National Agricultural Research, Extension,
Education and Economics (NAREEE) Advisory Board

"Water Quality and Quantity"

Report and Recommendations from a Focus Session on this Topic Conducted at the NABREE Advisory Meeting held in Washington D.C.
October 24 - 26, 2006

Executive Summary

Agriculture and the food production, processing and marketing system are heavily dependent upon water availability and quality. This report looks at water as a system to identify points where additional research and education, or modification of policy incentives may be needed.

USDA's Agricultural Research Service is working on technology to reuse degraded water, to improve water conservation and to increase water use efficiency in agriculture. The Cooperative State Research, Education and Extension Service funds research on water resource issues including transport of pathogens in water and on producer management behaviors for water conservation. It funds integrated research, extension and education at the watershed, regional and national scale.

The Economic Research Service addresses interactions between agriculture and the quantity and quality of water supplies and in conjunction with the National Agricultural Statistics Service (NASS) collects data on production practices and input use for major crops. NASS also publishes water quality data.

This report makes recommendations designed to discover and integrate new knowledge into developing dynamic strategies addressing water supply and quality over large eco-regions or watersheds. Research is needed to increase choices for conserving water in agriculture and facilitate widespread adoption for efficient water use. Integrating research findings into policy and management options can reduce agriculture's role in pathogens, chemicals, and sediment as major watershed pollutants.

To increase the value of new knowledge, translational research is needed to help link it to policy instruments, incentives and market-like mechanisms to drive water use efficiency. Comparative evaluations of how well best management practices work versus new economic incentives or market-based mechanisms to achieve or improve water quality would be productive.

To prepare for future constraints, research on how regulatory processes can stimulate more efficient water use to accommodate both growth and demand for western water is critical. Analyzing perverse incentives such as agricultural subsidies which may unintentionally encourage unsustainable water use; better documenting more clearly past use, current trends and anticipated water allocation and use by sector; and research to improve the productivity of rain fed agriculture are all necessary.

Communication and coordination to improve water management requires adopting a risk management framework for thinking about water quality and quantity. A standing interagency scientific task force may be needed to continually exchange ideas and integrate new knowledge from

the myriad of federal agencies and scientific organizations involved in gathering water quality and quantity data.

Introduction

Agriculture and the food production, processing and marketing system are heavily dependent upon water availability and quality. Population pressures on water quantity and quality will continue to grow, both in the United States and elsewhere. Drought and climate changes including changing rainfall distributions may reduce and shift previously available water supplies and increase the challenge to agriculture's access, particularly in the South Central and Western U.S. There is a need to better understand the climatic impacts, variability and trends in water supplies available for agriculture, as well as to better understand surface and sub-surface interaction of water sources and the drivers of water quality. This includes the role that agriculture and the entire food system plays in the overall water system of the United States.

The National Agricultural Research, Extension, Education and Economics (NAREEE) Advisory Board in its October 2006 meeting explored issues surrounding water quantity and quality and related environmental factors. The session explored supply and demand for water resources, including competition between urban and rural water users; and water quality including chemical (e.g.: pesticide, herbicide, nitrogen, phosphorus, and so forth) and bio-contamination, which are especially relevant to agriculture and rural communities. Our goal was to develop some priority recommendations on questions that need research, extension, education and economics work.

The Advisory Board strategy was to look at water as a system and identify points where additional research, education or policy incentives may be needed. This requires an appreciation of how and how much the whole spectrum of important variables affect the system, in order to avoid making decisions about one part of the system that become counter-productive because of complex reactions in other parts. Agriculture is the largest consumptive user of water in the United States, though the water system is much broader than agriculture.

The Board reviewed white papers by and heard from outside experts who have worked on water quality and quantity issues. These included researchers and research leaders, a representative of water users in the West, and Research, Education and Extension (REE) agency experts on water. We identified some high priority focal points for additional research to clarify problems not well understood; we saw that extension programming and education in other venues are needed to educate farmers, business people and rural and urban citizens about how to protect water quality and resources; and we learned about economic research on policy instruments to achieve improved water quality and preserve and efficiently allocate available water resources. Independent presentations made by outside experts reinforced each other and agreed on several important points that deserve attention.

Work Needed

We need a clear picture of how much water is used and where, and trends for the future. This includes the role agriculture and the food system plays in the overall water system of the U.S.

We should have limnology research that monitors and evaluates a much wider variety, and much larger scale, of water contaminants and pollutants and types of ecosystem impacts. There may be opportunities to reframe some water issues, e.g.: to one of water storage in many areas, as opposed to focusing on water use. We need to define, measure and establish each ecosystem's sustainable water requirements to determine how much water can be withdrawn and consumed, and when that results in measurable ecosystem damage or non-resilient decline. It is important to monitor and report promptly and publicly when water quality declined and when and what enforcement ensued. Data on the dynamics of valued ecosystem services (e.g.: hunting and fishing, providing habitat for pollinators) that compete with direct use by agriculture for watershed resources could be very useful for policy decisions.

