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Challenges and Issues in the Next Decade: A Proactive Role for Agricultural and Resource Economists

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Economic and environmental challenges in the global economy raise significant issues that require public policy and private sector attention over the next decade. Price volatility, invasive species, sustainable biofuels production, and climate change all affect our agricultural and resource base and its future. Agricultural and resource economists must provide analyses of public policy and private sector strategies based on innovative research that integrates insights across disciplinary boundaries. Proactive communication of the results to decision makers can make a difference in how these important societal issues are addressed and help to shape the future.

Key Words: economics, environment, policy research, communication

Significant challenges face the North American as well as the world economy. Financial and economic instability are currently the center of attention. There have been significant disruptions in agricultural and food markets in the face of spiking energy costs at the same time that economic growth in developing economies has increased demand for food and feed for livestock production and rapidly rising production of biofuels has increased demand for agricultural feedstocks. In the face of growing global trade, food safety issues and invasive pathogens and species have become a greater concern. At the same time, there is increasing consensus in the private and public sectors that climate change is a factor that must be addressed by the agricultural and food sector, but that it also offers potential opportunities for agriculture to play a role in mitigating future climate change by providing ecosystem services, including carbon sequestration.

These economic and environmental challenges offer great opportunities for agricultural and resource economists to apply their research skills to generate important insights for policymakers and private sector decision makers dealing with these issues, which are high on the public policy agenda and driving business decisions today. We have considerable interest and analytic capacity. But I am concerned about whether agricultural and resource economists have specialized too much in their individual research focus on somewhat narrow topics. There is need to collaborate much more broadly with other researchers both inside and outside our profession in order to achieve results meaningful to the complexity of the issues. We must integrate our knowledge about the physical and social elements of these economic and policy issues.

I will touch upon some of the major issues that we must address, identify some critical research needs, and briefly discuss some of the challenges facing researchers in the next decade.

Current and Emerging Issues

The growing global economy and the increasingly integrated economies of the world provide significant benefits but also create new challenges. The economic growth in Brazil, Russia, India, and China, known as the BRIC countries,

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as well as a number of other developing countries, has generated unprecedented demand expansion for food, feed, and fuel. This has led to growing world food trade based on trade agreements and rapidly expanding numbers of middle class consumers. As diets are improved through the addition of more animal protein, replacing long-consumed staples, demand for feed and/or meat imports further increases world trade. However, this is not without challenges related to potential animal disease concerns, such as the bovine spongiform encephalopathy (BSE) related closure of Japanese and Korean markets to North American beef products.

Further, burgeoning demand for petroleum in rapidly developing economies is partially behind the recent rapid rise in oil prices and increased interest in bio-based energy production. The rapid expansion of corn-based ethanol shows that agriculture can be expected to play a role in providing renewable fuels to replace some of the fossil fuels we now rely on (Babcock 2007).

The recent food price crisis, affecting not only North America but the world, was driven directly by our own agricultural perfect storm combination of these factors, exacerbated for a time by the springtime floods in the heartland Corn Belt and expectations for reduced crop yields. Subsequent good weather during the growing season and less loss of planted acreage due to the flooding than initially anticipated led to near record corn and soybean production in the United States. There were also improved commodity crop harvests in other major exporting countries, following several less stellar years in some instances. The upshot was extreme price volatility for agricultural crops during the past year, accompanied by very high input costs driven partly by petroleum prices and their impact on fertilizer, transportation, and other costs.

A major consequence of higher feed costs occurred within the livestock industry. In the face of increasing corn prices in particular, livestock production became significantly less profitable or even a losing situation. Rising grain prices led to decisions to reduce livestock and poultry production by some and cut profits on animals then in the lengthy production cycle for dairy and beef. Further, the decision to lock in future grain prices at fairly high levels early in the year led to continued losses by some in the industry even as grain prices subsequently receded. Pilgrim's Pride, a major poultry producer, was forced into bankruptcy because of corn futures contracts locked in at high prices and excess capacity in the industry relative to demand, which resulted in lower poultry market prices. There is supply contraction underway in the livestock and poultry industries currently, as would be expected with higher feed prices, declining domestic and export demand in the face of economic slowdown, and uncertainty about prospects for near-term recovery in world economies. To the extent that factors driving grain prices going forward continue to make feed more expensive as a livestock input cost, there may be some downsizing of the industry at least in the intermediate term. Longer term, adjustments and continued demand growth would be expected to reverse that situation.

