Challenges and Strategies

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AGree

AGree seeks to drive positive change in the food and agriculture system by connecting and challenging leaders from diverse communities to catalyze action and elevate food and agriculture policy as a national priority. Through its work, AGree will support policy innovation that addresses four critical challenges in a comprehensive and integrated way to overcome the barriers that have traditionally inhibited transformative change. AGree anticipates constructive roles for the private sector and civil society as well as for policymakers.

Background on This Document

This document describes four interconnected challenges confronting the global food and agriculture system. The challenges necessitate changes in U.S. policy and demand innovative private sector and civil society actions. To address these challenges, AGree has identified a comprehensive framework of strategies that, together, address the four challenges. The challenges and strategies were identified through dialogue and informed by research. Brief descriptions of the strategies are found on the following pages.

Although all the individuals formally affiliated with AGree may not agree completely with every statement that follows, they are committed to working together to find solutions to the challenges facing food and agriculture.

As illustrated in the graphic on page iii, there is no hierarchy among the strategies; all are needed to successfully confront the challenges. In 2012, AGree will address a subset of the strategies, focusing our efforts on issues we are best positioned to address. Many of the strategies are being addressed in depth by other initiatives and organizations. Where possible, AGree will seek to amplify the work of others.

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Agriculture production and productivity must increase to meet growing demand. The global population is projected to top 9 billion people by 2050, and with it a growing middle class will move away from a grain-based diet to more meat, dairy, and fresh produce. Much of this population and income growth will occur in sub-Saharan Africa and South Asia. As 85 percent of food is eaten in the country in which it is produced, food production gains are needed in those regions in particular. A focus on increased production in these regions can help alleviate poverty, spur economic development, and promote political stability.

Increasing productivity will require significant investments in agricultural research, education, and extension, particularly in areas where productivity growth is lagging, such as sub-Saharan Africa and South Asia. Investments must support diversified farming systems and practices that are resilient to changing climate. They must also conserve increasingly scarce water resources and land and improve soil health and habitat.

In both the near and long-term, U.S. trade and food aid policy and foreign assistance should support, not undermine, productivity in developing countries and provide smallholder farmers with access to markets. As income levels and purchasing power rise in developing countries, U.S. producers will benefit from expanding markets. The United States, and the world, will also benefit from less poverty, more economic development, and political stability that these investments can bring about.
Changes in Annual Agricultural R&D Spending in Africa between 2001-08, Select Countries

Although overall agricultural R&D spending in Africa increased by 21 percent between 2001 and 2008, it varies greatly between countries. Annual spending has increased in Nigeria, Ghana, Tanzania, and Uganda, yet fallen elsewhere, such as in Ethiopia and South Africa. Overall investment levels in most countries in sub-Saharan Africa fall below levels required to meet agricultural R&D needs.

Adoption of Improved Varieties, 2008

There is considerable variation in the adoption of modern seed technology across sub-Saharan Africa and Asia. Improved seed varieties have been adopted in Asia and Latin America at rates of 60 percent (or above) for rice, wheat, corn, and sorghum. African countries lag considerably, in part because some of the crops they raise, such as cassava and millet, have not received the same level of research attention as more widely traded crops.

Corn Yield Comparisons 1961-2010

In 1961, average corn yields in Africa and Asia were nearly the same, both less than 1.2 tons per hectare. During the last half-century, Asian farmers have adopted new cultivation and irrigation practices and new inputs (such as fertilizer and improved seed) at a much faster rate than farmers in sub-Saharan Africa. This has resulted in an average Asian corn yield in 2010 of 4.5 tons/ha., more than twice the current level in sub-Saharan Africa.
Good nutrition is critical to health. In the United States, four of the leading causes of death—chronic heart disease, stroke, cancer, and diabetes—are diet-related, and millions of Americans face related health problems that cause hardship and expense. Today, more than one-third of U.S. adults and 17 percent of children are obese and highly vulnerable to early-onset chronic disease. At the same time, approximately one in seven individuals in the United States struggles to find or have sufficient income to purchase enough food for a healthy life.

The causes and effects of poor nutrition are complex. Evidence is clear, however, that health care costs are growing and many of those costs are tied to poor or high-calorie diets. Systemic changes to the food system are needed to enable and encourage better dietary choices to promote long-term health.

