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Research Needs and Challenges in the Food, Energy and Water System: Findings from an NSF Funded Workshop

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Research Needs and Challenges in the Food, Energy and Water System: Findings from an NSF Funded Workshop

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IN OCTOBER 2015, the Center for Agricultural and Rural Development at Iowa State University, Ames, Iowa hosted a two-day National Science Foundation-funded workshop exploring the challenges and pitfalls associated with integrating biophysical and economic models. The workshop brought together leading economists, statisticians, crop scientists, hydrologists, climate scientists, and other biophysical modelers, to identify and address the key scientific, engineering, and data challenges associated with understanding our food, energy, and water (FEW) system. Approximately 80 people attended the workshop with about half of them representing social scientists (primarily economists) and the rest from the physical and natural sciences. Economics and social sciences were intentionally emphasized so that the findings would be particularly relevant to research needs in those fields.

The direct product of this workshop is a white paper, available at *http://www.card.iastate.edu/few*, which provides guidance to the National Science Foundation in formulating future funding initiatives in this area.

In addition to the four workshop leaders, about two dozen participants, listed as coauthors, contributed to the final white paper, which identifies several major gaps in existing modeling capacity that present substantial impediments to understanding the FEW system.

While the white paper identifies a number of areas of necessary research, the following broad areas are the highest priority for future funding.

Goals of the Workshop

- identify the key gaps in modeling capabilities and scientific understanding within the individual behavioral, biological, and natural systems that comprise the FEW system;
- identify key challenges in model linkages across the behavioral, biological, and natural systems that comprise the FEW system;
- identify the major statistical and econometric challenges in estimating the accuracy of these individual and linked models when they are used for forecasting and for predicting the outcomes of policy decisions;
- identify the key data and cyberinfrastructure challenges required to develop the needed modeling capabilities within individual components of the system and to achieve linkages across the modeling components of the FEW system; and
- identify key challenges in adapting and using these models to incorporate climate change.

Economic Models of Decision-Making in Coupled Systems

A clear theme emanating from many of the talks at the workshop and follow up discussions was the need for integrated models to have adequate representations of human behavior. While there is a growing and increasingly visible literature that couples human system models with biophysical models, many studies do not incorporate economic and social drivers. Too often, decision making in coupled economic and biophysical models are not explicitly modeled, or based on overly simplistic rules of thumb. Poor policy recommendations are likely to come from models that do not adequately represent how incentives will alter behavior.

We discussed a number of approaches, including more widespread use of models with simple representations of humans as economic agents who attempt to improve their own welfare or profits. To appropriately capture potential changes to policy, it can also be very important to incorporate market responses, both regionally and internationally. Additionally, there are situations where simple profit maximization assumptions will not adequately represent human behavior. In these cases, insights from behavioral economics, sociology, and psychology may be useful to build models better representing likely responses to policy and other system drivers. Needed model improvements also include better representation of decision making related to adaptation behavior and the adoption of new technologies. Finally, some decisions have important dynamic components where beliefs of the decision maker about future prices or environmental considerations affect decisions made today. There is a paucity of models that can incorporate these dynamic considerations and that can appropriately incorporate uncertainty in decision making.

Coupling Models Across Disciplines

A second area of concern in integrated modeling identified at the workshop was the difficulty of linking models from one discipline with those created in another discipline. Sometimes this misalignment occurs due to the modeled variables in each system, other times it has to do with the scale of model output. For example, economic models often assume decision makers maximize utility, which in an environmental context might depend on the clarity of water in a lake or stream. If a water quality model is utilized to predict changes in water quality associated with changes in regional farming practices, the model output will only be useful as an input into the utility function if it produces a measure of clarity that matches the economic model variable. Thus, model developments that make integration across disciplines seamless require more attention.

Model validation and comparisons

Another common theme that arose throughout the workshop was the continuing challenge of how to best validate and assess integrated models. Undertaking model comparisons at a variety of spatial and temporal scales has proven a successful strategy within individual model assessments, and integrated models could be compared likewise. Another promising approach is to use the results of retrospective assessments of the outcomes of past policies and compare those to the estimates generated by the integrated model to see how closely they align. However, the need for new approaches for model validation is clear.