Agriculture accounts for over 70% of the consumptive use of water in the United States. More and better data are needed, as well as more frequent and meaningful integration of the available data, to thoroughly understand consumptive use of water in agriculture and its interaction with other sectors. Water conservation is verifiably economical in agriculture and in other commercial uses; for example, water use efficiency in agriculture and in other uses has increased significantly as reflected in decreased per capita water withdrawals of approximately 25% since 1980. After hydro power which accounts for the largest water withdrawal but is all rapidly recycled rather than consumed, irrigation accounts for the second largest water withdrawal, and though a small part of it is recycled, it is mostly consumptive use. Better irrigation technology can both increase crop yields and reduce water use, implying a need to focus much more attention on the dollar value produced per unit of water used or the yield per unit of water or comparable measures to have a better metric for understanding agriculture's use of water. New technologies and economic strategies and incentives can improve the efficiency of water use in agriculture, as well as in other sectors. We need to be able to forecast their impacts in different places and user circumstances.

There are differences in consumptive use and renewable water supplies available in different regions of the country, with most of the West having far less annual rainfall than the East. Better transfer mechanisms are needed for water both from one use to another and from one region to another. Markets have a role to play in water quantity and quality if there are limits to available supplies. In the West, quantity restrictions create a potential for markets. In the East which has more plentiful supplies, and in the case of water quality issues, there are presently no quantity restrictions. Hence, in these latter areas markets cannot function as an allocation or decision making tool.

Unacceptable water quality affects agriculture as well as all water users and causes new environmental issues. Top water pollutants and contaminants are pathogens, numerous chemicals and sediment. These are all closely associated with agriculture, as well as with municipal and manufacturing water use. Better monitoring, measuring and sorting out of the amounts, risks and attributable sources are necessary to develop sound policy. The role of sediment as a contaminant of water needs to be better understood.

Agricultural non-point source pollution is now the leading source of water quality degradation. This generates a need for improved and more rapid water quality monitoring and enforcement. Best management practices comparing protection of water quality and quantity have not been adequately evaluated. Understanding sources and magnitude of impacts requires appreciation of the variable and important time lags in their effects.

Reuse of waste water needs significant research attention as it is a potential primary source of

growth in water supplies for agriculture and the economy as a whole in coming years. The cleaner the water at the end of any use, the less costly it is to reuse. Better understanding of how water quality affects the health of ecosystems upon which we depend, including impacts on fish and other wildlife, is important in making decisions on allocations. More effective integration of what is known into such decisions is an imperative to achieve long term sustainable agriculture.

Only two mechanisms usually prevail to provide sufficient incentive for environmentally sustainable resource conservation or use decisions -- one is market based and the other is regulatory. There is need to speed up the regulatory process that deals with growing demand for water in the Western United States. More large scale integration of water use and supply data are required to make both regulatory and market decisions more effective. Understanding elasticity of responses to policies is valuable.

Better translation of science can ensure that research is used more effectively in policy decisions. Extension and other outreach methods to educate users of water both in agriculture and other sectors, including the consumer, will be important to enhance future water quality and quantity, or maximize the benefits of what is available. A most useful way to facilitate this is by integrating known information into prognostic models.

Regulations on non-point sources of water pollution will become an increasing constraint for water users to reconcile. The existence of regulatory programs, even if not actively enforced, provides an incentive for individuals to behave in ways to avoid possible regulatory actions or lawsuits. Hence, there is important value in creating regulations for goals related to water quality and quantity. Assessing environmental policies' impacts and estimating the economic consequences of various policy options to reduce agriculture's negative impact on water quality can be valuable to policy makers. Decade-long federal studies found that Environmental Protection Agency (EPA) and USDA regulations collectively produced between three and seven times the monetary benefits of their costs.

Engaging researchers at State Agricultural Experiment Stations to help stakeholders, from farmers to homeowners, to adopt better practices to improve water use, quality, etc. is critical. Participatory research involving land managers can result in better understanding of messages derived from research related to water quality and quantity.

Work Underway

USDA's Agricultural Research Service (ARS) is working on technology adapted to reuse degraded water, to improve water conservation and to increase water use efficiency in agriculture. ARS works with other federal agencies and the private sector to develop cost effective technologies and improve understanding of the hydrological cycle and its impact on agriculture and the environment. The ARS Water Resource Management Program is focused on problems that currently face the nation. In particular, they are looking at irrigation, drainage water management, integrated erosion and sedimentation technologies, water quality protection systems, effectiveness of conservation practices, and watershed management along with its interaction on water availability and ecosystem restoration.