The federal government’s “Dietary Guidelines for Americans” are designed to foster healthy diets. Current guidelines encourage Americans to eat more fruits, vegetables, and whole grains, while eating less high-fat and processed foods. Yet food guidelines are not enough. Individuals make food choices based on a variety of factors. Enabling and encouraging food choices that promote healthy diets require a comprehensive approach that addresses availability, access, affordability, information, and acknowledges social and cultural factors that drive food choices. The policy debate about how best to shift diets is extremely heated, with differing views about the role of taxes (on soda and salt, for example), regulations, marketing, and restrictions on the use of food assistance dollars available through the Supplemental Nutrition Assistance Program (SNAP).

Appropriate and effective roles and actions must be identified for all stakeholders in all sectors, and both supply and demand issues must be examined. Food choices are highly personal, but the impact of widespread malnutrition is shared by all of society.
According to USDA’s Economic Research Service, the average American consumed 2,594 calories daily in 2009, a 19 percent increase since 1970. Increases in consumption of added fats and oils and grain-based products have accounted for the bulk of the overall increase, while shares of other food categories have remained fairly stable.

As reported by the Centers for Disease Control, about 35 percent of American adults and 17 percent of children and adolescents were obese or extremely obese in 2010. Just 30 years ago, only 18 percent of adults and 5 percent of children and adolescents were deemed obese or extremely obese.
Food and agricultural producers everywhere balance growing and changing demand for food with the constraints and opportunities of the physical and economic environments in which they operate. Innovators around the world—in operations ranging from large-scale transgenic grain production in the Great Plains to organic dairy production in New England, to agro-ecological systems in West Africa—have found ways to minimize water use, build soil, enhance habitat, reduce greenhouse gas emissions, and minimize reliance on chemical fertilizers and pesticides while building profitable operations. This has resulted in greater diversity both within and across individual farm operations.

Consumers are also driving the diversification of production systems. Globally, rising incomes increase demand for more meat and fresh produce. In the United States, more consumers are seeking food that is certified organic and “sustainably grown,” locally produced, and less processed, among other demands. Many of these products are increasingly available at farmers’ markets, local stores, and even large retailers, who source them from both smaller, local producers and multinational corporations. Food with such attributes is the fastest growing U.S. food sector.

A growing body of research recognizes that fostering diverse systems will enable agricultural producers to successfully meet changing market and environmental conditions over the long term. Additional research is needed to understand the effects of various types of diversity (germplasm, crops, livestock breeds, farming practices, business models) at a range of scales (individual farm, landscape, region, or nation). More science is also needed on such issues as long-term productivity; conservation of soil, land, water, and habitat; and capacity to adapt to changing climate and ecological conditions. Policymakers must carefully consider how best to appropriate government resources and research efforts among crops and production systems. In addition, policymakers will confront different perspectives about whether changes are needed to ensure diverse systems coexist and thrive alongside one another, such as organic crops adjacent to crops from transgenic seeds, for example.
After agricultural biotechnology was first commercialized in 1996, U.S. farmers adopted it rapidly. Acres planted to genetically modified organisms (GMO) seed accounted for more than half of cotton and soybean areas in 2000, with corn adoption below 30 percent. By 2011, GMO seeds were used in at least 90 percent of acres planted of these three crops. More than half of all GMO cotton and corn seed planted include multiple genetic modifications to address both herbicide tolerance and pest resistance.

Share of Organic Sales by Marketing Channels, Various Years

Increasingly, marketing organic food has become a mainstream business. Between 1991 and 2006, the share of organic sales made in conventional outlets, such as supermarkets, rose from 7 percent to 46 percent. Organic food products have grown from 1.2 percent of total food sales in 2000, when the rules for the National Organic Program were first adopted, to 3 percent in 2009.

Share Of U.S. Acres Planted to GMO Seed, Specific Crops, 2000-2011

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Diverse Production Systems

Some field trials show that diverse low-external-input (LEI) cropping systems can achieve comparable results to conventionally managed rotations in specific locations. At Iowa State University’s Marsden Farm, researchers have achieved comparable yields and financial returns, on average, from three different production systems since 2003. The three- and four-year rotations required about 25 percent of N fertilizer (manure from the farm was used) and 15 percent of herbicide applications as the conventional two year corn-soy system. More research is needed to better understand the potential for reducing fertilizer and pesticide use while maintaining – and increasing – overall productivity and profitability.
Farmers and ranchers in the United States are aging, and many worry the country may face a shortage of new farmers and ranchers to fill the gap when today's producers retire. Young people starting new commercial farm operations often cannot afford the high cost of land. New farmers also often lack the experience, access to capital, and social connections that are important to success. In addition, complicated estate taxes are barriers to new entrants. Meanwhile, large commercial farms (which produce 85 percent of U.S. food) have become complex, multigenerational family businesses with significant land and machinery assets. The complexity poses significant legal, capital, and management barriers that make passing these farms along to a new generation difficult.

