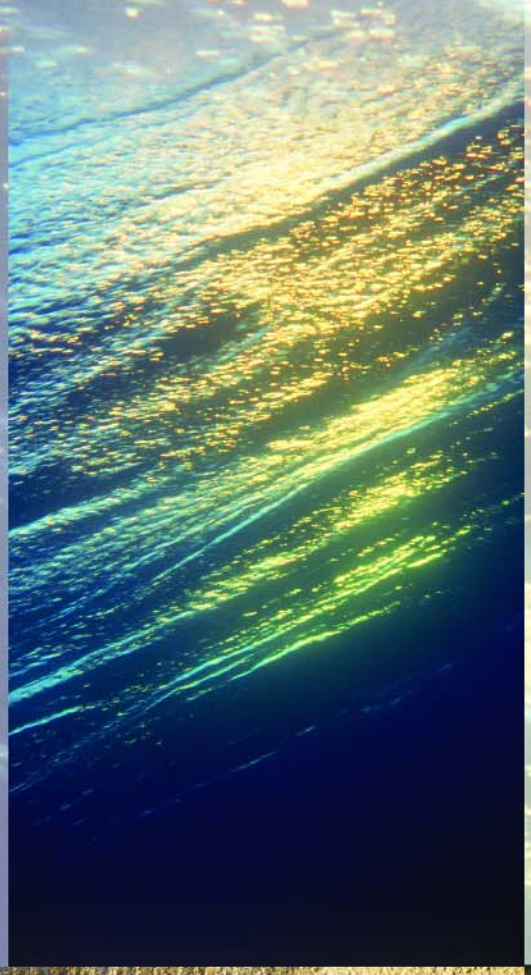


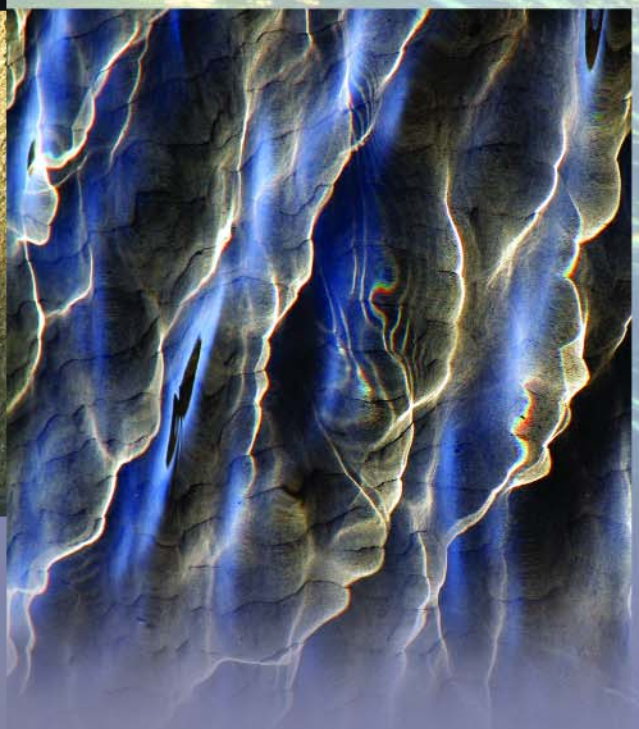
U.S. Department of Agriculture
Research, Education, and Economics
Mission Area

Agricultural Water Security Listening Session

Final Report

September 9-10, 2004
Park City, UT

James P. Dobrowolski and Michael P. O'Neill, Editors
Lisa F. Duriancik, Associate Editor



Research, Education, & Economics
United States Department of Agriculture

Under the leadership of the Under Secretary for Research, Education, and Economics (REE), the REE mission area provides Federal leadership for the discovery and dissemination of science-based knowledge to address the wide ranging problems and opportunities that come under the broad heading of food and agriculture. The public increasingly expects sound science, accurate data, and objective analysis to be an integral part of public decision-making.

Building on the extraordinary possibilities of cutting-edge research and new technologies, REE is more capable than ever of delivering environmentally and economically sound solutions to new challenges in production agriculture, food safety, and nutrition. It is also well positioned to ensure that new knowledge and technologies generated by the REE agencies are transferred to the farmers, ranchers, consumers, food processors, and others who will use them.

The mission area consists of the Office of the Under Secretary for REE within the Office of the Secretary and four agencies: the Agricultural Research Service, the Cooperative State Research, Education, and Extension Service, the Economic Research Service, and the National Agricultural Statistics Service. The Under Secretary for REE, supported by the REE office, provides leadership and overall guidance in shaping the food and agricultural research agenda for the Nation, bringing together and listening to the research and stakeholder community on common interests and concerns. The Under Secretary also oversees management of the agency programs, promoting collaboration with other USDA mission area agencies and responsiveness to their research needs.

Working with agencies across the government and at research organizations across the country, the four REE agencies conduct programs spanning the biological, physical, and social sciences related to agricultural research, economic analysis, statistics, outreach, and higher education. The agencies and their missions are:

- Agricultural Research Service (ARS). As USDA's principal in-house biological research agency, ARS provides the scientific knowledge and technologies needed to ensure the viability of American agriculture. It conducts research to address agricultural problems of high national priority and aggressively works to transfer research results to the marketplace. The work of ARS provides the scientific base for the quality, affordability, safety, and variety of the food and agricultural products that all Americans enjoy.
- Cooperative State Research, Education, and Extension Service (CSREES). In partnership with the land-grant universities and other public and private sector organizations, CSREES provides the focus and funding to advance a global system of extramural research, extension, and higher education in the food and agricultural sciences and related environmental, social, and human sciences to benefit people, communities, and the Nation.
- Economic Research Service (ERS). The Economic Research Service provides economic analysis on efficiency, efficacy, and equity issues related to agriculture, food, the environment, and rural development to improve public and private decision-making. ERS economic analysis is shaped primarily for use in the decision-making process by policymakers, though the ultimate beneficiaries of informed public and private decision-making are the American people.
- National Agricultural Statistics Service (NASS). NASS serves the basic agricultural and rural data needs of citizens, agricultural workers, and rural residents by objectively providing important, usable, and accurate statistical information and services needed to make informed decisions. NASS statistics keep those involved with America's agriculture well-informed, provide the basic information necessary to keep agricultural markets stable and efficient, and help maintain a "level playing field" for all users of agricultural statistics.

The four agencies have unique and diverse capabilities and encompass multiple scientific disciplines. Their collaboration makes possible comprehensive investigation of complex issues or problems. REE capabilities enable projects that begin with fundamental research and end with the transfer of new knowledge and technologies to public and private decision makers. A range of funding mechanisms affords the mission area the flexibility to enlist individuals and institutions most appropriate for the problems and issues at hand.

The agencies conducting the REE mission area programs perform seven primary functions:

- Provide national leadership to identify, develop, conduct, and manage programs in the food and agricultural sciences;
- Create basic research knowledge at the frontiers of the biological, physical, and social sciences;
- Apply knowledge in innovative ways to address problems and issues;
- Collect, process, and disseminate agricultural statistics;
- Promote commercial development and timely transfer of new knowledge and technologies to users;
- Educate and inform the Nation's public and private decision makers; and
- Strengthen higher education to develop the skills of the Nation's evolving workforce.

U.S. Department of Agriculture
Research, Education, and Economics
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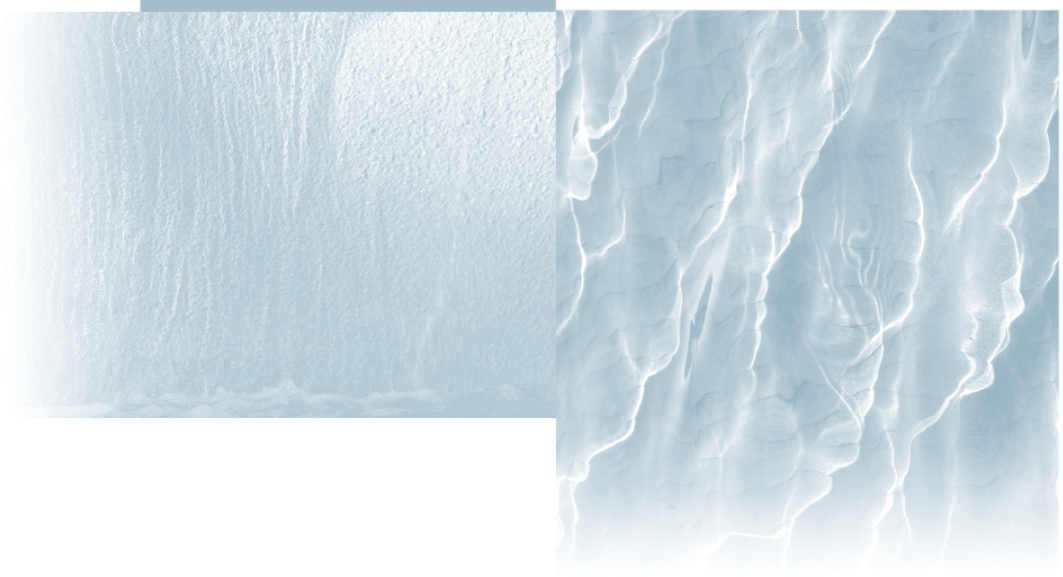

September 9-10, 2004 • Park City, UT

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United States Department of Agriculture

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Photos by Julie Boardman, Alchemy LLC

PHOTO COURTESY USDA NRCS

1. Executive Summary

On June 5, 2003, Interior Secretary Gale A. Norton and Agriculture Secretary Ann M. Veneman signed a Memorandum of Understanding (MOU) aimed at promoting improved water management and rapid response to emerging water supply shortages in the West. This MOU highlights the need for expanding the research and education programs focused on better management of water resources. The MOU also sets the stage for improved cooperation between the Departments.

In response to the MOU, greater demand for water worldwide, and increasing susceptibility of rural landowners to mounting pressures for more water to urban and urbanizing areas, Dr. Rodney J. Brown, Deputy Under Secretary for USDA Research, Education, and Economics hosted a listening session on Agricultural Water Security in Park City, Utah, September 9-10, 2004. Brown noted that the time has come to make substantial changes in the way we think about and manage water resources—particularly how we value water across diverse geographic settings.