The Cooperative State Research, Education and Extension Service (CSREES) National Research Initiative for Water and Watershed Programs supports research on water resources issues. Focus

areas include source, fate and transport of pathogens in water and producer management behaviors for water conservation. Future priorities are intended to help understand agricultural pharmaceuticals in water. The other CSREES competitive grant program is a National Integrated Water Quality Program (NIWQP) providing funding for integrated research, extension, and education at the watershed, regional and national scale. In 2004, the USDA Research, Education and Economics mission area organized a listening session on agricultural water security, which identified six critical areas for research and education. They include irrigation efficiency and management; drought risk assessment and preparedness; general water conservation and management; rural and urban water reuse; water marketing, distribution and allocation; and bio-technology. Since then CSREES has addressed three of those areas with the existing agency resources. Bio-technology research in the NRI was expanded to address drought resistant and salinity tolerant plants. Social, economic and behavioral factors affecting water resource management are being addressed in the NIWQP program, with a focus on water quality. Water Reuse in Agriculture was the focus of a special conference in October, 2006 to identify research and education needs. However, no funding source exists to stimulate research and education on agricultural water reuse. A challenge for the REE mission areas is to develop a more coordinated strategy to address the nation's water resource issues in agricultural, rural and urbanizing communities.

The Economic Research Service (ERS) research program addresses interactions between agriculture and the quantity and quality of water supplies. Survey data are obtained to monitor use of water in agricultural production to assess adoption of irrigation and conservation technologies and to assess the use of inputs that can affect water quality. These data also allow assessment of USDA policies and economic incentives that affect technology choices that impact farm profitability and environmental quality, including the quality of water for human and wildlife uses. ERS also researches environmental policies originating outside USDA, primarily through EPA to evaluate the economic consequences to agriculture from constraints placed on production to achieve environmental goals. In conjunction with National Agriculture Statistics Service (NASS) through the Agricultural Resources Management Study Survey Program, ERS collects data on production practices and input use for major crops.

Through NASS, the same data are collected for vegetables and fruit crops. Water quality data published by the NASS include the Census of Agriculture and the census follow-on Farm and Ranch Irrigation Survey which tracks total feet of water used for irrigation and the average acre feet applied per acre as identified in the Census of Agriculture.

Recommendations

1. *The USDA monitor and integrate sufficient data on water supply and water quality over large eco-regions or watersheds to be able to provide useful prognostic forecasts to understand and optimize the best future decisions on water for agriculture*. Research data and strategically focused new information must be converted into knowledge by connecting the individual pieces into an integrated and dynamic picture.

2. *New scientific methods and technological applications need to be developed in order to expand the choices for conserving water in agriculture*. Significant research and education efforts should focus on how to improve and provide widespread adoption of efficient water use in both agricultural production and processing. This includes more water-efficient irrigation technologies, developing crops that require less water, and improving processing technologies to use less water.

Efficient systems will be required to reduce water quality degradation; to minimize polluting inputs to, and outputs from, agricultural processes; and to integrate safe, low cost water cleansing systems into agricultural system effluents wherever feasible.

3. *Education on water use efficiency and water quality protection must be increased to improve water policy implementation and compliance throughout the economy, including well beyond agriculture*. Translation of research can help link research results to policy instruments, incentives and market-like mechanisms to drive water use efficiency. Developing better transfer mechanisms for water requires economic, sociological and institutional design research and outreach. This includes evaluating agricultural policy incentives for water use that results in excess demand for water.

4. *The Board recommends a comparative evaluation be made of best management practices versus economic incentives to allow market based mechanisms to function in agricultural practices for achieving better water quality*. This should include incorporating time lags to realize impacts from changes in practices.

5. *The Board recommends conducting additional research to specifically determine agriculture's role in contributing pathogens, chemicals and sediment as major watershed pollutants. Data are needed to better determine how pollution occurs and how it might be reduced.* All significant chemicals and pathogen contaminants need to be monitored.

6. *The Board recommends evaluating all reasonable ideas on how regulatory processes can stimulate more efficient water use to accommodate growth and future needs, and to plan for scenarios when and where that demand has become unsustainable*. This includes attention to the existing value of regulations as an incentive to comply with the intent of providing better quality water and/or more efficient use of water. There is a need to discover and review incentives that encourage increased use of water.

7. *It is recommended that USDA and its partners define optimal ways to improve water management while sustaining current economies and meeting emerging needs.* These actions are urgent because of the demand for water from numerous sources in the United States. This will require better monitoring frameworks for all uses of water

8. *The Board recommends that research be undertaken to better understand the interaction between surface and sub-surface water*. This research is needed to produce large scale predictive models of different watersheds. There is an urgent need for additional research for the use of reclaimed water from agriculture and other sources. Potentially a large portion of the water used in agriculture could come from reclaimed water.

9. *Research is needed to document more clearly past use, current trends, and anticipated future water allocation and use by sector, and to identify societal implications of continued reallocation of water from the agricultural sector to environmental and urban uses.* Results of such research would be valuable to policy makers at all levels of government and to stakeholders in the water community.

10. *We need to have a base of research results that can anticipate and improve the productivity of rain-fed agriculture*. This should include the range of possibilities from genetically modified drought-resistant crops to shifting from production choices that require more water than is likely to be available into ones that will suit the circumstance of diminished future water availability.

11. *A standing interagency scientific task force at the highest levels of government is needed to exchange ideas and integrate new knowledge from the federal agencies and scientific organizations involved in gathering water quality and quantity data*. This could be beneficial to the numerous subcommittees in Congress that have competing jurisdiction over water.

Water Quality and Quantity Working Group

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