Equally important in attracting young people into farming are quality-of-life issues. Such factors as ample social opportunities, good schools, shopping, health insurance, and quality infrastructure in the community can be as important as the expected returns from the farm business. Communities with diversified economies, strong institutions, and diverse amenities are more attractive than communities that do not have the qualities and opportunities required for a good quality of life.

In recent years, new state and federal programs to promote entry into the sector have included targeted loans for beginning farmers, help with legal and financial complexities in transferring ownership, training programs to help young people without farm backgrounds learn the basics, and efforts to support unrelated farm managers and farm workers become producers. Determining the effectiveness of these efforts is imperative.

Communities are critical to farming success. Deeper understanding is needed of the links between rural community well-being and the strength of the agricultural sector, and its attraction for younger farmers. Growing consolidation of farm production on fewer and larger operations has meant gains in efficiency, but it has also raised concern about the erosion of traditional connections between family farming, thriving rural communities, and landscape and natural amenities. On the other hand, growing interest in local, regional, and organic food has spurred growth in small farms in many areas. Comprehensive reform of U.S. food and agricultural policy must include investments in communities that support farmers and ranchers as well as effective programs to attract young people into the occupation.
Average Age of Principal Farm Operator, Select Years

While the average age (age 50) of U.S. principal farm operators was fairly stable through the 1960s and 1970s, it began to creep up during the last few decades to age 57 in 2007, according to the latest Census of Agriculture.

Iowa and National Average Cropland Value, 1950-2011 and 1997-2011

Although nominal Iowa cropland prices are not necessarily representative of national norms, this figure shows the relative stability of U.S. land prices through the mid-1970s, the spike and the severe drop-off in the 1980s, and the recent climb in prices, coinciding with the emergence of ethanol as a major outlet for U.S. corn. Since 2004, average cropland prices in Iowa have climbed more than 150 percent. These high prices create a significant barrier to entry for young farmers. National data available since 1997 show a similar increasing trend.

Source of Initial Land Acquisition for Beginning Farmers or Ranchers

According to USDA survey data from 2006, beginning farmers were more likely to have acquired their initial land for farming from nonrelatives than from relatives (both purchases and other types of transfers). That tendency is strongest in the Northeast and Northwest United States, where commercial land transactions between nonrelatives accounted for more than 50 percent of initial deals.
Hired farmworkers are a large proportion of farm labor today, especially on larger farms. At more than one million workers, seasonal and year-round hired workers now make up more than one-third of the agricultural labor force. Hired workers are particularly important for labor-intensive crops such as fruit, tree nuts, and vegetables, and on confinement livestock operations. These workers earn less than most U.S. workers (about $9 an hour in 2010), face difficult working conditions, have limited education and health care options, and are heavily foreign-born. It is estimated that more than one-half are not legally authorized to work in the United States, and have not been for more than two decades.

Farm-labor policies are controversial. The H-2A guest worker program certifies only about 75,000 to 100,000 temporary foreign workers per year and is considered cumbersome and expensive by many growers. Growers complain about farm labor shortages, and some have lost crops when workers were unavailable. Recently, farm industry leaders have pressed for immigration reform to provide a more reliable supply of legal foreign agricultural workers. At the same time, some farmworker groups are concerned that expanded foreign guest worker programs will lower farm wages and worsen working conditions. Efforts to compromise have been complicated by larger congressional debates and disagreements on the best approaches to overarching immigration reform.

Agriculture labor and its related issues are not confined to fields and farms. Today, more people are working in the agricultural input and food processing sectors than in growing and raising food and livestock. Many food processing jobs, like farm labor jobs, tend to offer low wages ($12 an hour in 2010 on average) and rely increasingly on the same immigrant labor pool.

A critical objective of future farm and food policy should be to improve wages and working conditions throughout the food and agriculture sectors, and to support comprehensive immigration policy reform that recognizes the importance of immigrant labor in these industries. Efforts to improve the skills, supply, and working conditions of the farm and food labor force will require careful balancing of the goals of improving social justice, individual opportunity, community well-being, and the competitiveness of farm and food businesses.
**Farmworkers in United States Agriculture, 1950-2010**

While the overall number of workers in the farm labor force has fallen precipitously since 1950, the share of hired workers in that supply has increased. As reflected in the Farm Labor Survey conducted by USDA, the share of hired workers has increased from 23 percent in 1950 to 33 percent in 2006, while the overall labor force fell by nearly 70 percent. This decline largely reflects the increase in mechanization that has characterized the history of row crop production and to a lesser extent livestock production.