Agricultural water security is described as the need to maintain adequate water supplies to meet the food and fiber needs of the expanding population—maximizing the efficiency of water use by farmers, ranchers, and rural communities. Ninety leading researchers, educators, practitioners, and managers involved in water supply, management, distribution, and use came to explore new opportunities and help to determine the relevance of USDA's research, education/extension, and economic efforts (REE) in

Agricultural Water Security—and to develop a basis for an expansion of USDA REE programs that takes full advantage of partnerships with other Federal and State agencies.

Expected outcomes of the Listening Session included efforts to assess the current capabilities of the USDA-REE agencies (ARS, CSREES, ERS, and NASS) to address REE needs; determine the USDA program needs that might be fulfilled by a coordinated USDA REE effort for Agricultural Water Security; determine the gaps in existing knowledge for agricultural REE efforts; identify strategies and opportunities that will advance USDA REE efforts and provide products and solutions to USDA customers, stakeholders, and partners; and identify commonalities among the topical themes and describe some of the necessary steps to move USDA toward national programming in Agricultural Water Security.

ARS scientists Bert Clemmens and Dan Upchurch related the current status of research in USDA that addresses Agricultural Water Security in five areas of concern: agricultural watershed management, irrigation management, drainage management, water quality protection, and biotechnology. USDA scientists are challenged under dryland conditions to predict and mitigate drought without adequate real-time data about crop water needs and irrigation management. They also are challenged to suggest better technologies under the constraints of incomplete hydrologic information. USDA researchers continue to address new technologies for the reuse of saline drainage water and water-relevant biotechnological research.

David Sunding, University of California, Berkeley, discussed the current status of water-quantity related economics to tackle irrigation efficiency and technology adoption, water trading and institutional motivation, water reuse and recycling, and risk management. Water economists are evaluating mechanisms to technology adoption—often adoption of more efficient technologies occurs during drought or flood when the incentives and returns are more immediate. Economic researchers are pursuing the concepts of water trading with concerns over third-party effects and hydrologic impacts and evaluating the competitive costs for desalination. Their efforts to elucidate risk allocation are based on attempts to understand risk aversion, asset position, incomes, and variability of profits.

Washington State University Extension and Research Specialist Jim Dobrowolski discussed the status of extension/education and provided four key approaches to promote the implementation of water conservation technologies for rural and urban environments: 1) lifestyle changes with place-based education, 2) rural and urban plant substitution with locally adapted species and reduction of "lawnscapes," 3) shifting the attitudes of youth towards valuing water and water conservation, and 4) incentive-based training for the next generation of scientists and practitioners at the university level.

Bill Hallman of Rutgers University, in his current status of human dimensions, provided evidence that the "laying out the facts" approach to adoption outreach or Education Deficit Model shows little relationship between the facts provided and behaviors changed. We need to apply some mental models in this educational process, understanding what people know, what they want to know, and what they think about an issue. Sacrifices required to do the right thing must have available alternatives, be equitable, and be clearly effective. He emphasized that not all technologies are universally acceptable.

This report contains the recommendations of the many conference participants, who brought experience as university, Federal, State and local scientists, educators, and administrators. Each participant was initially assigned one of six thematic areas according to their expertise:

- Drought mitigation and preparedness;

- General water conservation and management;
- Biotechnology;
- Irrigation efficiency and management;
- Water marketing, distribution, and allocation; and
- Rural/urban water reuse.

Conference attendees participated in five breakout sessions:

(1) To discover their desired future state to 2025 in Agricultural Water Security;
(2) To identify USDA's existing strengths and opportunities;
(3) To recognize current gaps and barriers;
(4) To recommend three bold steps and stakeholder engagement; and
(5) To envision a "green light" scenario planning across and within the six thematic areas.

What emerged as major themes of the listening session breakouts and discussion were that a desired future state requires behavior changes about water resource supply and use, that future development must include water availability planning, and that water needs are matched with water supplies through greater diversity in agricultural systems and the ability to trade water shares. Existing strengths, influence, and opportunities highlighted USDA's partnerships with the Land-Grant University system (research and extension), with industry, and among agencies within the Department. USDA's influence from financial assistance programs (both Farm Bill and grant opportunities) and the Department's infrastructure of scientists and network of educators were touted as great strengths.

Gaps and barriers to accomplishing Agricultural Water Security included but were not limited to funding commitments for research, education, and extension in water resources planning; management, behavioral, policy and economic sciences; lack of sound sciences in water management and planning; unknown effects of water marketing; differing standards between rural and urban environments; failure to incorporate climate change; overly optimistic water planning; and USDA's lack of coordinated water efforts and bureaucratic infrastructure.

At the listening session, participants envisioned a set of bold steps that will serve as a catalyst to achieving the desired future state. These unranked steps are:

- Water management transcending political and social boundaries—connecting urban, rural, environmental, and agricultural uses of water at the watershed or basin scale.
- USDA extending its knowledge base to the urban sector—providing tools developed for agricultural and rural environments to address urban water issues.
- Efficiencies gained through improved irrigation management translating into greater instream flows without imposing economic loss on irrigators.
- Redirecting genomics research from a production focus to address environmental issues such as drought or salinity tolerance.
- A national network of drought (or water management) centers providing science-based information for improved decision making and water savings.
- Expanding flexibility in decision making for water management through effective water markets.
- Revamping educational efforts to produce behavior change among citizens in agricultural, rural, and urban environments.

Finally, Listening Session participants envisioned possible actions if they were given the "Green Light." Unranked green light activities include:

- A paradigm shift from production-oriented to

sustainability-oriented water use—measuring "crops per drop" as part of a "blue revolution."
- Promoting the National Integrated Drought Information System to better prepare communities for drought in the United States.
- Improving the quality and availability of data needed to improve water resource management.
- Creating a national water quantity initiative to promote research, education, and extension efforts and to coordinate with existing USDA water quality efforts.
- Coordinating and conducting "National Town Meetings" on Agricultural Water Security—emphasizing water savings goals for communities and watersheds.

PHOTO COURTESY USDA NRCS

2. Background

Are there critical water issues today? Generally we don't respond to water-related issues until we experience a drought or flood or our livelihoods are at stake. Considerable evidence exists that our settlement and policy choices, especially in arid areas, were shaped by having settled those regions during historically wet decades. Populations continue to increase, exemplified by the burgeoning growth of southern tier states: the top nine fastest-growing cities over 100,000 are all in the desert southwest, where water use, distribution, and allocation are all hot-button issues...again. The Endangered Species Act, Clean Water Act and in-stream flow requirements also drive regional water allocation, economics, and marketing. Unchecked expansion of urbanization in southern California precipitated the 2003 signing of the Colorado River Delivery Agreement and inaugurated the U.S. Department of the Interior's Water 2025 initiative. As part of Water 2025, the Interior Department has committed to improving irrigation efficiency at the headgate and has teamed up with the U.S. Department of Agriculture (USDA) to advance this issue. Improvement of desalination technology and efforts to move forward water marketing also are addressed by Water 2025. USDA is investigating an expanded role in water quantity research, education, and extension in partnership with its highly successful water quality programs.

Freshwater demands have tripled since 1950[1] while water supplies remain fixed. Demand is expected to double by 2035, leaving

[1] Postel, S., 1997, Last oasis: facing water scarcity, New York: Norton

48 percent of the world population (2.4 to 3.4 billion people) living in water-stressed environments by 2025[2]. Securing water for this growing demand has involved the improvement and construction of storage facilities and greater reliance on groundwater resources—both unsustainable over the long-term. The World Water Council World Water Vision Commission Report (1998)[3] suggested two approaches to water resource sustainability (i.e., bringing water supplies in line with demand): 1) improve technologies to provide "new" sources of freshwater such as desalination and/or inter-basin transfers and 2) provide greater efficiencies in water management and conservation. Both are required to help provide equitable water distribution among all demands. Public awareness of water shortage is high; this listening session is indicative of USDA's awareness.

What is Agricultural Water Security?

As the human population continues to grow across the United States and around the world, there is a growing demand for safe, reliable sources of water to meet the needs of the expanding population. Farmers, ranchers, and rural communities are vulnerable in part to past water policies and to the mounting pressures to provide more water for expanding rural and urban irrigation, municipal and industrial uses, and drinking water demands, while sustaining ecosystem services. How much water do we reapportion from agriculture to other uses before we compromise our ability to sustain adequate agricultural production to meet the demands of an expanding population? Agricultural Water Security is used here to describe the need to maintain adequate water supplies to meet the food and fiber needs of the expanding population—maximizing the efficiency of water use by farmers, ranchers, and rural and urban communities.

Drought and the reliability of water supplies for agriculture and rural communities historically have been linked to western states. However, issues surrounding Agricultural Water Security now represent a national crisis. Water supplies formerly used by irrigated agriculture in Georgia, South Carolina, and Florida are being consumed by expanding urban populations. Shifts in the allocation of these water resources could have dramatic impacts on the long-term supply of food and fiber in the United States.

On June 5, 2003, Interior Secretary Gale A. Norton and Agriculture Secretary Ann M. Veneman signed a Memorandum of Understanding (MOU) aimed at promoting improved water management and rapid response to emerging water supply shortages in the West. This MOU highlights the need for expanding the research and education programs focused on better management of water resources. The MOU also sets the stage for improved cooperation between the Departments.

What are the research needs in Agricultural Water Security?

There is considerable scientific information regarding the efficient use of water for agricultural irrigation. Similarly, much is known about the impacts of drought on plant growth and productivity. There is a need to expand the knowledge base of Agricultural Water Security through research programs aimed at:

• Developing integrated information and

2 Pereira, L.S., I. Cordery and I. Iacovides, 2002, Coping with water scarcity. UNESCO International Hydrologic Programme. 272 p. (http://unesdoc.unesco.org/images/0012/001278/127846e.pdf).

3 World Water Council, 1998, World Water Vision Commission Report: A water secure world, vision for water life and the environment. 83 p. (http://www.worldwatercouncil.org/Vision/Documents/CommissionReport.pdf).

improved technology (satellite, survey, and sensor) on the impact of water conservation policies and practices at the watershed scale;
- Decision support systems (DSS) and the required data streams that would foster behavioral changes and that lessen our vulnerability to water shortage;
- Accurate quantification of water use and the development of a nationwide, integrated watershed data and information resource that is useable and accessible;
- Quantifying the full impacts of drought;
- Risk assessment associated with drought—links to global climate change;
- Investigating perceptions about water users, water managers, and federal, state, and local water agencies;
- The role of water banks and other market-based mechanisms;
- Water relevant biotechnology research—development of drought tolerant or water conserving plant species for agriculture and landscaping; and
- Impacts of water reuse on downstream communities and stream ecology—does upstream efficiency lead to decreased supply downstream?

