, along with other economic variables, to advance effective farm management. Big data has the potential to aid farmers in the production of high-quality, safe, and affordable food at profitable levels, while stewarding our resource base. The application of big data may also improve tracking of food safety and production attributes to better meet consumer needs and demands. Maintaining access to data is critical to economists’ ability to inform public and private decisions using sound analyses. Examples of challenges and related research include:

Challenge 1: Maintaining, storing, and aggregating big data—While the value proposition of big data appears immense, such data is messy, requires standards, and is valuable in disaggregate and aggregate form.

Research can reveal how best to maintain, store, and use data resources. New tools can be made available to farmers to verify that the input and output relationships are optimized for the management of their farms. Big agricultural data analytics can be used to develop insights for decision-making in real time, while also providing in-depth analysis. Efforts are needed to develop technology that ensures data privacy and the flow of data in rural areas.

Challenge 2: Tracking food safety— It is essential to track, monitor, and eradicate threats to our food, feed, fiber, and fuel supply, such as Salmonella, Listeria, and E. coli, wheat rusts, citrus greening, and livestock viruses like swine and avian flu. To build a safer and more economically viable U.S. food supply, we need to harness the possibilities of big data in evaluating the spread of diseases, pathogens, and viruses, and mitigate outbreak/contamination risks and economic impacts. Regional and national big agricultural data projects can evaluate the movement of viruses while also administering methods to contain the spread of threats. Researchers can create methods and a protocol for achieving a comprehensive monitoring system.





Challenge 3: Matching products with markets—Consumer buying decisions reflect a complex matrix of priorities. Increasingly, consumers are considering health, environment, affordability, and quality as they purchase food and related products. It is difficult to track materials through complex supply-chain processes. Big data may allow for the tracking of value-added attributes. This information can be used during the development phases of products and services, and in the placement and promotion of market-ready products. Research into consumer behavior that uses big data analytics can inform rural entrepreneurs about opportunities for growing businesses or targeting production.

Challenge 4: Ameliorating survey gaps—Government statistical agencies are experiencing suppressed response for some public surveys. New approaches may be possible, using precision data that reduce the need for some survey-based data. This information could be stored behind a secure firewall, shared, and updated cost-effectively, through mobile or web-based technologies. Big data management and analytics may be used to record important information for effective functioning of agricultural markets. Research can be done to determine the best infrastructure and management techniques to store and integrate data systems to prevent duplication. New approaches could reduce respondent burden on growers and landowners while retaining the value of data.

Challenge 5: Mitigating asymmetric market information—Policy issues regarding data ownership, market power, and privacy are not well understood. Aggregated data could inform profit-making ventures in the marketplace or influence the marketplace unfairly. The level of data aggregation today may not pose a threat to market-moving transactions, but continued growth in technology adoption and data collection and aggregation could someday make this possible. Historically, USDA collection and public dissemination of data has reduced asymmetric transfers of information between parties to agricultural markets. Research on how private data sets may affect commodity markets or how private data will be used to gain market advantages is important.

Challenge 6: Advancing evidence-based policy—Evidence-based policy is policy informed by rigorously established objective evidence. It can be advanced with the onset of more seamless and robust survey and big data information that can also be disaggregated in secure environments. Analysis is needed to make the connection between evidence and policies based on that evidence. For example, layering crop insurance and soil data can lead to more accurate crop insurance rates. Similarly, working land and land retirement programs can become more targeted and accurate than before. Traceability along the supply chain can provide insights for various policy decisions. Big data can also speed up the time lags associated with obtaining policy-making information.

Challenge 7: Ensuring researcher access to big data—Big data may be a significant asset for supporting productivity gains and policy improvements. However, researchers need access to the data. Data markets may be one way of enabling access; strong partnerships may be another. Producers and public and private entities may need to build coalitions to ensure privacy and confidentiality, reliability, sustainability, and use of big data. Research is needed on the value that information derived from big data may have at the national, regional, and local levels. Work can also be done to understand the value of coalitions that share data to address specific types of questions relating to food safety, agricultural markets and trade, farm management, and resource management.



Rural America is an important source of our food, water, energy, and other natural resources, as well as a source of spectacular natural beauty. Even so, rural America is often mischaracterized as a uniform, distressed place predominately driven by the agriculture and mining industries. In fact, rural America is distinguished by diversity on many dimensions.

Rural America is diverse with respect to industrial composition, and so has been subject to the same spread of labor-saving technologies as the economy as a whole, giving rise to job displacement and structural unemployment. While mechanization and automation have caused the vast majority of job losses, these losses have been, in some cases, exacerbated by fierce foreign competition. Restoring these labor markets is thus both challenging and multidimensional. In some places, the economic and cultural connection between urban and rural places is becoming less pronounced. In others, local amenities related to natural resources, parks, and landscapes are supporting robust rural economic growth that is unconnected to extractive industry or proximity to a city. Rural America can be better put into context by understanding three broad categories of economic areas: (1) areas rich in natural amenities; (2) rural communities adjacent to urban areas; and (3) remote or extractive-based rural communities that have struggled historically. While these categories are neither mutually exclusive nor exhaustive, the trichotomy provides a useful way to conceptualize the problems and prospects of Rural America today.