**Legal Status of Hired Crop Farmworkers, 1989-2009**

According to data collected by the U.S. Department of Labor, the share of hired workers without legal status but doing crop field work has increased from 7 percent in 1989 to about 50 percent in recent years, a seven-fold increase. The share of U.S. citizens doing such work declined between 1989 and 1998, but has been increasing modestly in recent years.

**Median Weekly Earnings Across Select Low-Skilled Occupations, 2006**

Across a variety of low-skilled jobs in the United States performed by significant numbers of undocumented workers, wages for crop farmworkers are among the lowest.

Note: Weekly earnings include wages, bonuses, overtime pay, tips, and other forms of monetary compensation.
As the global community seeks to significantly increase food production to meet rapidly growing demand, it must do so in a manner that conserves and enhances limited land, soil, and water resources. Most land suitable for sustained crop production is already under production, and some of the world’s most critical crop production regions chronically overdraw irrigation water from aquifers. Research and investments are needed to develop methods, technologies, and improved varieties that enable simultaneous improvements in productivity, water use efficiency, and soil conservation.

One strategy is to focus on landscape-scale conservation, in which multiple interests across many jurisdictions work together to devise strategies that meet multiple goals, such as production of food, protection of biodiversity, soil conservation, and protection of drinking water. Achieving landscape-scale conservation presents inherent challenges when the actions that contribute to it are the subject of a wide range of individual and systemic decisions and practices. The complexity of both water and land governance systems in the United States and around the world requires thoughtful research to determine which policy changes and resource management practices will ensure effective conservation and enhancement of water and land.

In the United States, maintaining abundant and productive natural resources over the long term will require landowners, producers, and government agencies to develop more integrated and collaborative management approaches. Such approaches should seek to, among other outcomes, keep marginal and highly erodible lands out of production, end the overdrawing of aquifers for irrigation, resolve competition for use of limited surface water, conserve wildlife habitat alongside crop and livestock production, and stop the proliferation of invasive species. Effective, integrated landscape-scale management of land and water use in the United States will require moving beyond current jurisdictional boundaries and adversarial approaches to resource management and toward creative collaboration among landowners, tenant operators, environmental groups and conservation advocates, urban interests, and agencies across all levels of government.
Over time, an increasingly large share of U.S. lands have shifted away from agricultural uses, especially cropland. The share of public (including parks and roads) and urban areas combined has risen from about 5 percent of total land area in 1945 to 16.5 percent in 2007. (The jump in public lands between 1978 and 1982 reflects improved reporting of land devoted to state parks and wildlife areas.)

The largest shares of natural area that have been converted for agricultural uses are in Asia, Europe, and South America.

Total daily water withdrawals from surface and ground water sources in the United States have increased steadily since 1950, at 2.8 percent annually during the period. Water for irrigation uses has increased during that period, but it leveled off in the 1980s and has declined slightly during the last few decades. U.S. agriculture uses significantly more water than the rest of the U.S. economy (estimated to be 80 percent of the total), but much of that is rain-fed rather than drawn from surface or groundwater sources.

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Agriculture is an inherently risky business, subject to floods, droughts, and unanticipated pests and diseases. During the Great Depression and the Dust Bowl, the federal government created risk management programs for farmers that buffered the effects of declining prices and volatile weather. At the time, the average farmer’s income was about one-third lower than that of the overall U.S. population. The large proportion of people who lived in rural America had few if any alternatives to farming, and their production was important to a growing nation. By 2011, however, the situation had changed. The number of farm and ranching operations had declined drastically, the average farm household’s income was substantially higher than non-farm households, and job opportunities in rural America extended well beyond farming. The original rationale for these programs no longer fits the circumstances of American agriculture.

Budget pressures in Washington have further raised questions about the safety net for farmers. The approximately $5 billion annually in direct payments to farmers, which is based on historical crop acreage rather than demonstrated financial need, has come under special scrutiny. Most economists agree that these payments do not put much additional money in farmers’ pockets. Rather, the payments are absorbed by increases in land and input costs, especially for those who rent a significant share of their farmland. In recent years, the focus of farm safety net programs has also shifted toward ensuring farmers’ access to crop insurance, in which the government subsidizes both premiums and administrative costs.