What are the education needs in Agricultural Water Security?

Vast amounts of educational materials exist for improving water conservation and water management. Much of this information has not been adapted to local watershed conditions. Moreover, citizens often fail to recognize their role in advancing or threatening Agricultural Water Security. There is a need to provide outreach and education programs aimed at:
- Understanding the limits of water supply in a region's watersheds;
- Improved/expanded application of known/existing science for irrigation and water management through educational programs;
- Understanding the interrelationships between the various aspects of water management—supply and demand, water quantity and quality, groundwater and surface water, human demands, and environmental needs;
- Outreach to farmers, ranchers, and rural communities towards adoption of greater use of recycled water and crop substitution;
- Place-based education—eliminating sub-tropical lifestyles and the farming of low water efficient crops in desert climates;
- Educating water managers in both rural and urban communities—impacts of water supply will be disproportionately felt by lower income families;
- Educating landscapers in rural, urban, and urbanizing areas—use of drought tolerant trees, shrubs, and turf, reduce turf and lawns in some areas, use of drip irrigation (instead of sprinklers), reuse of irrigation water;
- Educating residential pool designers—how can we develop pools that serve the recreational need and minimize water losses;
- Educating the public (adults) using adoption outreach techniques to promote behavioral change in how rural and urban households and farms use or think of water efficient plants and other xeriscaping, low water use fixtures and appliances, efficient irrigation devices, water conserving practices, and the role of impervious surfaces—public service ads, include water supply as part of the local television/radio weather reports, campaigns to convert toilets and showers to water conserving models; and
- Educating the public (youth)—building water conservation as part of the basic curriculum; "waterwise" school programs.

Agricultural Water Security Issues

In the fall of 2003, a comprehensive literature survey of topics on water supply, management,

distribution, and economics was undertaken to explore the current state of knowledge on Agricultural Water Security (Dobrowolski, personal communication). This literature survey now is available on the internet at http://www.csrees.usda.gov/water. The literature survey was used to develop a unique visual tool (Alchemy Consulting LLC, 2004) for describing current issues, opportunities, and challenges related to Agricultural Water Security. This "USDA Agricultural Water Security Issues Map" (see center section) depicts a wide array of challenges that must be met to adequately address Agricultural Water Security. The map also shows opportunities for key partnerships—where federal, state, and private efforts can cooperate to produce sustainable solutions for Agricultural Water Security.

Six possible areas of USDA effort were identified from the literature review and the Issues Map. These six areas or themes are

- Water marketing, economics and distribution;
- Irrigation efficiency and management;
- Water reuse at the farmstead, community, and household levels;
- Drought risk assessment and management;
- General water conservation; and
- Biotechnology (plant breeding and genetic and microbiological efforts).

Many of the key topics, questions and challenges related to each of the six theme areas are listed on page 17.

Agricultural Water Security Interventions

For each of the six currently identified theme areas, opportunities for USDA interventions were explored. These interventions are viewed as opportunities to develop sustainable solutions within the six theme areas. A "USDA Agricultural Water Security Interventions Map" (see center section) was developed to visually depict opportunities for sustainable solutions along with courses that may not lead to sustainable solutions. Positive opportunities are shown above the themes and less sustainable ("Dead End") opportunities are shown below the themes.

The Agricultural Water Security Listening Session

In the spring of 2004, Dr. Rodney J. Brown, USDA Deputy Under Secretary for Research, Education, and Economics (REE), convened program leaders from the Cooperative State Research, Education, and Extension Service (CSREES), the Agricultural Research Service (ARS), the Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS) to begin planning a listening session focused on Agricultural Water Security. The purpose and expected outcomes for the listening session appear in the box on page 18.

Dr. Brown invited 75 leading researchers, educators, practitioners, and managers involved in water supply, management, distribution, and use to attend a USDA listening session on Agricultural Water Security to be held in Park City, Utah, September 9 and 10, 2004 (see Appendix A). In the end, the listening session brought together more than 90 of the top individuals from research, education, and economics to explore new opportunities for USDA. Participants in the listening session represented federal agencies, university research and education programs, state water resource agencies, regional water districts, the Western Governors' Association, engineering firms, and non-profit organizations. A full list of all participants in the Listening Session appears in Appendix E.

AGRICULTURAL WATER SECURITY THEME AREAS

Irrigation Efficiency and Management

Improving the technology of irrigation; improving adoption of the best available irrigation technology; recognizing the impacts of more efficient irrigation at the household, farm, rural and urban irrigation district, and river basin scale; determining what practices are best suited to improving irrigation efficiency for site-specific conditions. What happens to water that is "conserved" through improved irrigation practices? What are the physical and socio-economic conditions where improved irrigation efficiency and water management can provide the greatest benefits?

Drought Mitigation and Preparedness

Planning for drought impacted areas; role and impact of global change; alternative crop rotations; recognizing the "warning signs" of drought; real time analysis of drought conditions; forecasting "short-term" droughts; socio-economic dimensions of drought preparedness—social and economic acceptance of planning, behavior change; marketing issues with alternative crops; decision support for planting times; crop choices relative to precipitation predictions. How can a policy of disaster assistance be moved towards a policy of drought mitigation and preparedness?

General Water Conservation and Management

Conserving water in rural/agricultural and urban settings; homeowner practices—what education tools are effective/not effective? Improved crop placement and selections, improved water distribution systems, private sector/industry uses of water—landscape industry, food processing, forest products processing, etc.; conversion of farms and ranches to housing tracts—is there sufficient water? What educational/extension campaigns work (reduced water allocations for agriculture, changes in water laws, low-flow showers, low-flush toilets, etc.) and fail? What are the physical and socio-economic ramifications associated with shifting agricultural practices?

Rural/Urban Water Reuse

Greywater or sewage water recycling; turfgrass irrigation practices related to greywater or sewage water use; retrofitting homes for greywater recycling; How willing are builders to implement these measures? Water quality and other safety issues related to greywater and sewage water usage for agriculture or turfgrass. What are the human dimensions—lack of acceptance, extreme costs, and social equity—who can afford to recycle water?

Water Marketing, Distribution, and Allocation

Policy instruments to alter water availability—water banks, leasing water rights, etc.; urban/agricultural water costs; food/homeland security issues of "disappearing agriculture"; land use and water availability; growing "people" instead of crops in the desert. Are water markets or water transfers sustainable? What are the "true" costs of agriculture? What are the socio-economic ramifications (in practical terms)?

Biotechnology

Traditional plant breeding efforts to develop salt and drought resistant plants; improved genomics—functional genomics for salinity and drought tolerance; short-term versus long-term opportunities associated with biotechnology; international export issues related to refusal of GMO crops; water conservation predictions as a result of biotechnology. What are the socio-economic issues related to development and adoption of biotechnology?

USDA Agricultural Water Security Listening Session

Purpose:

To determine the relevance of USDA's research, education/extension, and economic efforts in Agricultural Water Security—and to develop a basis for expanded USDA research, education/extension, and economic programs in Agricultural Water Security that take full advantage of partnerships with other Federal and State agencies.

Expected Outcomes

- Assess the current capabilities of the USDA-REE agencies (ARS, CSREES, ERS, and NASS) to address research, education/extension, and economic needs;
- Determine the USDA program needs that might be fulfilled by a coordinated USDA effort of research, education/extension, and economics for Agricultural Water Security;
- Determine the gaps in existing knowledge for agricultural research, education/extension, and economic efforts;
- Identify strategies and opportunities that will advance USDA research, education/extension, and economic efforts and provide products and solutions to USDA customers, stakeholders, and partners; and
- Identify commonalities among the topical themes and describe some of the necessary steps to move USDA towards national programming in Agricultural Water Security.

An advisory team representing each of the four USDA REE agencies—CSREES, ARS, ERS, and NASS—was formed to plan and conduct the listening session (see page 3). The advisory team, working with a small group of professional facilitators, organized the listening session in three main components. The first component of the program was an opening general session aimed at establishing the current state of research, education, and economics. The second component of the program was four small-group breakout sessions organized around the six themes. Each of the four breakout sessions focused on specific predetermined questions. The final component of the program was a general session aimed at "pulling together" information from the breakout sessions. The listening session agenda with the breakout session questions appears in Appendix C.

Evaluation and course correction

After the completion of the first day, participants in the listening session were asked to provide input and feedback to the Advisory Committee on "course corrections" for the second day of the listening session. The Advisory Committee used this information to clarify questions regarding the structure of the session and to update the agenda for the second day of the listening session.

PHOTO COURTESY USDA NRCS

3. Current Status

The current status presented here is a brief overview taken from presentations made during the Agricultural Water Security Listening Session. Four related topics are described here—research (including field and laboratory efforts), economics, human dimensions, and education/extension. A comprehensive literature survey was conducted in support of this current status description (see http://www.csrees.usda.gov/water. for more information). The box on page 22-23 provides an overview of Federal research funding for water resources described in a recent report from the National Academy of Sciences.

Current Status of Research

Demand for greater supplies to meet the long-term needs of greater domestic, industrial, hydropower, and irrigation use remains a strong concern. Some of these supplies may be at the expense of domestic agricultural production. Climate change or variability, world population growth, and increasing affluence combined with past policies that promoted settlement on marginal lands will exacerbate the demand for new supplies while freshwater supplies remain fixed. Engineers call for action to improve and expand our nation's infrastructure that includes dams, drinking water systems, navigable waterways, and energy production (ASCE 2001)[4],

[4]American Society of Civil Engineers. 2005. Report card for America's infrastructure. http://www.asce.org/reportcard/2005/index.cfm

while other groups promulgate the removal of obsolete dams or structures that threaten natural systems. They call for greater use of nonstructural means and innovation for flood control, energy production, reduction and elimination of water pollution, and greater efficiency in water allocation and use. New supply options to alleviate impending shortages (e.g., desalination and importation from distant sources) are few and expensive.