Research at the FEW nexus is high on the federal agency agenda for good reason. Society faces a multitude of challenges in managing the tradeoffs between outputs from these systems. Models can be an important tool to help clarify the importance of these tradeoffs and provide insights for policies to ameliorate unintended consequences of changes in the system. The workshop held in Ames identified that better representations of decision making creates a number of ways in which models of these systems can be improved upon. For more details, please visit the workshop web site to read the complete white paper. ■

Crude Oil Prices and US Crop Exports: Exploring the Secondary Links between the Energy and Ag Markets
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on Iran for its nuclear program, US soybeans were not entering the Iranian market during the 2014/15 marketing year. With the lifting of those sanctions, US soybean exports to Iran have started to flow. Removing Iran from the calculations, OPEC members' demand for soybeans has fallen by 16 percent.

Our study shows mixed results—for the corn market, the pattern of exports to countries dependent on oil is fairly similar to countries that are not dependent; however, for the soybean market, oil-reliant countries are purchasing a smaller percentage of soybeans than non-reliant countries. If oil prices remain low, as currently indicated by futures (see Figure 1), the impact of lower oil revenues could have greater influence on US crop export demand. The Russian and Venezuelan economies are buckling under the strain of lower revenues and that pressure is likely to spread to other (OPEC or non-OPEC) oil producing countries. For now, the larger factors influencing US crop export demand seem to be the record size of global crop production over the past couple years and the strength of the US dollar. Both of those factors reduce US crop demand, whether the country is oil reliant or not. ■

Table 1. Oil-Reliant US Crop Export Customers (Source: USDA-FAS)

Corn	2014/15	2015/16	Change	Soybeans	2014/15	2015/16	Change
	(million bushels)				(million bushels)		
Mexico	365.67	431.64	18%	Mexico	107.34	108.77	1%
Colombia	130.71	152.02	16%	Russia	11.64	17.86	53%
Saudi Arabia*	24.00	19.77	-18%	Vietnam	28.42	15.66	-45%
Venezuela*	17.52	11.79	-33%	Colombia	13.68	13.89	2%
Canada	29.43	10.56	-64%	Egypt	26.18	13.06	-50%
Egypt	34.19	9.68	-72%	Tunisia	6.90	8.31	20%
Trinidad	2.46	2.72	11%	Malaysia	9.01	5.51	-39%
				Saudi Arabia*	7.60	5.18	-32%
				Canada	15.61	4.99	-68%
				Iran*		4.54	
				Venezuela*	1.16	2.20	90%

* Denotes member of OPEC

The Yield Response to Nitrogen: Subjective Belief Bias in Nitrogen Management
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Our research finds differences in the actual yield response to changes in nitrogen application and the response perceived by producers. What are the underlying causes of this difference? One explanation is that decision makers may not assign the correct (true) probabilities to uncertain outcomes. Another explanation is that differences in the actual and perceived nitrogen response stems from being overly optimistic. For example, producers may attach too great of a probability to 'good' growing conditions, where nitrogen's role in plant growth is perhaps greatest. A third possibility is that producers perceive nitrogen to be a relatively inexpensive risk-limiting input: this is the nitrogen-as-insurance argument. For example, "If I apply more nitrogen, nitrogen won't be the limiting factor," or "I have a greater probability of a larger yield, somewhat regardless of the weather outcome."

The source of the bias in producers' perceptions about nitrogen's role in crop growth is the subject of our ongoing research. What we have learned so far is that the bias can be large. That it exists at all has implications for designing policies for water quality and nutrient use and gives important insight into how educational programs of nitrogen management might be more effective.

References

Babcock, B.A. Effects of Uncertainty on Optimal Nitrogen Applications. *Rev. Agr. Econ.* 14 (1992): 271–80.

Sawyer, J., E. Nafziger, G. Randall, L. Bundy, G. Rehm, B. Joern. 2006. Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn, *Iowa State University Extension Publication,* available at http://www.extension.iastate.edu/Publications/PM2015.pdf. ■

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References:

Hayes, D.J. and H.H. Jensen. 2003. "Lessons from the Danish Ban of Feed-Grade Antibiotics." *Choices.* Third Quarter 2003. *http://www.choicesmagazine.org/2003-3/2003-3-01.htm*

Jensen, H.H. and D.J. Hayes. 2014. "Impact of Denmark's Ban on Antimicrobials for Growth Promotion." *Current Opinion in Microbiology* 19: 30–36.

Sneeringer, S., J. MacDonald, N. Key, W. McBride, and K. Mathews. 2015. "Economics of Antibiotic Use in U.S. Livestock Production." USDA Economic Research Service, Economic Research Report Number 200, November 2015. *http://www.ers.usda.gov/publications/err-economic-research-report/err200.aspx* ■