Whether this price volatility was a one-time event caused by short carry-over stocks, spiking demand due to income growth, biofuel production and investments in commodity markets by financial institutions, or bad weather and high petroleum prices, remains to be seen. If it represents a more fundamental shift in demand for agricultural products due to long-term trends in developing country demand growth, tighter petroleum supplies due to economic growth without adequate new supply sources, and continued production growth in biofuels, then increased agricultural commodity price volatility may be a continuing challenge. In that case, new public policies and private sector strategies may be called for.

In addition to these economic factors, there are biological and environmental challenges to be addressed. Directly related to increased economic trade are potential increased incidences of invasive species and pathogens in the form of insects or plant and animal diseases. Currently, these are manifesting themselves through outbreaks such as the green ash borer, which has destroyed thousands of acres of forest and urban trees across the northeastern United States and swaths of Canada, citrus greening in Florida, Avian influenza, and numerous others. The challenge of trying to head off such invasions strains import inspection resources, and it is widely recognized that a tiny percentage of imported products are actually inspected. The inspections are targeted based on best available information on potentially contaminated shipments because of origin, type of product, and potential economic damage if introduced into the United States. Nonetheless, it is a huge

and growing challenge to get into place procedures to ensure the best possible inspection outcomes given resource constraints, trade agreements, and low level of sophistication in production practices in some countries of origin for imports. In addition, uncontrollable routes of entry exist such as windborne, as in the case of soybean rust attributed to hurricane-introduced contamination in the southern United States. Eradication and control strategies that are effective and economically efficient must be developed.

Of course, these problems may be relatively minor compared to climate change, increasingly recognized as a force that will require innovative adaptation and mitigation strategies for agriculture. The Intergovernmental Panel on Climate Change (IPCC) 2007 report argues that climate system warming is underway and attributable in large part to human activities, especially the emission of greenhouse gases. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) comprise respectively 77.0, 14.3, and 7.9 percent of greenhouse gases (IPCC 2007a). Agriculture generates these three principal greenhouse gases, with CO_2 primarily due to land cultivation, while CH_4 and N_2O are primarily due to livestock and crop production (Pacific Economic Cooperation Council 2008). Warmer temperatures in some higher latitude countries, including the northern stretches of the United States and Canada, may lengthen the growing season and increase productivity in those areas as long as temperature increases over the next century are in the range of 1–3ºC. Beyond that range, productivity increases would decline. The interaction of productivity-enhancing CO_2 within an uncertain temperature-increase range up to some limit and increased precipitation remains undetermined (IPCC 2007b). This all adds up to a great degree of uncertainty about the impacts of climate change on U.S. agricultural productivity. Warmer temperatures of even 1–2ºC in lower latitude countries may cross the threshold of tolerance for crop production based on current agronomics (IPCC 2007b). This implies that lower income tropical countries would need to rely more on trade increases to feed growing populations, given current technology.

Recent research based on output of 23 global climate models that provided the basis for the 2007 IPCC report confirms that tropical countries, which experience less annual temperature extremes, will be the first to feel the effects of heat stress due to climate change. However, by the end of the century the seasonal growing temperature in temperate countries will likely exceed the hottest season currently on record. Agricultural production will face serious challenges, with stress on crops and livestock globally (Battisti and Naylor 2009). So this implies that trade increases may be less than certain as a solution to potential food shortages in tropical countries.

Further, disastrous climate change would magnify water scarcity in some regions and produce excess rainfall in others. Water management may become a critical challenge in some parts of the United States, especially southern states, where precipitation is projected to decline.

Finally, it is unclear to what extent climate change will affect the broad provision of ecosystem services beyond that of providing food and fiber to include carbon sequestration, clean water and air, and desirable landscape vistas. However, it is clear that the public and private sectors will increasingly move toward steps to pursue mitigation and adaptation to impending climate change.