USDA's current research seeks to understand some of these critical issues, addressing Agricultural Water Security in five areas of concern, agricultural watershed management, irrigation and drainage management, water quality protection and management, biotechnology, and issues beyond or linked to agriculture. USDA-ARS, in cooperation with other agency and university scientists, is addressing the uncertainty in water supplies posed by climate change, weather vagaries, risks, and extremes—and watershed-scale issues that combine geomorphic processes with human impact to influence hydrologic, erosion, and sediment/contaminant responses. Flood control using conventional but declining infrastructure coupled with new concepts in channel stabilizing technologies are research efforts by USDA and others to avert damaging flood events while maintaining ecosystem services and sustaining flows throughout the year.

Recent, long-term drought has focused USDA research attention on drought mitigation and preparedness using climate analysis with climate controls on the frequency and degree of plant water stress as the central motivation. Efforts to predict drought through monitoring at multiple time and geographic scales are challenged by our ability to provide seasonal weather prediction, and the large spatial and variability of drought is challenging. USDA scientists are linking multiple atmospheric phenomena to elevate our climatic prediction skill—and by scrutinizing opposite shifts in tropical Pacific and North Atlantic Ocean temperatures, scientists are creating knowledge of the onset of persistent drought across North America. USDA and partners continue to improve the realism of climate models with higher grid resolution, more physically based parameterizations and more complete coupling, though current models remain imperfect.

Water needs are often most critical in dryland conditions, where USDA researchers sustain water supplies and promote successful crops by soil water forecasting for drought planning and management, improving soil management for water conservation using residue and tillage management, appropriate crop selection and rotations, and identifying the physiology and genetics of drought and salinity resistance in crops.

Irrigated agriculture represents 62 million acres in the United States, or 18 percent of total cropland, and produces 60 percent of the market value. USGS 2000 figures estimate 47 percent of irrigated agriculture to be surface irrigated (flood, furrow), 46 percent sprinkler irrigated, and 7 percent micro-irrigated. Of the 153 million acre-feet or 65 percent of freshwater withdrawals, 58 percent comes from surface water and 42 percent from groundwater sources. In the major river basins, surface water supplies are often over-allocated—where allocations are based on incomplete hydrologic information, environmental uses often ignored or uncounted, and where Native American settlements potentially reduce available water. Groundwater resources often are developed in excess of recharge. U.S. irrigated agriculture faces current water sustainability issues, reduction of water available to agriculture by urbanization, and a decline in the areal extent of irrigated agriculture.

Given the high cost of desalination and the political barriers to large-scale water transfers, USDA has chosen to focus on water demand management alternatives that provide a greater range of choices that include improving technical efficiency (i.e., the ratio of output to input) through

irrigation and drainage management research:

- Application of modern irrigation technology (e.g., microirrigation, sprinkler irrigation, high-tech surface irrigation) will reduce the amount of water applied to agricultural fields, which in some cases, although not all, translates to real water conservation;
- Developing precision agriculture and integrating field, farm, and watershed management systems to conserve water, reduce erosion, and improve water quality while minimizing economic risk;
- Better drainage systems design, evaluation and simulation models defining the physical limits where integrated farm and watershed systems are applicable;
- Improved irrigation and drainage technology provides a more uniform environment for plant growth, which tends to increase yields, and in some cases increases water consumption;.
- Determine crop water requirements and subsequent impacts on water rights and allocations by States and the Federal government;
- Expand weather station networks to provide near real-time crop water needs.

Water delivery research shows that constraints in water delivery from large projects cause on-farm irrigation systems to perform below potential, to spill excess water and to not be able to utilize modern scheduling methods—a current cooperative effort between Bureau of Reclamation's Water 2025 and USDA.

With greater water demand, urban sectors may look to rural agriculture for additional water sources. At the same time, USDA scientists are looking to rural/urban sources of wastewater for agricultural irrigation and investigating water quality/human health implications. Research into Soil-Aquifer-Treatment (SAT) technologies promotes expansion of groundwater storage as water banks and the reapplication as subsurface irrigation from both controlled drainage water and tailwater. USDA researchers continue to address new technologies for the reuse of saline drainage water to achieve zero discharge by blending waters and through a sequence of increasingly salt-tolerant crops.

USDA's biotechnology research is improving the water use efficiency (WUE) and dehydration stress protection of traditionally important row crops (e.g., corn and wheat), horticultural crops (fruit), and ornamental plants (e.g., turf) with conventional breeding and genomic tools. USDA-ARS formulated goals for water-relevant gene products developed under two basic strategies: (1) expression of adaptive proteins and compounds and (2) modification of regulatory pathways to induce native dehydration stress protective genes. These scientists direct their key efforts towards moving the leaf water potential thresholds downward—so that crops show better growth rates under stress conditions and improved drought recovery. For example, though WUE of cotton is influenced primarily by environmental characteristics (75%) and less by genetics (17%) and environment/genetics interactions (8%), when WUE is genetically improved, cotton lint yields increased in upper Midwest studies.

Beyond agriculture, scientists focus on stormwater quantity and quality problems in urban and urbanizing watersheds, spatial analysis of water quantity management strategies, modeling to elucidate urban expansion effects on drainage and delivery to surrounding landscapes, and river system modeling for storage and quantity linked quality in terms of concentration and dilution. Researchers continue to model and evaluate possible regional impacts of climate change on water allocation. Federal and State governments and private foundation partners investigate brackish water and sewage desalination, disposal and non-traditional uses of brine and salt, and membrane function as part of research efforts to improve water reuse technologies. Reuse water contaminant bioassays, con-

taminant removal, and inactivation are also dynamic research endeavors. Researchers identify and study water quantity issues solvable by groundwater recharge, aquifer storage, and recovery and attempt to understand public concerns and human reaction to water reuse for potable water, community gardens, schoolyards, golf courses and parks.

National Academy of Sciences Report on Water Resources Research

The National Academy of Sciences-National Research Council (NRC) initiated this report in response to growing U.S. water problems and the recognition that the research necessary to solve tomorrow's water resource problems needs to be initiated today. Further, the NRC recognized that the type and quantity of research needed to solve the country's water problems are unlikely to be adequate if action is not taken at the Federal level. The report builds on the findings of the NRC's earlier report, *Envisioning the Agenda For Water Resources Research in the 21st Century,* which established 43 high-priority research needs in the areas of water availability, water use, and water institutions. The 2004 report—*Confronting the Nation's Water Problems: The Role of Research*—examines current and historical patterns of investment in water resources research and generally assesses its adequacy, addresses the need to better coordinate the nation's water resources research enterprise, and identifies institutional options for the improved coordination, prioritization, and implementation of research in water resources.

The Committee on Assessment of Water Resources Research surveyed water resources research funding using 71 subcategories, 60 from the 1965-1975 effort and 11 new to the 2004 report. The survey requested total expenditures for FY 1999–2001, current and projected future activities, how research performance is measured, and the mix of research in terms of fundamental versus applied, internal versus external, and short-term versus long-term.

Federal Coordinating Council of Science, Engineering, and Technology (FCCSET) categories used in the 2004 report

I. Nature of Water
II. Water Cycle
III. Water Supply Augmentation and Conservation
IV. Water Quantity Management and Control
V. Water Quality Management and Protection
VI. Water Resources Planning and other Institutional Issues
VII. Resources Data
VIII. Engineering Works
IX. Manpower, Grants, and Facilities
X. Scientific and Technical Information
XI. Aquatic Ecosystem Management and Protection*

*New category for the 2004 report that represents an area of expanded growth in terms of water resources research, extension, and education.

The survey determined that real levels of total spending in water resources research remained relatively constant (around $700 million in 2000 dollars) since the mid 1970s. When Category XI (aquatic ecosystems) is subtracted, the total funding level has declined over the last 30 years. Funds have declined severely since the mid 1970s for water supply augmentation and conservation (III), water quality management and protection (V), water resources planning and institutional issues (VI), and resources data (VII) research. Water resources research funding has not paralleled

growth in demographic and economic parameters such as population, Gross Domestic Product, or budget outlays. Underfunded and in need of future attention include water demand/use, water law and other institutional topics, and water supply augmentation/conservation.

The topical balance changed since the 1965–1975 period, to the point that the present situation is inconsistent with current priorities. The current water resources research portfolio appears heavily weighted in favor of short-term research. A mechanism should be developed to ensure that long-term research accounts for one-third to one-half of the portfolio. The sum of individual agency priorities does not add up to a truly comprehensive list of national water resources research needs.

Multiple looming water crises across the U.S. suggest that the $700 million currently spent on water resources research is not sufficiently focused or is not effectively addressing national needs. Water resources research across the Federal enterprise was largely uncoordinated for the last 30 years, although there have been periodic ad hoc attempts to engage in interagency coordination.

USDA's Research, Education/Extension and Economics (REE) mission area is discussing important, nationally underfunded priorities represented by the six thematic areas introduced to this listening session. While these discussions are focused on national priorities, one should remember that all water problems are local and the REE mission structure provides unique opportunities to balance these priorities between national and local issues.

For more information on the report, visit the National Academy of Sciences website at: www.national-academies.org.

Current Status of Economics

Water quantity-related economics tackles irrigation efficiency and technology adoption, water trading and institutional innovation, water recycling and reuse, and risk management. Economic research in irrigation efficiency and technology adoption covers a wide range of issues, from assessing the profitability of technological improvements to studying the determinants of farmers' irrigation choices. Investments in irrigation technologies can reduce the amount of water needed to produce a crop (e.g., improved irrigation technologies can improve uniformity thereby improving yield). Irrigation efficiency is a function of economic conditions such as relative prices, environmental characteristics, and the availability and input of human capital. Hurdles to achieving irrigation efficiency include costly investments, durability issues, and uncertain returns. Often adoption of more efficient technologies occurs as spikes during droughts or floods—when returns are immediate. Non-market interactions like environmental benefits also influence irrigation technology adoption. A large body of empirical evidence suggests consistent results for the adoption of new irrigation technologies—more efficient irrigation technologies promote conservation by reducing total applied water. Aggregate benefits also accrue to investment in irrigation efficiency technologies; farmers have the opportunity to expand their operations, lease, rent, or sell this newly "found" water or garner goodwill by providing ecosystem services such as instream flows for wildlife habitat. Most of these adoption studies involve cross-section analysis, and are site specific, so their results may not apply across time and location. Benefits and costs related to technology implementation have implications for policy, education, and extension. Incentives must exist, partially driven by the availability of water markets, institutional innovation, pricing struc-

tures, peer pressure, and the desire to "do the right thing."