In rural America, the farm employment share declined from 15% in 1969 to 6% in 2015, illustrating the broad restructuring that took place throughout rural regions of America in the second half of the 20th century. At the same time, labor-saving technological changes led to significant expansion of agricultural production which, in many cases, assisted American and international citizens via product distribution through trade and lower food prices. However, at home, export-based industries have produced lower job growth due to automation, persistent unemployment, and a labor market that adapts slowly to change. Economists and social scientists have posed the question, "What can be done to revitalize areas that are experiencing stagnant or negative growth?" We know that rural prosperity matters; yet the literature has not established how it reinforces economic efficiency, regional sustainability, and economic resilience. The challenge areas below focus on determining how communities develop how communities increase wealth and prosperity, and discuss how to measure rural prosperity, what drives it, and what information public policymakers can use to craft evidence-based policy to increase it.

Challenge 1: The differences across counties and the heterogeneous definitions of "rural" indicate that a clear, one-size-fits-all rural policy will not work. Intra-regional approaches may be more appropriate. Federal labor, fiscal, trade, and interest rate policies all have disparate spatial impacts that depend, among other factors, on the export dependence and capital intensity of local industries. The most effective policies to enhance growth will acknowledge the unique features of each area or region. Beneficial federal policies should strike a better balance between the farm sector and the nonfarm rural economy.

Economists are natural and objective partners for evidence-based policymaking. In particular, they are equipped to investigate urgent research questions, including how prosperity can be enhanced through improving the diversity of rural economies and how best to assess which sectors can compete in the rural America of the 21st century. Estimating the economic impacts of training or of new businesses on total net job or income creation is essential to determining whether community support is justified. Such information can be used to evaluate economic development policy, or understand the impacts of exogenous shocks, once the net multiplier effects are known. Research on the social costs and benefits and distributional impacts of pursuing one strategy over another in different contexts is critical, and something economists are uniquely positioned to pursue.



Advancing rural economic growth for a robust America



Challenge 2: There is evidence that local rural entrepreneurs and the self-employed help rural and remote communities achieve sustained growth and prosperity, while mitigating trade shocks. The internet, cell phones, and advances in transportation have the potential—with additional rural connectivity infrastructure—to make U.S. businesses more accessible. Local entrepreneurs further magnify the positive economic impacts of their business activity on the community by favoring procurement from other local businesses. However, more research is needed to understand if there are missed economic opportunities with high potential returns in rural areas because of market and institutional failures. Which types of entrepreneurs or self-employed workers are most important for rural growth? What can be done to increase economic opportunity where globalization and automation have caused profound structural change in labor markets? When is compensation for such economic change feasible and justified? How exactly should compensation be implemented if there are job losses due to automation, and how should the shift of laid-off workers from declining to advancing sectors be facilitated?

Challenge 3: It is essential to better understand human capital development. Regional development or local development investments tend to benefit the owners of fixed assets via housing prices. Recent research suggests that land-grant university extension services or other technical assistance programs are very cost effective. A robust understanding of the concept of human capital development is critical in order to cost-effectively move forward. For example, rural areas have long been a source of well-educated youth who migrate to urban areas and contribute to the prosperity of the area that they migrated from. What should be done about brain drain, and how it affects the incentives and ability of rural people to invest in local schools. Is rural brain drain an externality?

Challenge 4: The U.S. has now reached an overall level of income inequality that may be suppressing economic growth. Economists believe that some stratification of income is required for growth—it provides an incentive for people to make economic gains. However, in practice—in a world of imperfect capital markets, imperfect information, institutional inertia, etc.—individuals who are have limited incomes may be prevented from achieving their potential. This can undermine growth and contribute to worsening distributional outcomes. More investigations on this topic at the subnational or regional levels, or for rural versus urban areas, are needed. It is important to understand whether a pronounced and prolonged income gap could have important implications for the economic future of the entire U.S. and regions of rural communities, as well as the impact on relationships with other countries or regions.

Challenge 5: Social mobility is an important driver of innovation in the marketplace as well as economic growth. Yet, there may be labor-saving impacts of globalization and automation, including robots and 3-D printing technology, which cause multiple limits to social mobility at the local, regional, and even national level. Related research questions ask: How do poverty and inequality evolve and eventually stagnate over time and geographic area? Do greater local poverty and inequality reduce growth and the ability of local regions to adapt to economic and political forces? What forces are driving changes in social mobility, income, and poverty? What is the most appropriate role for government to play in mitigating rising poverty and inequality?

Challenge 6: Rural data are essential for understanding evidence-based policy outcomes. To evaluate policies and hold politicians, policymakers, and the private sector accountable for performance, there is a need for reliable data. The federal government plays a critical role in producing invaluable statistics. These data are also essential for providing the private sector with timely and quality information that influences marketing and firm location decisions. The costs of federal statistical systems are relatively trivial, but these efforts benefit the U.S. economy greatly. Private vendors have little incentive to fill the gap in rural data and lack efficient infrastructure to do so. The market price for data from very small, rural areas would be placed more at risk without publically funded upkeep of this resource. Additionally, Big Data, which has exhibited reliability and comparability problems over time, requires the benchmark information offered by government statistical resources in order to be valuable.

Challenge 7: The positive and negative impacts of migration are not well understood. There is a need for research on what federal and state policy makers and rural communities themselves can do to attract retirees, if they wish to do so, and what the benefits and costs to rural communities are of attracting such migrants. Research on the impact of other populations migrating to rural areas, such as international immigrants, is also needed.



Developing the solution supply chain by integrating innovation into the marketplace

To be released at the U.S. Research, Education, Extension, and Economics Summit in 2017

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