Major Research Challenges

Agricultural and resource economists can bring valuable insights to private sector strategies and public policies to adapt to the effects of and to mitigate climate change. Their insights will also be valuable on how most effectively and efficiently to provide carbon sequestration as a major element of a climate change mitigation strategy, to develop a solid basis for ecosystem services to generate improved water quality and quantities, and to provide societal public goods in addition to agricultural and resource production. Evaluating the net gains from trade and their distribution has been the focus of much research used in developing trade policy. Identifying cost-effective strategies for preventing or controlling invasive species and diseases, which are at least partially due to increased trade, can also draw on our substantial skills. Finally, evaluating the trade-offs between food, feed, and fuel, and their implications for how we deploy our agricultural and natural resources to provide sustainable biofuels, will require a great deal of additional analysis.

Climate Change

Climate change mitigation and adaptation are likely the most important and far-reaching strategies to be developed in the foreseeable future. If climate change is fairly gradual, U.S. farmers will be able to adapt by changing crop selection, adjusting crop management, and making new capital investments. The private sector technology supply industry should also be able to anticipate needed adaptations and the new capital equipment they may need to provide (Antle 2008).

Due to inertia in climate and economic systems, adaptation by agriculture and forestry will no doubt be required. How much adaptation will be needed will depend on the level of climate change mitigation that is achieved, local climate change potential, and capacity of producers to adapt in their own or other regions. Studies that have investigated the economic value and nature of adaptation practices generally show that adjustments such as planting date and variety can greatly reduce the economic impact of climate change. In agriculture, principal mechanisms to facilitate adaptation include research, extension/training/outreach, informal producer networks, and government policies (Rose and McCarl 2008). Adaptation can be a successful element of U.S. agriculture's response to climate change, probably at relatively modest cost.

However, recent projections that normal season average temperatures will exceed the hottest currently on record for temperate countries means that major adaptations of crop varieties to develop heat tolerance and the ability to grow under heat-induced water stress will be needed. Irrigation systems suitable for diverse agro-ecosystems will also be needed. This requires significant investments in research soon to meet longer-term challenges expected to be brought on by climate change (Battisti and Naylor 2009).

In addition to adaptation, it is widely agreed that substantial mitigation of greenhouse gas (GHG) emissions is necessary in coming decades to keep atmospheric concentrations of GHG to levels that limit the risk of future severe climate change and its devastating effects. A globally cost effective policy requires that emission cuts are achieved at similar marginal cost in all countries and on all emission sources where control is practical. Government can create a fairly pervasive and uniform price incentive to reduce emissions. This may involve creating a cap-and-trade system wherein an overall limit on emissions is set and then market-based trading is allowed within that limit. Alternatively, emissions may be taxed. Or, some combination of the two approaches may be used. Technology policy, including carbon capture and storage, will also need to be part of an overall climate policy to reduce global, long-term GHG emissions. Therefore, effective and efficient mitigation policy will require devoting significant resources to developing a broad range of technologies and putting into place a pervasive, significant price on emissions (Pezzey, Jotzo, and Quiggin 2008).

All this means that agricultural and resource economists must continue to conduct analyses evaluating alternative approaches that will help policymakers and private sector decision makers anticipate implications of changes they may need to make because of climate change concerns. We can analyze the potential cost of such changes and the anticipated benefits thereof, both for individuals and for the public at large. We will need to work with our colleagues in the physical sciences as well as other social sciences to undertake analyses that are meaningful in order to determine possible future courses of action to adapt to climate change. Shogren (2008, p. 4) argues that "…economics can make good climate change policy better, and can prevent bad policy from getting worse."

Ecosystem Services

Ecosystem services and the potential for agriculture to generate income through their provision, beyond the provision of food and fiber for which markets exist, has only recently become the center of informed discussion by the lay public and policymakers. For example, the Food, Conservation, and Energy Act of 2008 directs USDA to "establish a framework to measure environmental services benefits from conservation and land management activities" and to focus on carbon markets for agricultural producers (Kraft 2008, p. 26). Thus, ecosystem services and rural lands are seen as closely aligned.