For decades, water marketing and institutional innovation constituted focal points for economic research and analysis. Often water crises, such as drought or flooding, have yielded innovation. After several years of experience with water banks and water trading, these mechanisms are gaining broad acceptance. For example, a sellers market exists in California, with farmers lined up to sell water to the Metropolitan Water District of Southern California. Types of trades might include short-term, dry-year option, long-term/permanent, and trades through banking arrangements. Trading relationships exist among farmers ("ag to ag"), between the farmer and an urban entity ("ag to urban"), and between the farmer and a watershed council or local, State or Federal agency to support ecosystem services ("ag to environment"). Concerns associated with water marketing include third party effects in the area of origin to secondary water right holders, and hydrologic impacts—reductions in potential groundwater recharge, downstream and instream flow reductions, and physical and chemical aquifer changes from physical water banking.

The economics of water recycling and reuse often involves linkages between urban and agricultural sectors. Initial efforts focused in urban areas where positive benefit/cost ratios exist for recycling and reuse projects. Desalination projects continue to increase in importance, especially around coastal urban centers. Competitive costs for desalination at $700 to $800 per acre-foot promote implementation and create a supply backstop while limiting water market process. Risk allocation involves flood or drought insurance that reallocates risk but does not lower total damage. The value of insurance depends on risk aversion, asset position, and farm and household incomes, and the variability of profits.

Current Status of Extension/Education

Truly innovative extension and educational programs promote implementation of water conservation technologies for landowners and residents who expect the complete package—water on demand that matches the multitude of amenities available in modern suburban life. Following years of population growth, lifestyles that support unlimited use of culinary water for recreation and irrigation have become less sustainable.

This summary presents four key educational approaches and the corresponding advantages and disadvantages associated with these approaches. The four approaches are:

- Lifestyle changes with place-based education;
- Rural and urban plant substitution with locally adapted species and reduction of "lawnscapes";
- Youth education—shifting attitudes towards water; and
- University-based education—training the next generation of scientists and practitioners.

Some efforts aimed at changing lifestyles have led to measurable gains in water savings. Often, these approaches combine alternative water pricing structures and youth education. This combination successfully challenges individuals and families to better respond to drought. In Utah, former Governor Leavitt called together major water wholesalers to work towards a 25 percent reduction in per capita water use for the State of Utah ("Slow the Flow, Save H_2O" and Utah Water Checks).

A second lifestyle approach involves voluntary challenges to "green communities." As an example, leaders from Mercer Island, Washington, challenged everyone in the region to reduce their water use by 1 percent each year for the next 10 years. Utility bills were redesigned to include historic data to help residents track their water use over time. A bill insert was first includ-

ed with the January/February 2001 billings to introduce the new "Be Responsible" program.

Some drawbacks to educating for lifestyle changes include dealing with short-term responses. As an example, many individuals and families only respond to temporary requests—save water during a drought. Once the drought "ends," people revert to their former lifestyle. These lifestyle changes also can lead to economic fallout: restricted water use often impacts the landscape and nursery industry. Social oxymorons also create difficulties. Demanding water conservation during a rain storm often leads to a lack of trust in the system. Educational efforts must be flexible and responsive to current conditions.

The most effective education efforts often involve partnerships with universities and nongovernmental organizations (NGOs). It is critical to recognize that not all educational efforts are founded in universities. Many NGOs have a tradition of very effective educational programs developed outside the traditional university context (e.g., US Golf Association, California and Colorado Water Education Foundations, Soil and Water conservancy districts).

Current Status of Human Dimensions in Water and Agriculture

Across education, it is common to assume that if people just understood the facts they would: (1) do the right thing, (2) there wouldn't be a problem, (3) we could have a rational discussion, (4) they would reach the right conclusion, and (5) everything would be fine. Often described as an education deficit model—this assumption is really seductive to analytical people—simply given the same assumptions and data, there can be only a restricted set of conclusions and actions. Defining the problem as an "educational deficit" leads inexorably to the one true solution, and that is educating people.

Conversely, there exists plenty of evidence from behavioral research that education alone doesn't work. The correlation between knowledge and action rarely exceeds 0.20. New information is often twisted in ways to support existing beliefs, decisions, and actions. For example, people know the 'facts' about:

- Smoking and continue to smoke,
- Diet and continue to be overweight,
- Drinking and Driving . . ., etc.

Plenty of evidence that education alone does not work comes from marketing. When was the last time you were convinced to purchase something because you were given "the facts"? If this worked, would we all drive the same car? Plenty of evidence exists from real life. When was the last time you convinced anyone in your family using pure logic or information? Simply providing facts rarely meets an individual's needs, wants, or expectations. People don't know what they don't know and so they are unlikely to seek education. Knowledge is power, if it is the right kind of knowledge. There are complete theories developed surrounding adoptions of precautious or cautious behavior, for example, stage-theories.

Some mental models are appropriate to addressing this educational dilemma. It is important to know what people know about an issue and to know what people want to know about an issue. But it is more important to know how people think about an issue. We need to understand the system/technology and its interactions with motivations, consequences/outcomes and/or values.

Because "whisky's for drinking, water's for fighting over" we can use water as a test case for our mental models when compared with traditional education deficit models. Water is a common property with a history of complicated allocation schemes. It is ironic that water can be both a "free" and a valuable resource, and both a common resource and private property. Water

can be symbolic, one has or lacks water, that "clean" water exists and the concept of wastewater. We deal with water as a common property by requiring the creation of market incentives, dividing up the property giving allocated "rights" for use, depending on people to "do the right thing," and developing technology to extend the resource.

We face problems when implementing market incentives by pricing water to achieve optimal allocations, potential regressive impacts, the need to meter/monitor the efficacy of these incentives, and the lack of required market feedback. Problems also occur when allocating water "rights," because the basis for allocation is always contentious, and after allocation it is difficult to reallocate for newcomers. Contention often surrounds allocations for the "rights of nature."

Motivating people to "do the right thing" requires more than simply getting people to change their behavior in the short-term, since responses to an emergency are often short lived. People often feel a sense of entitlement towards the distribution, delivery, and quality of water. Persuading people to change behavior in the long-run requires a cultural change that takes time. Mechanisms for social disapproval don't always exist, and individuals may exhibit contrasting behaviors in public versus in private.

Success with persuading pro-social behaviors depends on a shared vision of the nature of the problem and that the solution is the correct one. Sacrifices required to do the right thing must provide available alternatives, be equitable, and clearly effective (self-efficacy). Rewards for self-sacrificing behavior should unambiguously accrue to the individual, society, and be equitably distributed.

Encouraging the use of any resource extending technology necessitates more than merely postponing difficult decisions. These technologies should create new opportunities for reallocation without creating new problems. Not all technologies are universally acceptable: "If you build it, they may not come." And finally, you can't educate people into acceptance.

PHOTO COURTESY USDA NRCS

4. Desired Future State for Water Resources to 2025

Listening session participants produced a broad picture of the future for water resources to 2025—to use as a comparison and signpost for the current status, to help define bold steps to achieve this future, and to formulate approaches to achieving the bold steps. When the group envisioned a future state, it tapped into the group intellect and experience and garnered a cross-section of perspectives that created a future that is more expansive and profound than the vision of a single contributor. Groups reported these concepts back to the full session at the end of the exercise. Visually captured as a map, this exercise created a "pull" or accelerator into the future for participants, much as an athlete uses mental imagery to excel. Commonalities among the thematic breakout groups, detailed below, dealt with educational opportunities, planning processes that consider availability of water, diversity of production systems in agriculture, and more advanced water marketing.

The most common statement describing the desired future state in 2025 focused on increasing public understanding and education regarding water resource supply and usage. Groups described a common best case scenario that increased understanding would result in behavioral changes with a positive impact on water resources. Participants hoped that with greater understanding would come greater levels of cooperation, collaboration among interest groups and the public, and greater trust among those controlling and needing to use water resources, whether in streams or in their homes. In general, it was envisioned and desired that in 2025, fewer

conflicts might exist over water resources.

Participants' concern over water conservation in built environments compelled them to urge local planning entities to consider the availability of water when evaluating proposed development in communities. They envisioned buildings where water reuse would be the normal mode of operation. Participants imagined the ability to easily capture and reuse water from rooftops and paved areas for irrigation of lawns or landscaping, eliminating the concept of storm water management. The group foresaw low-water-use lawns or reduced lawns in some areas. These would be replaced by landscaping with adapted native plants and other xeriscaping practices.

A Desired Future State

Increase public understanding and education leading to a behavioral change about water resource supply and usage

Local community planning includes water availability when proposing future development

- Very low water-use lawns or reduced lawnscapes in some areas
- Stormwater and greywater reuse an expectation for all built environments

Greater diversity in agricultural systems to match the water needs and limitations

- More water-use-efficient crops
- Crop substitution
- Better climate, weather, and water-use forecasting

The ability to trade water resource shares

Household, municipal and industrial, and environmental water needs would be considered together

In agriculture, the group favored an increase in the diversity of production systems and to customize production systems to match needs and resource limitations. For example, participants thought about the use of alternative crops and imagined different produce choices for consumers in grocery stores. Many envisioned agricultural production systems that maintained or increased productivity while decreasing resource use and minimizing resource degradation. For example, increasing the water-use efficiency of crops through biotechnology could result in some decrease in water requirements. In addition to increasing efficiency at the crop level, increasing efficiency of management through improved timing of practices could significantly impact water use and crop survivability. As a means to achieve this, a need was voiced for improved short-term and long-term forecasting tools for weather, climate, and predicted water use. Forecasting tools would require links to management decision support and provide easily usable and accessible information to producers. These tools would not only mitigate the impacts of weather and climate on crop production, but would also help to prepare agriculture for climate changes.