Ensuring the steady production of a healthy, abundant, and affordable supply of food in the United States is a core national interest. Therefore, the government must continue to ensure that farmers and ranchers can manage their risks. But a more cost-effective set of risk management tools is necessary to minimize the financial burden borne by taxpayers. The nation must ask, to what extent farming faces unique risks, and what role government and the private sector should play in reducing risk? And, when the federal government does provide subsidies, should they be linked to adoption of specific practices (e.g., linking crop insurance subsidies and conservation compliance)? Creating incentives for prudent long-term management of risk, rather than management for short-term gains, will also be essential. These are all issues that must be raised and resolved in any discussion of the role of risk management in U.S. agriculture.
Payments to Farmers through Farm and Crop Insurance Programs, 1963-2011

The magnitude of farm program payments have varied historically, depending largely on world market conditions and prevailing prices. In nominal terms, total farm program payments, derived from the Direct Payment Program, the Countercyclical Payment Program, the Marketing Assistance Loan Program, and the Average Crop Revenue Election Program, has fallen by 75 percent since its 2000 peak level. Over the same recent period, crop insurance net indemnities (total indemnities minus farmer-paid premiums) have become a more important part of the farm safety net, reaching a record $5.9 billion in 2011.

Composition of Farm Safety Net Program Payments, 1999-2010

Farm payments received in the direct payment and conservation program categories have been quite stable over the last decade or so. Other forms of payment have fluctuated considerably. Conservation and direct payments made up 30 percent of total payments in 1999, and have risen to 66 percent in 2010.
Reduce post-harvest losses and food waste.

Determining how much additional agricultural production is needed to meet future demand for food depends, in part, on how much of that production is lost due to waste or spoilage between the farm and table. In less-developed countries, 15 to 50 percent of harvests are estimated to be lost both in the field and post-harvest owing to pests, diseases, and lack of adequate storage and other infrastructure, especially for transporting goods to market. Reducing post-harvest losses in developing countries requires both public- and private-sector investment in agricultural research, development, and extension, including in appropriate storage technologies and in improved infrastructure to better connect smallholder farmers to local, regional, and international markets. Training and education about effective drying and storage practices are particularly critical.

In the United States and other developed countries, food waste is also a significant problem. A recent study estimates that in the United States, more than 600 pounds of food are wasted per person per year. The majority of waste is at the consumer level, where about one-half of the food purchased is wasted. High food waste at the consumer level is attributed to relatively cheap food prices in developed countries and minimal awareness about the scale of food waste. Although improvements have been made, better management throughout the supply chain and at the consumer level is needed to reduce loss. Reducing both post-harvest losses and food waste requires multiple strategies, including increasing consumer awareness, changing consumption behavior, and refining incentives among supply chain participants in the private sector.

The strategies for reducing waste and loss will necessarily be different because the underlying causes are different, but curbing waste and loss in both developed and developing countries will nevertheless be critical to reducing hunger in developing countries and meeting future demand.
Sources of Food Waste for Cereals, by Region

Where the majority of food waste and loss occurs varies considerably between developed and developing countries. Although the accuracy of most data in this area is subject to debate, in the European Union and North America, about 60 percent of the waste in cereal grain products is believed to occur at the consumer household level, while in sub-Saharan Africa and South Asia, more than 60 percent is believed to occur at the farm level or in post-harvest handling or storage.

A 1997 ERS/USDA study estimated that Americans wasted or lost 27 percent of the edible food available for human consumption by retailers, consumers, and food services. This figure does not include waste that occurs at the farm and processing stages.

Breakdown of 96 Billion Pounds of Edible Food Loss in the United States, 1995*

*1995 is the most recent year for which a reliable estimate is available.
U.S. consumers are increasingly concerned about the direct and indirect impact of their food choices. Consumers are “buying locally” in an effort to both improve food quality and safety and to address social or economic concerns, such as supporting job opportunities in the local economy or preserving farmland.

As a result, it is increasingly common for small-scale direct markets such as farmers’ markets and large-chain supermarkets to both compete to provide regionally sourced foods. Although the global food system continues to play an important role in meeting demand for food, emerging demand for regionally or locally sourced foods represents a small, but growing, share of the market.

Strengthening local and regional food systems in low-income countries is also a goal. Improved transportation facilities within countries make it possible for smallholder farmers to supply growing urban markets with fresh foods. With the expansion of transportation infrastructure, especially in sub-Saharan Africa, it is becoming increasingly possible to trade across national borders, and, in doing so, increase the economic resilience of rural communities and promote greater food security based on locally grown and preferred foods.