But there are a number of policy challenges related to agriculture being able to provide ecosystem services successfully. To the extent ecosystem services have economic value, identifying the link between them and the quality of life of

individual households is a fundamental challenge. Then, one must determine how to use that link to integrate ecosystem service values into business and individual decisions. Although institutions, public policies, and private sector activities are in place, most are currently unable to integrate ecosystem services successfully into viable economic products. Much additional work is needed to fill the big gap in economics in providing insights into how to integrate values directly into the economy, particularly on the demand side, such that it would give people the ability to place values on ecosystem services. Entrepreneurs may then be able to leverage these consumer values to expand the potential for market approaches to provide ecosystem services (Swallow et al. 2008).

Ecosystem services offer an opportunity for agricultural policy as society focuses on natural disasters and the effects of climate change. There will be increasing potential for ecosystem services to help mitigate and adapt to these natural forces. Incorporating green payments into farm programs may help move agriculture to provide a more multifunctional set of outputs that can deliver valuable ecosystem services (Ruhl 2008). There is a major role in climate regulation for agriculture in reducing GHG and sequestering carbon (Swinton 2008). Farmers will also have other opportunities to manage their land to provide ecosystem services such as wildlife habitat, improved water quality, and appealing landscapes.

Agricultural and resource economists obviously have the tools to address policy design and evaluate alternative approaches to providing beneficial ecosystem services. The challenge will be to identify and evaluate opportunities to create valuable products through market activities and/or policy incentives. Once these are identified, educating individuals and policymakers about how to implement them successfully will also be required.

Invasive Species

Policymakers and economists face a challenge in analyzing optimal pest control policies because of uncertainty regarding invasive species' impact on current biological and economic relationships. Critical mistakes in policy choices could result if economic and biological relationships are not adequately integrated into analyses of policy options. This is particularly problematic because responsibility for invasive species policy is fragmented among many government agencies. This does little to encourage integrative approaches to prevention and control. Bioeconomic modeling is required in understanding economic and ecological costs created by such fragmentation. Invasive species policy-making is a process rather than a single decision, and bioeconomic modeling can be helpful in every stage in this process (Goodhue and McKee 2006).

Optimal strategies will vary with anticipated biological growth, the economic cost of prevention and control, and economic valuation of potential damages as a function of invasion level (Kaiser 2006). Assessing these parameters requires creative and interdisciplinary processes. Controlling invasive species in agricultural systems requires policymakers and producers to be able to compare the costs and benefits of alternative controls (McKee et al. 2006). However, they must often do this with only limited information available, again pointing to the value of economic modeling.

The spread of highly pathogenic avian influenza (HPAI) across Asia and Europe has created concern that it will eventually turn up in the United States. HPAI is of more concern than many invasive pathogens because it has the potential to spread rapidly and could be zoonotic, spreading between animal and human populations. The death rate in human cases in Asia has been quite high in the relatively small number of cases that have occurred. This is the reason for so much concern about a pandemic potential. If HPAI enters the United States, the cost of eradicating large segments of the commercial poultry flocks could be enormous but necessary to guard against pandemic spread among humans should the disease become zoonotic. Small backyard flocks have been the source of outbreaks that have infected commercial flocks with various strains of avian influenza previously, so it is important to focus attention on these small flocks in developing mitigation strategies for HPAI. Elbakidze (2008) emphasizes the need for careful strategy design to control potential outbreaks of avian influenza across backyard poultry farms. Designing a compensation program to incentivize a flock owner to disclose the presence of disease is one important element of a policy. The other element is to encourage development of inexpensive test kits for use by animal caregivers to aid in early detection of any disease present.

What this means for agricultural and resource economists is that in dealing with invasive species we must cut across disciplinary boundaries to do useful modeling. Each invasive species has unique characteristics and potential to harm agricultural or natural systems and, therefore, must be dealt with through a case-by-case analytic approach. Some have zoonotic potential, which makes the urgency of research attention even more compelling. With continuing growth in world trade, invasive species and pathogens will undoubtedly be with us despite our best efforts to prevent their entry into North America. The opportunities for you to employ your skills may be unbounded in this arena!