All participants desired a more advanced water marketing and distribution system that reflects the real value of water. Attendees imagined advances in water institutions that mirror the real estate market. They envisioned an ability to trade water resource shares and to link multiple resources together to evaluate benefits in a more holistic manner. Household, industrial, agricultural, and environmental needs would be considered together, and the tradeoffs between costs and benefits of water allocation plans for each sector would be made explicit.

PHOTO COURTESY USDA NRCS

5. Strengths, Opportunities, Gaps, and Barriers

Following the future pull for water resource issues in 2025, the group identified 1) USDA's current strengths and opportunities, and 2) gaps in knowledge and barriers to achieving the desired future for each theme in breakout sessions. Below are the common strengths and opportunities among those identified by the thematic groups followed by a section on gaps and barriers.

Strengths and Opportunities

Each thematic group, charged with affirming USDA's strengths and opportunities, focused on the following key question:

KEY QUESTION

What are USDA's current strengths that would move us forward towards our desired future state (e.g., through cooperative research, education/extension, and economics programs)?

Participants commonly recognized as strengths interagency interaction, both "horizontally" among Federal agencies and "vertically" from local to Federal levels, and among different

kinds of infrastructure in addressing water security. Perhaps most importantly, attendees recognized that USDA has a long history of effective, cooperative approaches and actions in working with agricultural producers, State and Federal entities, and tribal governments. Attendees felt that established partnerships between USDA agencies and the Land-Grant University system and with industry strengthened USDA's ability to lead efforts to address water resource issues. Partnerships among USDA/CSREES, State land-grant universities, and cooperative extension at the county level provide great strength and opportunity from existing national to local and trusted networks. Strong relationships exist between ARS and ERS and land-grant universities. Some USDA agencies have the advantage of direct national and local-level personnel and infrastructure to carry out activities. Attendees felt a great need for continuation of such coordination and "vertical integration" of activities at the Federal, State, and county/local level in order to have substantial impacts in water security. They agreed that the infrastructure and expertise necessary to assess these impacts exists.

USDA strongly addresses water security through USDA action agencies that directly manage lands (U.S. Forest Service) and partner with landowners (NRCS) on significant amounts of the nation's land and some water resources in its Farm Bill programs and national forest system. USDA exerts significant influence in practices on private land through USDA financial assistance programs (both Farm Bill programs and grant opportunities), through strong extension education (Cooperative Extension) and technical assistance (NRCS). More specifically, groups agreed that Cooperative Extension Service and CSREES represent leaders in outreach education. All attendees agreed that through the Cooperative Extension Service, USDA uniquely links research with education and outreach to effect real change in water security. Attendees felt USDA-REE agencies have a history of developing strong interagency collaborations with partners including NRCS and EPA among others to provide not only the science but also the education component so critical in successfully addressing water security.

USDA's resources include the infrastructure of scientists, educators, and managers from across USDA REE agencies and the land grant system with a large body of scientific knowledge and capabilities from which to draw. Groups touted the strength of USDA's data and information resources on water. In general, attendees recognized that much sound science already exists with opportunities to be further developed and applied in order to make rational decisions. Attendees identified extension as one tool that could effectively deliver science-based information using the outreach educational experience and approaches of the cooperative extension system.

USDA biotechnologists currently utilize genetic engineering to modify crop traits to improve water-use efficiencies, and future improvements are likely. Germplasm resources are available for many crops, and bioinformatics can be used. Precision agriculture is another USDA-funded management tool with potential to improve the efficiency of water resource use. USDA funded economists and water managers work diligently to improve their experience with water trading, and water markets exist with well-defined water rights.

USDA and Cooperative Extension also have a history of engaging and informing communities, including community leaders, and of developing tools to assist with informed decision making. Along those lines, participants felt one opportunity for USDA in the area of water security would be to broaden its priorities to include water reuse and to develop more partnerships (perhaps EPA) to address this issue. Participants also recommended that USDA consider expanding its traditional focus and customer base to address urban water use issues.

Gaps and Barriers

Following their discussion of strengths and opportunities, participants were asked to consider gaps in knowledge and barriers to achieving their identified desired future state. Prior to the "Gaps and Barriers" breakout session, each small group was given the following question to focus their discussions.

KEY QUESTION

What are the gaps in existing knowledge in agricultural research, education/extension, and economics and barriers that prevent us from achieving our desired future state?

Common gaps and barriers identified by all participants in response to the key question above are summarized below. Following this initial summary, gaps and barriers unique to each thematic group are detailed. Participants identified many gaps in knowledge, data, or decision tools and noted a lack of information in several areas. All groups determined that these numerous gaps were directly related to a lack of funding for research, education, and extension in water resources planning, management, and the associated behavioral, policy, and economic sciences. They also felt there was a need for more interagency interaction and coordination, both "horizontally" among Federal agencies and "vertically" from local to Federal levels. Attendees cited agency infrastructure characteristics that they felt might pose challenges to effectively addressing water security. There were a few policy-related issues raised such as a lack of sound science in water management and planning, unknown effects of water marketing, differing standards for urban versus rural and newly-built versus established environments, failure to incorporate the effects of climate change and concomitantly being overly optimistic in our water planning. In addition, many of the participants recognized that there is a lack of a shared vision or understanding of common goals among stakeholders regarding water resources and that conflict over water is a great barrier to successfully addressing water quantity. Some attendees felt there was a lack of understanding of behavioral choices and decision making processes at the local level. Many gaps were identified in the areas of education and outreach to both farmers and citizens. One barrier to achieving the desired future state was perceived as being a lack of qualified, trained individuals capable of addressing future water security needs and that agencies seem to unclearly target their educational activities and audiences.

Highlighted and unique to thematic groups are the following gaps and barriers:

Irrigation Efficiency and Management

Irrigation efficiency participants found a mismatch between societal needs and agricultural production that fostered a lack of emphasis on alternative crops. The state of water delivery infrastructure can be a barrier to attaining maximum on-farm water use efficiencies. The group felt USDA's emphasis on water quality programs eclipsed efforts to focus on quantity aspects and pointed to a lack of a research emphasis over longer temporal and broader spatial scales. USDA lacks sufficient research on the interrelationships between agricultural water use and other water needs. USDA's activities in response to crisis rather than long-term planning for water security was cited as an anticipated barrier to addressing the issue. Group discussants considered current state-of-the-art technologies (e.g., remote sensing) to be poorly supported or to need refinement.

Drought Mitigation and Preparedness

Participants found gaps in decision-relevant national forecasts and their ability to reduce uncertainty for agriculture on a seasonal, annual and long-term basis. Institutional barriers have cropped up that involve the tendency for farmers to receive crop insurance payments in lieu of proactively practicing drought preparedness. They felt the deficiency of an assortment of drought tolerant crops, water conservation techniques, and available water markets presented a barrier to appropriate water management and use.

General Water Conservation

Participants associated USDA with limited involvement in urban and rural water issues. They felt that conservation programs and practices may promote greater water consumption due to flaws in water rights, lack of adjudications, and inappropriate water pricing. There is a knowledge gap of the effects of shifting regional water use patterns on communities and ecosystems and uncertainty about the impacts on water supply from improved land treatment and ecosystem management. Stakeholders lack "place-based" education related to water consumption, conservation and management. Participants recognized as a barrier ineffective and protracted dissemination of research to the farm. Unknown decision-making processes and a general lack of integrated decision support systems plague appropriate water use at the farm level.

Rural/Urban Water Reuse

USDA needs incentives to focus already existing capacities in the direction of water reuse technical assistance, financial incentives and outreach. Failure of early technological innovations, fear of health hazards and contamination, and a general lack of public commitment restrict adoption of water reuse technologies by stakeholder groups. Greater research emphasis needs to be placed on the feasibility of installing new reuse technologies—some perfected in other countries—into existing and new construction. Rural-based agencies have not integrated or pursued water reuse and conservation strategies in allocating water to agriculture. Other suggested barriers implicate agency misunderstanding of behavioral aspects to adoption and maintenance of reuse technologies. Also, the group felt that Federal research priorities cannot be shifted fast enough to address the near-term needs of agriculture and other water users.

Water Marketing, Distribution, and Allocation

Participants discussed institutional and economic barriers to water transfers and associated third party effects that can influence the flexibility of water rights holders to adopt water security measures. No mechanisms currently exist to help determine the most appropriate level of intervention. Stakeholders often do not recognize the existence of a water problem and/or understand water processes. For example, groundwater institutions and regulations are separate from those associated with surface water planning and management despite the hydrologic connection. Watershed planning needs to encompass all aspects of ground and surface water quantity and quality.

Biotechnology

Antagonism to biotechnology-derived plants with higher water-use efficiencies and other fall-out from Genetically Manipulated Organisms (GMO) fears might present a significant barrier to public acceptance of plant substitution. Other suggested barriers/gaps focused on broad mismatches between research solutions and problems, and an emphasis on major crop species only—leading to a lack of strategic investment in water-relevant genomic research. Participants recognized an important gap in interdisciplinary education that linked processes and responses through molecular, physiological, and ecological scales.

TIMOTHY NUNAN

6. Bold Steps

Charged with thinking outside of their comfort zone and identifying uncommon steps to achieving the desired future state in water resources, participants produced a few bold steps within each thematic area. These bold steps set goals that are slightly out of reach—but might propel USDA into reaching extraordinary results. Each of the bold steps can be broken down into measurable action steps and embedded into a strategic plan to insure accountability and success.

Groups also were asked to consider possible partners that could work together with USDA to achieve the bold steps. The two "Bold Steps" illustrations (see center section) summarize the responses from the six breakout sessions and present some commonalities identified among the groups.

KEY QUESTION

What are the three key strategies and strategic partners that will help us bridge from the current to the desired future state (e.g., collaborative or cooperative research, education/extension, and economics projects)?

CARLOS LOZANO

7. The "Green Light" Exercise

A green light exercise alerted the participants to various potential actions and fostered an environment where bold steps are taken and the future vision is successfully achieved. Green light measures, when analyzed by the group, represent actions that seem both viable and possible. Each of the six thematic area teams were presented with the following key question and the groups were charged with creating a strategy to achieve the desired future state from previous discussions. This section summarizes the responses from the six breakout sessions and then presents some commonalities identified among the groups.

KEY QUESTION

You and your team have a "green light" from USDA to create a strategy and agenda for research, education/extension, and economics to achieve the desired future state. What strategic alliances and partnerships are critical? Suggest a plan/strategy and substantiate your choices/decisions.

