



CONTRIBUTIONS OF ECONOMICS TO NIFA PRIORITIES

PLANT AND ANIMAL SYSTEMS¹

Agriculture and forestry exist to provide food, fuel, fiber and other benefits for consumers and livelihoods for producers. People manage these ecosystems, and people benefit from them. Biology clearly stands at the center of plant and animal systems' research. But for research to be effective at improving human-managed plant and animal systems requires understanding human managers and their socio-economic environment.

The social sciences explore why people behave as they do, individually and collectively. Economists focus on how people manage scarce resources, such as land, water, work, time and money. For producers, what plants or animals will they choose to produce? What practices and technology will they use? For consumers, what foods, fuels and fibers will they buy? How do changes in tastes, prices and policy affect their choices? For the general public, how does the management of plant and animal systems affect environmental quality, public health and welfare?

What Economists Can Contribute

Over the years, economists have contributed to research in plant and animal systems in key ways:

- **Economists frame the science in a human systems perspective.** Drawing on behavioral analysis in the context of markets and policy, economists can help to orient biological research for its greatest effect in human-managed systems.
 - Stephen Farber and his coauthors (2006) developed methods for assessing the trade-offs between biology and economics inherent in managed ecosystems.
 - John Antle and his coauthors developed a framework for an integrated analysis of tradeoffs between economic and environmental indicators in managed ecosystems confronting sustainability issues (Stoorvogel, *et al.*, 2004).
 - Richard Adams and his coauthors (1990) examined the impacts of climate change on agricultural productivity by combining economic, atmospheric and plant models.
- **Economists analyze the factors that influence producer and consumer behavior.** Economic analysis informs the motives for technology adoption, the conditions for producer shifts from one production system to another, the conditions for changes in the use of resources, and the dietary choices of consumers.
 - Economists Scott Swinton and Frank Lupi along with coauthors in multidisciplinary teams elucidated why producers adopt environmentally friendly agricultural practices and how market shifts and government policies change the value of natural ecosystem services (Chen, *et al.*, 2009; Landis, *et al.*, 2008).

¹ Prepared by S.M. Swinton (Michigan State University), N. Kalaitzandonakes (University of Missouri) and C.E. Ward (Oklahoma State University), February 2010.

- Kalaitzandonakes and Bijman (2003) explained the behavior of key global agri-food companies in the market acceptance of genetically modified foods, going beyond the accepted view that consumer attitudes alone explained their market woes.
- Lusk, Roosen and Fox (Lusk, *et al.*, 2008) found European consumers willing to pay large sums for beef steaks from cattle not fed genetically modified corn, revealing why U.S. beef exports had suffered in European markets.
- **Economists understand the impacts of markets and prices.** Prices are among the incentives that influence the choices of consumers and producers. Economic analysis of market functions contributes to reliable predictions and informs policy makers.
 - McCarl and Schneider (2001) identified optimal strategies for forest, crop and animal management that would reduce greenhouse gas emissions over a large range of hypothetical carbon prices while accounting for economic price feedbacks.
 - Searchinger *et al.* (2008), demonstrated that failure to count the carbon emissions that result indirectly from U.S. biofuels policy as farmers worldwide respond to market incentives and convert forest and grassland to new cropland leading to increases instead of savings of greenhouse emissions.
- **Economists measure the impacts of new technologies on producers, consumers and markets.** Technological innovations in plant and animal systems can bring about yield improvements, changes in market structure, trade, prices and consumption, cost reductions and other efficiencies. Economic analysis can explain and measure these impacts.
 - Qaim and Zilberman (2003) showed that pest-resistant genetically modified crops have great promise for the developing world at a time when conventional wisdom seemed to suggest the opposite.
 - Kristjanson and coauthors (1999) found that a vaccine to prevent trypanosomosis in African cattle generates a 33 percent rate of return from improved meat and milk productivity.
- **Economists measure and explain the returns to research and outreach.** The funding of research and Extension calls for accountability, whether in the public or private sector. Taking into account changes in prices, economists have tools for measuring the impacts of research and outreach on producer and consumer welfare.
 - Evenson and Gollin (2003) demonstrated that the Green Revolution generated dramatic returns to research, especially by lowering food prices for consumers.
 - Alston and co-authors (2000) showed that such generous returns are not rare; across 300 studies, returns to research and Extension averaged a staggering 48 percent per year with no evidence of a decline in the rate of returns in recent years.
 - Alston, Bedow and Pardey (2009) demonstrated that declining public agricultural research and development have reduced global food capacity and productivity growth—revealing that private research and development have not been a sufficient substitute.

Needs and Opportunities

Future research in plant and animal systems has to provide solutions for key issues including:

- Meeting the rising world demand for cereals, animal protein, water and energy in environmentally sustainable systems;
- Guarding the safety of the agri-food supply chain just as it becomes more international and complex; and
- Managing changes to rural landscapes, agricultural markets and communities that could come with climate change and associated government policies.

As the nations of the world become interdependent, choices in plant and animal research will grow more complex. Priorities for plant and animal research in wealthy nations will diverge even more from poor nations. New plant and animal products from the U.S. will likely be traded, requiring upfront consideration of global market integration, divergent international regulations and diverse consumer preferences. Rising awareness of regional and global environmental challenges calls for understanding of land managers' behavior and responses to policy initiatives. These big-picture puzzles are too big for a single discipline, even one as broad as biology. Economists are experienced in framing research questions in terms of the "big picture" and complementing biological research with analysis of economic feedbacks and impacts on societal welfare. Investment in future collaborative bio-economic research should, therefore, be expected to pay high dividends.

900 Second Street, NE
Suite 205
Washington, DC 20002
Phone: 202-408-8522
www.cfare.org



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