Local and regional markets strengthen the connections between producers and consumers. They increase the ability of producers to respond to consumers’ needs and wants. They also increase consumers’ awareness of the role of food and agriculture in their personal health and welfare. Strong regional food systems serve as the building blocks for a strong global food and agriculture system. With economies of scale and high-quality standards, the specific advantages of regional agro-ecosystems can be more fully tapped.
Intra-Regional Trade Flows

The share of member countries' total trade that occurs within the community is smaller (less than 15 percent) in regional trade arrangements in Africa (such as ECOWAS in West Africa, EAC in East Africa, or SADC in southern Africa) than for comparable regional arrangements in more developed regions of the world, such as in Asia (ASEAN), North America (NAFTA), and Western Europe (EU). For the latter trade blocs, intra-regional trade flows accounted for 40 percent of total trade flows, on average.
Ensuring that vulnerable populations in the United States and abroad have sufficient and nutritious food is imperative. In 2010, 49 million Americans faced food insecurity, and their numbers have been rising since 2000. Poverty is the primary cause of insufficient access to adequate and nutritious food. Lack of knowledge and other factors, such as ease of access to nutritious food, may also be contributors.

Food price spikes hurt the poor and vulnerable populations globally. The 2007-2008 food price crisis was the latest to focus world attention, including discussions within the G8, G20, and G77. Not only do price spikes and supply shortfalls risk hunger and starvation, but they drive the price of food higher over the long term. The impact of price spikes is especially pronounced for low-income populations, who spend a higher percentage of their disposable income on food. In addition to spikes, general price volatility in agriculture stemming from unpredictable weather and other conditions adds to price pressures. Differentiating between price volatility, price spikes, and high prices is important for identifying the appropriate policy intervention. Export bans on staple food commodities, for example, may have a short-term effect on volatility, but rarely affect long-term food price trends.

Addressing price spikes and supply shortfalls requires pursuing multiple strategies simultaneously. These include investing in agricultural productivity gains that build resilience to climatic conditions; removing barriers to trade; conserving land and water resources; reducing post-harvest losses; and pursuing new renewable energy strategies that would use feedstocks that do not rely on crops and that are food staples across much of the world. Other factors that may contribute to price spikes, such as speculation, warrant investigation.

In addition to these longer-term strategies, food safety nets should be strengthened in the short term, either through public-sector intervention or private charities. Policy has more effectively targeted food safety nets to needy populations, and the nutritional quality of food distributed through safety net programs has improved. Further work, however, is needed to improve the nutritional quality of food assistance and the effectiveness of various approaches.
Share of Food Consumption in Household Expenditures, Select Countries

Although countries in all regions of the world have reduced the share of expenditures that households spend on food over the last few decades, average households in Asia and Africa continue to spend 40 percent or more on food, making them more vulnerable to price spikes such as occurred in 2007-2008.

Global Corn Stocks-to-Use Ratios, 1960-2011

The long-term decline in global stocks-to-use ratios for the major grains and oilseeds over the last few decades, precipitated in large part by changes in farm policy regimes and government stockholding behavior by the EU and the United States in the 1980s and 1990s, has contributed to recent price spikes. When grain stocks are low, markets have historically been more vulnerable to supply shocks, leading to large price shifts. Since peaking at nearly 46 percent in 1986, the global stocks-to-use ratio for corn has declined by more than two-thirds.

Oil Price versus Corn Price, 1986-2011

In 2006, movements in U.S. oil and corn prices began to track each other pretty closely as a result of three main factors: 1) increased importance of ethanol in U.S. corn demand (now about a 40 percent share), 2) increased share of energy in crop costs of production (over half of operating costs for corn), and 3) the treatment of commodities (both energy-based and agricultural) as a unified class of assets in commodity index funds by investors.
Align agricultural and food production in the United States with improved environmental outcomes.

American agriculture is highly productive, and innovations in technology and farm management have improved the sector’s environmental performance over time. No-till farming, for example, has reduced erosion, and new technologies such as high-efficiency irrigation and GPS-supported precision agriculture have in some cases significantly reduced water and input use. Yet evidence also indicates that in too many places erosion rates continue to exceed soil regeneration rates, aquifers are overdrawn, surface and ground waters are contaminated with sediment, nutrients, and pesticides, and habitat loss continues.

U.S. agricultural conservation programs are not specifically designed to enable achievement of goals prescribed by major environmental laws, such as the Clean Water Act and Endangered Species Act. Federal farm conservation programs reward the adoption of USDA-approved conservation systems, but monitoring the performance of these systems is not required. Furthermore, current programs by and large do not allow USDA to focus resources to address the most significant problems, such as watersheds with high levels of sediment or nutrients in the water. Rather, funds are distributed across the country and awarded to growers who apply for them. In addition, programs that reward prescribed practices rather than high performance do not create incentives for growers to develop innovative approaches.