Sustainable Biofuels

There has been a renewed interest in producing sustainable biofuels to replace part of U.S. reliance on imported petroleum as the principal source of energy. The Food, Conservation, and Energy Act of 2008 provides a subsidy to encourage production of cellulosic ethanol. However, there are likely to be uncertain environmental consequences, as well as economic and social impacts, unless great care is exercised in implementing this program. Softening the environmental impact of grain-based ethanol and designing management practices and making smart choices in where cellulosic ethanol is produced are critical to developing sustainable biofuels production that is environmentally friendly. This means that we urgently need research that takes a systems approach, focuses on ecosystem services to meet multiple uses, and emphasizes understanding of implications of cost-effective policy and management practices at different spatial scales (Robertson et al. 2008).

The recent price instability in the agricultural and food sector raised much concern about food, feed, and fuel trade-offs. A number of estimates have been provided by our colleagues about the causes of rising food prices and their ties to bioenergy policy, especially subsidization of ethanol production from corn in the United States. While economists understand that there are myriad factors driving rising food and feed prices, biofuels are an obvious candidate for blame given their rapid growth and the substantial proportion of the U.S. corn crop devoted to them. However, burgeoning demand from developing countries, higher cost of processing and transportation of food because of high energy costs, drought- and flood-related shortages in some countries, and financial institutions investing in commodities have likely all been contributing factors. The question now is to what extent this confluence of factors was a one-time event or the harbinger of continued price instability to a greater degree than typically faced by the food and agricultural sector. Understanding the short-term and longer-term implications of the factors involved offers opportunities for good research and outreach, with the results used to better inform all involved. Future public policy and private sector decisions will be shaped by the analysis provided, as well as by the various interests of those concerned about their particular niche in this larger puzzle.

Communicating Research Results

I have identified several potential research opportunities related to important societal issues for the next decade. The research will require access to significant funding for areas not necessarily well-funded at this time. The challenge will be to generate those funds from the public and/or private sectors, possibly a combination of the two. This will require proactive dissemination of our research results to a variety of audiences, including federal policymakers, farm group leaders, private firm managers, and myriad interest groups, including environmental organizations. While it is critical to undertake sound research and report it to your peers, it is equally important to disseminate your work through short articles without economic jargon to the decision makers in a position to help obtain the necessary research funding to analyze these important societal issues.

The Association of Agricultural and Applied Economists (AAEA) has adopted a more aggressive outreach program to help get research findings to appropriate lay audiences. This effort is under the leadership of the AAEA Outreach Committee. It includes the well-established quarterly *Choices*, published electronically and disseminated to targeted groups of potential users. Each issue includes one or two themed sets of articles addressing agriculture and trade, resources and the environment, consumers and markets, agribusiness and finance, or rural economics as broadly defined areas. Individual articles submit-

ted outside the themes are also published. All articles are peer-reviewed.

The AAEA Outreach Committee then works with the Council of Food, Agricultural and Resource Economists (C-FARE) to provide congressional staff and broader policy briefings and "webinars" based upon selected *Choices* theme articles.

A second leg of the outreach strategy is to post periodic topical analyses on current policy issues. The intent is to provide *Policy Issues* postings on a regular basis. The challenge is to identify timely topics and get articles produced quickly. This means a matter of a few weeks rather than several months or more. Presumably, these articles will draw from research that contributors are already involved in when the topic becomes a current policy issue. The *Policy Issues* postings also require quick-turnaround peer reviews.

The final element of the AAEA enhanced outreach effort is a Shared Extension Materials Exchange among our agricultural and applied economics colleagues which will provide them access to timely educational resources based on high quality analyses created by those with topical expertise. This serves a function previously provided by regional extension committees, which have largely fallen by the wayside or lost much of their critical mass. It is a vital part of a comprehensive outreach plan for our profession.

I challenge each of you to think about how you might contribute to making AAEA's *Choices* and its *Policy Issues* successful in taking valuable research findings to those who can apply them to address important societal issues. The *Choices* website (www.choicesmagazine.org) provides information about how to contribute to these outreach efforts so important to future funding of your research.

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