Green-Light thinking involves no wrong answers, and it is the quantity, not quality, of ideas that is emphasized. Facilitators encouraged the free wheeling generation of ideas. By deferring judgement, people may hitch-hike a solution on

another idea that might have had little merit. In this green-light glow the facilitators banked on creativity flourishing. After the process played itself out, the group began to winnow the possible solutions down. Participants made the judgements, prompted by asking questions such as, "What effect could this solution have on other departments?" or "How much might that cost?" When the group selected the most effective solution, they went to work on specific steps toward implementation. The listening session attempted to serve as a conduit, rather than a short-circuit, of creativity, relying on what the group was passionate about— water—and identifying what part of these six thematic areas and where USDA could be the best. *"Success, or failure, very often arrives on wings that seem mysterious to us"* —Marcus Bach

Near-term recommendations common to all thematic discussion groups included fully utilizing and integrating existing resources within USDA, collaboration of REE directors, and the formation of a decision-making body with representatives from the mission agencies. USDA should organize internally around water security issues to enable, foster, and prioritize research, education (extension), and economic activity and programs. Groups suggested that USDA take results of the listening session and educate, share, and discuss these results internally and across the government. It was considered critical that USDA acknowledge that Agricultural Water Security is an important issue for the nation. Even though they were given the "green light," groups expressed concern that funding sources, needs, and requirements were essential to the successful start-up and implementation of Agricultural Water Security. Discussions commonly focused on cementing partnerships with other governmental agencies at the national, State and local levels. Suggested partners common to all groups included Federal agencies focused on the social sciences, economics, policy, law and health, State, local, and tribal agencies, land-grant and other university institutions, non-governmental organizations, K-12 educators, irrigation, conservation and groundwater districts, industry and commodity groups, and professional societies. Irrigation Efficiency and Management and Water Marketing, Distribution, and Allocation discussion groups focused on the accurate quantification of water use and the need for expanded water, remote sensing and long-term data collection, data accessibility, and improved data quality. Two groups expressed concern that the USDA Economic Research Service (ERS) was not more actively involved in water availability research.

In the longer term, Drought Risk Assessment and Preparedness and Rural/Urban Water Reuse discussion groups promoted the need for expanded capacity by providing appropriate staffing—making Agricultural Water Security a dedicated part of an employee's job.

Each group produced some unique and innovative strategies forming new "green light" directions described below.

Irrigation Efficiency and Management

The Irrigation Efficiency and Management group indicated that a paradigm shift was needed to achieve the desired future state. Their stated goal was to maximize or optimize socioeconomic return on consumed water in the agricultural sector, urban settings, and the natural environment. The needed paradigm shift would involve a movement from production-oriented goals for agriculture to sustainability-related goals—"crops per drop." That it might take a "blue revolution" on the same scale as the "green revolution" of the 1960's—with the caveat that success will depend on the economic, political, and cultural rules that people make. These rules determine

who benefits as a supplier of the increased water production and for what profit, and who benefits as a consumer of the increased production—who gets the water and at what price. Thus water markets must exist and adequate information about the value and use of water must be available.

The group saw improved satellite, survey, and sensor technologies as critical for better field-level water application and management and reduction of consumptive use. The group felt that establishing basin-wide management objectives for water resources would greatly improve the vertical integration of ideas from the farm to the basin scale. We must be able to compare water-use efficiencies among rural agriculture, ecological services, and urban environments to identify inefficiencies and balance best possible uses.

The group brought up some intriguing questions they thought critical for long-term success:

Can we assess the impacts of moving/exporting water globally through food products—do trade pacts help or hurt?

How will climate change effects be determined and incorporated into water security planning?

How will flexibility be infused into Federal/State/local water laws to meet the demands of conservation, and what use laws will exist that restrict hidden water transfers?

Drought Risk Assessment and Preparedness

The Drought Risk Assessment and Preparedness group stated that their goal for the green light exercise was to capitalize on existing leadership available through the Interim National Drought Council (INDC), the proposed National Integrated Drought Information System (NIDIS), and the National Drought Preparedness Act.

The group recommended that the Secretary of Agriculture convene a meeting of the INDC to discuss how to get consensus on the National Drought Preparedness Act. The INDC also could develop an action plan to implement the NIDIS report. Through this action plan, other strategic partners (Federal, State, private) could be identified. The INDC then could discuss relevant customer group follow-up as suggested in the NIDIS report. A final agenda item for the INDC meeting would be to discuss national water supply issues (e.g., National Drought Preparedness Act, National Research Council Report, 2025, Linder Bill, and the Office of Science Technology Policy (OSTP) memo from Dr. Marburger, Chief Science Advisor to the President).

A key element of the green light plan was a strategic effort to promote behavioral changes that lessen our vulnerability to water shortage. Possible actions associated with this effort included:

- National information campaign (year of water);
- Concerted planning effort—marketing, information, communications, clear messages to the media;
- Developing and implementing community incentives to conserve water;
- Compiling and sharing best practices for improved water management; and
- Quantifying the full impacts of drought.

General Water Conservation and Management

In the near-term, the group supported the development of a Federal document on water availability (currently being developed by the President's Office of Science and Technology Policy (OSTP) and greater visibility for the advisory committee on water information (USDOI/USGS). The group advocated establishing a clearer transfer of information from national to State levels by providing an operational directive, with

special emphasis on water policy. USDA should further engage stakeholders by taking the listening session concept to the local level—either live or with surveys.

Rural/Urban Water Reuse

Creating a national water quantity initiative for the USDA REE Mission Area was the green light goal of the Rural/Urban Water Reuse group. The group envisioned REE as providing national leadership, detailed expectations, and direction for this water quantity initiative. In the near-term, USDA needs to define their role in water quantity issues and efforts. Using the National Water Quality Initiative as template, USDA should promote shared leadership in Agricultural Water Security—an entity or entities to work with the REE Agencies and provide (1) advice, consultation, guidance, and input; (2) oversight policies/programs related to the water quality initiative; (3) representatives to include external and internal; and (4) collegial interface with administrative leadership of REE. Create additional research programs like the National Research Initiative to increase dollars related to water quality, companion programs that emphasize integration of research with extension (e.g., Sec. 406 under AREERA). Funding should consist of both competitive and base level sources. The group emphasized the development of curricula at all age levels and mechanisms to measure performance and impact.

Water Marketing, Distribution, and Allocation

Efficient allocation of water resources was the goal identified by the Water Marketing, Distribution, and Allocation team. This goal was linked to their bold step of getting water resources data in a useable form to users (i.e., decision-makers, researchers, etc.). The group, along with several others, stated that identifying critical data needs that enabled users to make informed water decisions was key to the success of their green light plan. As a first step, they envisioned completing a data assessment of existing data and determining quality and accessibility of those data. A second step involved determining data gaps in the information needed to address Agricultural Water Security issues. Critical data need to be collected and stored in order to achieve the green light goal. A final step involves making critical data available in a useable form and insuring appropriate storage, linkages, and accessibility for future use of the data.

The group also identified several concerns related to the green light goal. They saw institutional relationships and barriers in each State as a formidable hurdle to overcome for successful water resource allocation. The group saw the need for an integrated analysis of the impact of marketing on water resource allocation.

Biotechnology

For their green light goal, the Biotechnology group envisioned reducing water use by agriculture by 20 percent—while maintaining productivity—by 2020. The group recommended USDA take the lead to heighten awareness/concern about water issues and use the available science and information to identify causes of these issues (e.g., urban, agricultural, commercial, environmental, recreational).

The group saw a need to develop a compelling document that defined Agricultural Water Security issues and that could be provided to a wide array of audiences including the President, Congress, Cabinet Secretaries, Governors, State and Federal Agencies, counties, the media, stakeholders, and ultimately the public. They saw the

need to convene a national town meeting that would work from and integrate existing documents (e.g., Water 2025, DOE Report) into a compelling case for Agricultural Water Security. Ultimately, the objective was to get buy-in from the Administration, Congress, and Governors. The final aspect of the national town meeting was to develop goals for water use—such as reduce water use by 20 percent. These goals would create quantifiable targets that could be included in a national water plan.

A key aspect of the success of the green light plan was to leverage interagency investment in water-related biotechnology research. The group noted that a national needs fellowship could be established for water-related biotechnology research. Efforts also could be undertaken to foster public-private cooperation in water-related biotechnology research involving many of the partner groups identified above.

Low Hanging Fruit

Of the bold steps and green light strategies outlined above, which are accessible and attainable in the near-term—our low hanging fruit?

Participants recommended pulling together the information from the listening session to produce a crisp one-pager with wide distribution within and outside of USDA. The one-pager, final report and the Issues Map and Interventions Map, along with a commitment to take the initiative, should be utilized in a cabinet-level meeting to enlist national attention and support. USDA's role in Agricultural Water Security must be clearly and carefully defined to lend legitimacy and promote recognition. Part of cementing partnerships inside and outside of USDA requires the collation and inclusion of documents related to Agricultural Water Security across all pertinent agencies. Current research should be accessible and made more widely available.

Deputy Under Secretary Rod Brown agreed to assist the four agencies of USDA to clarify their institutional position and role in Agricultural Water Security, and to elevate the importance of the issue within the Department. By providing guidance, direction, and encouragement, he will promote the issue internally and thereby position USDA to lead this initiative.

PHOTO COURTESY USDA NRCS

8. Take Home Message

"The choices that we make today set our trajectory for the future."

—- Dr. Rodney J. Brown, USDA Deputy Under Secretary for Research, Education, and Economics at the Agricultural Water Security Listening Session September 10, 2004.

The time has come to make substantial changes in the way we think about and manage water resources. Drought and water quantity issues no longer are restricted to western States. We need to better understand the value of water within diverse geographic settings spanning the entire nation. When we pay for goods and services, how much of that payment goes for water in—

- A gallon of milk?
- A bushel of corn?
- Greens fees at a golf course?
- Fishing licenses?

Consumers gladly pay $1.00 for a liter of bottled water but bitterly complain when a liter of gasoline costs $0.60—is there a gasoline crisis or a water crisis? We must be willing to measure agricultural productivity in "crops per drop." Such a change will signal a paradigm shift toward a "Blue Revolution" where the value of water in the environment has a recognized value. This may ultimately lead to wholesale crop replacement—changing the nature and course of agricultural production across the nation.