Movement toward a more performance-based approach is needed to ensure alignment of agricultural practices with environmental standards. This will require greater monitoring capacity, more widely applicable metrics, a shift in regulatory focus from enforcing compliance to supporting improved performance, and stronger collaboration among government agencies. A critical challenge for agencies is ensuring that actions taken by individual producers lead to desired environmental outcomes at the landscape scale. At the same time, producers need some measure of certainty that the actions they take and investments they make to meet environmental standards will provide protection from regulatory or legal action for some reasonable period of time. Developing ecosystem service markets may provide opportunities to reward high performers. Opportunities may also develop for collaboration between government and various private sector “sustainability standards.”
Soil Erosion on Cropland, Select Years, 1982-2007

As estimated from National Resources Inventory data, soil erosion originating from U.S. cropland declined by 43 percent between 1982 and 2007. This improvement occurred largely as a result of conservation compliance rules and land retirement programs implemented in 1985, and working land programs, which began to receive significant funding in 2002.

According to the U.S. Environmental Protection Agency, agriculture’s role in impairing America’s waters and rivers has decreased markedly in the past few decades, dropping by between 46 percent and 75 percent across the three main categories. Reduced soil erosion and agricultural chemical run-off from greater use of conservation tillage and adoption of other conservation practices have contributed to this relative improvement, as have increases in pollution from nonagricultural sources, such as golf courses.

Both average nitrogen fertilizer use and average yield per acre of U.S. corn have climbed steadily since 1964. While nitrogen applications, a significant contributor to water quality impairment, have leveled off since 1980, yields have grown by more than 50 percent. USDA estimates that if all farmers in the corn belt adopted conservation best practices, average nitrogen use would decrease by 18 to 35 pounds per acre on more than 52 million acres (USDA/NRCS Conservation Effects Assessment Project).
Farmers around the world are experiencing the effects of a changing climate. Average temperatures are increasing, precipitation is less predictable, and floods are more common. Favorable climate conditions for crops are shifting geographically; optimal U.S. corn production conditions, for example, are shifting northward. Although aggregate climate trends are obvious and measurable, too little is known about the specific steps needed for agriculture to successfully adapt over the long term to anticipated shifts in the climate. Too little also is known about the consequent changes in pests, pathogens, invasive species, and habitat needs of wildlife. These changes pose challenges for all growers, but for those in developing countries with limited technical, financial, and educational resources, such changes can be catastrophic. In a ground-breaking addition to their Quadrennial Defense Review in 2010, the Pentagon identified a limited capacity to grow food as a significant threat to social and political stability in regions of Africa and Asia.

Both diversity of and within systems will likely contribute to the adaptive capacity and resilience of agriculture in the face of changing climatic, ecological, and economic conditions. A better understanding of the types and intensity of climatic and ecological changes is necessary for producers to better prepare. Also important is a better understanding of the relative resilience, flexibility, and adaptability of different farming systems in the face of climate and other predicted environmental changes.

Investments in research, data collection and distribution, education, and extension are needed to improve production across the existing range of climatic and ecological conditions, as well as the transfer of such technologies and techniques across borders. Information gaps and unmet needs for education and technical assistance must be identified and addressed, and possible interventions must be considered to better align patterns of crop and livestock production with conservation of natural resources.
Climate scientists believe that in a non-warming climate, the ratio between record daily high temperatures and record daily low temperatures should be approximately 1:1 over the long term. Between 2000 and 2009, the ratio was about 2:1. During a 12-month stretch ending in March 2012, U.S. cities registered new record highs at a rapid clip, exceeding new record lows for the period by a ratio of 5:1.

Numerous agricultural practices have the potential to add carbon back to the soil over time, helping to mitigate climate change. Some of the practices offer the added benefit of providing more resilience to crops under heat-stressed conditions, by helping to retain soil moisture.

Source: Lewandrowski et al., ERS/USDA

Source: Pimental et al.
Use best available science to better understand and reduce adverse human and environmental health and safety impacts of agricultural inputs and practices.

Heightened concern and demand in the U.S. and globally for a healthy, safe, and affordable food supply has driven research and adoption of new technologies and practices that have reduced exposure both to potentially harmful agricultural and food inputs as well as food-borne pathogens. These include improvements in contamination detection methods through improved institutional capacity and reduced costs of diagnostics. However, concerns remain that there is insufficient scientific understanding about the comprehensive, synergistic, and cumulative effects to human health and the environment from exposure to inputs used in agriculture production and food manufacturing, such as pesticides, chemicals, fertilizers, transgenic seeds, and antibiotics, and hormones.

In 2007, the U.S. National Research Council published “Toxicity Testing in the 21st Century: A Vision and Strategy,” which called for improved scientific understanding and sound methods and metrics for risk assessment. Widely embraced by diverse groups, the report recommends harnessing scientific advances to make toxicity testing quicker, less expensive, and more directly relevant to human exposures. More effort is needed to advance these and other strategies recommended for improved understanding.

Alongside improved scientific understanding, new practices and advances are needed in integrated ag-ro-ecological approaches, such as ecological intensification. These systems are designed to increase crop production while also improving environmental, social, and economic sustainability by managing biodiversity and ecosystem services. Diversified systems, which are currently a modest but growing component of U.S. agriculture, can also play a role. These systems include conservation agriculture, organic farming, alternative livestock systems, and mixed crop/livestock systems. Increased research in these systems is needed to further advance crop yields while protecting the environment.

Improvements in food safety will also be needed to further reduce the adverse health effects from biological contaminants. Each year, food-borne illness affects more than 48 million Americans. The Food Safety Modernization Act represented a sweeping reform of food safety laws. Support for its implementation is critical.
Total Pesticide Use in the United States, 1964-2004

Total pesticide use in the United States, as measured by the pounds of active ingredients in the products applied (which includes herbicides, insecticides, and fungicides), rose steadily between 1964 and 1982, but has leveled off over the last few decades. It declined by nearly 14 percent between 1997 and 2004, in part as a result of the wide adoption of genetically modified seeds (for corn, soybeans, and cotton) which incorporate protection against certain pests.

Reported Coastal Sites Globally with Hypoxic Zones, 1910-2000

Agricultural runoff, both from fertilizer and animal manure, is widely viewed as a major contributor to the expansion of hypoxic zones in coastal estuaries around the world. After remaining at relatively low levels through the 1950s, the number of sites around the world reporting significant hypoxia began to expand in the 1960s, growing from about 80 to more than 500 in the current period.

Incidence of Select Food-Borne Illnesses, 1996-2010

Since 1966, the Centers for Disease Control have tracked the incidence per 100,000 people of laboratory-tested infections resulting from major food-borne pathogens such as campylobacter, salmonella, and E. coli O157. Of the three types, the relative frequency of campylobacter and E. coli has declined in the past 15 years, while the incidence of salmonella infection has ticked up.
Redirect research, education, and extension priorities and strengthen institutions in the United States and developing countries.

Meeting the challenges facing the food and agriculture system requires a significant shift in the way we produce, process, distribute, and consume food. Agriculture is an important part of any discussion of nutrition and health, environment, the economy, and global stability, and it is neither realistic nor productive to address these issues in isolation. Research priorities must shift to meet these ongoing challenges, and agricultural research, education, and extension institutions in the United States and globally must be strengthened.

Although studies consistently indicate a very high return on investment in agricultural research, spending has slowed during the past few decades. In the United States, real (inflation-adjusted) growth in public agricultural research spending has declined by more than 20 percent since peaking in 1994. Major breakthroughs are needed both in basic agronomic research and in the development of technologies and techniques to intensify agricultural production in ecologically appropriate ways. Research must also be substantially more integrative, approaching challenges through interdisciplinary efforts that encompass both the physical and social sciences and leaders from government agencies, private industry, nongovernmental organizations, education and research institutions, the global research community, and more.

The core components of National Research Council's definition of sustainable agriculture, which was also used in the USDA “Research, Education, and Economics Action Plan” (February 2012), should guide research investment to: (1) produce enough to satisfy human needs, (2) enhance environmental quality and protect the natural resource base, (3) be profitable, and (4) increase the quality of life for farmers, farm workers, and society as a whole.
Real United States Public Agricultural Research Funding, 1970-2010

Public spending on U.S. agricultural research (from both federal and state sources) rose steadily between 1970 and 2002, when growth initially flattened and then fell. The decline is largely owing to budget pressures on overall federal agricultural spending and Congress’ view that other agricultural programs deserve a higher priority than research.

Global Average Yields for Major Crops, Annual Percent Change

A comparison of average yield growth for major crops between the period of 1961-89 (which included the Green Revolution) and 1990-2010 finds declines across the board, ranging from a drop of nearly 70 percent for wheat to less than 3 percent for soybeans.

Chinese Agricultural Research Spending (inflation-adjusted), 1961-2007

Spending on agricultural research in China has grown steadily since 1961, except for a brief drop-off during the chaos of the Cultural Revolution in the mid-1960s. Unlike the United States, the government of China engineered a spurt in spending in recent years, with average growth annually of 17 percent between 1997 and 2007.