A Desired Future State

Participants in the listening session described a desired future state where water use and management meets expectations for effectiveness and efficiency of use across all sectors (agricultural, rural, urban, municipal, industrial, and environmental). They envisioned a diverse agricultural economy where water is used efficiently to produce appropriate crops to meet local, national, and global food and fiber challenges. Together, they saw urban, rural, and agricultural communities connected in their efforts to conserve water to meet the demands of growing populations, protect environmental quality, foster economic development, and protect human health and well being. Finally, they described expanded economic and policy options to shift water uses while protecting individual, local, environmental, and State rights to water.

How will we achieve this desired future state? Fundamentally, we must believe that this future state is possible. Realistically, achieving this future state requires changes—sometimes small, other times large. These changes will span many scales—from the individual to the water district, to watersheds, States, and the nation. Individuals will need to change both how they use and how they value water. At the local and State levels, creative solutions will need to arise in place of water crises—spurred forward by new policies and economic tools. At the national level, government agencies will have to improve cooperation and partnerships that will transcend organizational structures to insure that the best available knowledge and programs are used to address issues at the national, regional, and local level.

Taking Bold Steps

Achieving the desired future state will require bold steps—by individuals, decision-makers, organizations, and government agencies from the Federal to the local level. These bold steps will require a new paradigm—one that bridges economic growth and environmental benefits. At the listening session, participants envisioned a set of bold steps that will serve as a catalyst to achieving the desired future state. These unranked steps are:

- Water management transcending political and social boundaries—connecting urban, rural, environmental, and agricultural uses of water at the watershed or basin scale.
- USDA extending its knowledge base to the urban sector—providing tools developed for agricultural and rural environments to address urban water issues.
- Efficiencies gained through improved irrigation management translating into greater instream flows without imposing economic loss on irrigators.
- Redirecting genomics research from a production focus to address environmental issues such as drought or salinity tolerance.
- A national network of drought (or water management) centers providing science-based information for improved decision making and water savings.
- Expanding flexibility in decision-making for water management through effective water markets.
- Revamping educational efforts to produce behavior change among citizens in agricultural, rural, and urban environments.

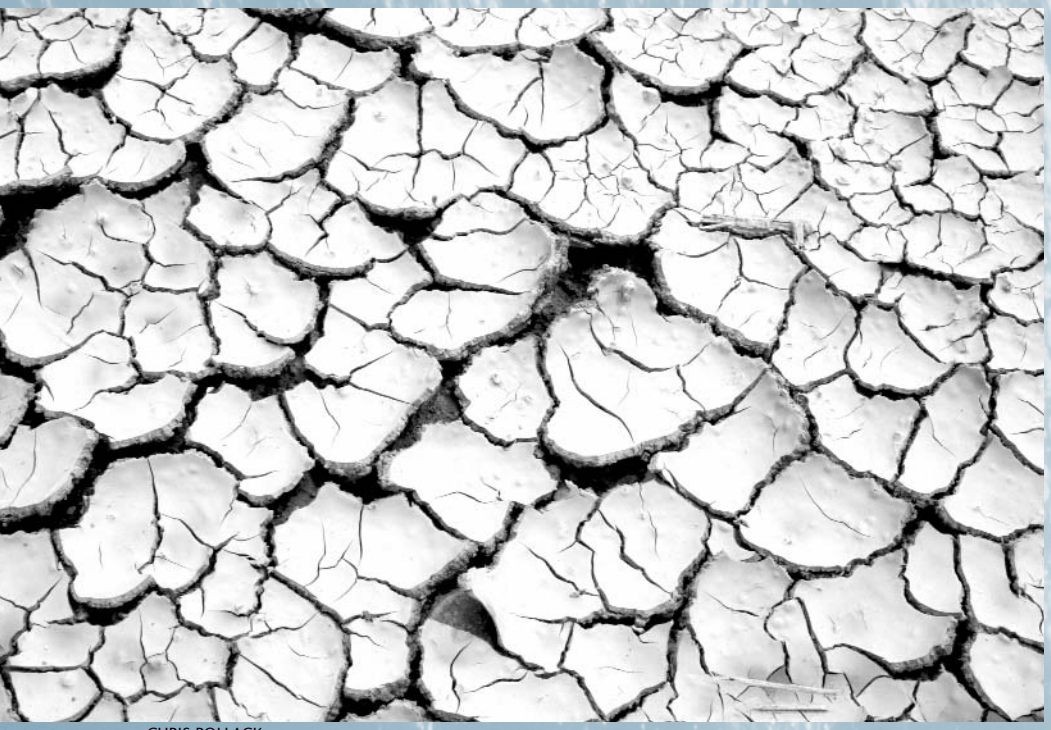
These bold steps challenge our current system of creating and disseminating knowledge. However, we must embrace this challenge if we intend to achieve the desired future state.

A Role for Research, Education, and Economics

No one agency alone can resolve water issues. Agency partnerships and cooperation are fundamental building blocks for achieving the desired future state. Agencies in the USDA Research, Education, and Economics (REE) Mission Area must provide knowledge and information needed to achieve sustainable solutions. The agencies of REE must reach out across government to build new partnerships that capitalize on existing successful programs within and beyond USDA.

Research must shift from a production focus to an environmentally sustainable production where water is recognized as a critical lifeline that connects agricultural and natural ecosystems. ARS and CSREES must lead the way on these issues—creating programs for environmental genomics, tackling urban and rural water reuse and conservation, and developing and building the network of information centers for drought preparedness. Good science will require additional financial resources and scientists—considered woefully inadequate and leading to agricultural water insecurity. The current insufficiency of financial support and incentives may be linked to our inability to interest and recruit young scientists to water related disciplines, particularly in the public sector. This research should provide a science base for current and future conservation programs—focused on protecting and improving the quality of the Nation's water resources. Education and extension programs supported by CSREES must explore how to achieve "real behavior change" by farmers, ranchers, homeowners, and water users of all types. Educational programs also must take advantage of new technologies—allowing information exchange and knowledge to move quickly and effectively among individuals and groups. New policies and expanded economic analyses are needed from ERS to guide agricultural conservation and commodity programs. Information collected and managed by NASS must be available to quickly and effectively address management of water resources in urban, rural, and agricultural settings.

USDA is strategically positioned to change the course of water resource management in the nation. The REE Mission Area must lead the way for USDA to take the bold steps and achieve the desired future state.



CHRIS POLLACK

Appendices

Invitation Letter from USDA Deputy Under Secretary Rodney J. Brown

USDA REE

United States Department of Agriculture
Research Education Economics
Office of the Under Secretary
Room 216W
Jamie L. Whitten Building
Washington, DC 20250-0110

AUG 12 2004

Dear Listening Session Participant:

I invite you to participate in a listening session to discuss USDA's research, education, and economic efforts in Agricultural Water Security. As we plan for the future, we want you to share your knowledge and experience towards this important topic. Attached are documents describing the purpose and expected outcomes from this listening session and a background document on the current water crisis.

The listening session will be held at the Yarrow Resort Hotel and Conference Center in Park City, Utah, beginning September 9 at 8:00 AM and finishing on September 10, 2004 at 1:00 PM. There is no registration charge for this listening session. A block of rooms is on hold at the Yarrow Hotel (Phone: 435-649-7000, Toll-Free: 800-927-7694, Fax: 435-645-7007, www.yarrowresort.com) – please make your own hotel reservations.

Please confirm your attendance at the listening session with Kelsi Bracmort (202-401-6124, kbracmort@csrees.usda.gov). Any questions or requests for information should be directed to Mike O'Neill (202-205-5952, moneill@csrees.usda.gov) or Dale Bucks (301-504-4600, dab@ars.usda.gov).

Thank you for agreeing to participate in the important activity. I look forward to seeing you in Park City.

Sincerely,

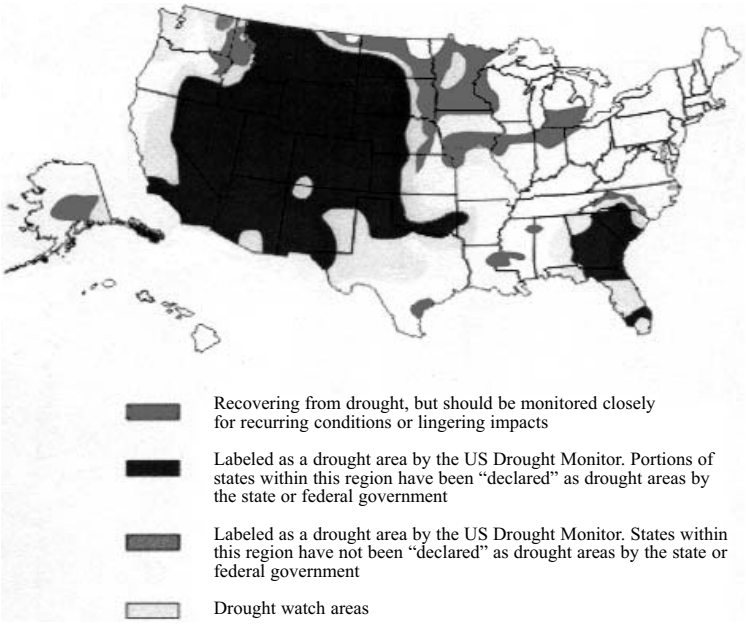
Rodney J. Brown

Rodney J. Brown
Deputy Under Secretary

Enclosures

Agricultural Water Security Listening Session
U.S. Department of Agriculture—Research, Education and Economics
Park City, Utah, September 9-10, 2004

Over the past decade, drought conditions have developed in virtually every state in the nation. These circumstances have resulted in serious impacts to agricultural production, natural resource health and welfare, and rural community development. The map below depicts drought conditions as of June 1, 2004.



What is the situation?

Due to a combination of drought cycles and impacts of global change, nine Western states are experiencing critical drought — similar circumstances exist in the East. Examples include:

- In California, Sierra Nevada snowpacks are melting faster and earlier than during any spring in 80 years.
- Colorado's drying reservoirs have brought lawn watering restrictions for 1.2 million Denver water users.
- In Arizona, where forests and soils are the driest in a century, fire danger is extreme.
- New Mexico and Nevada are bracing for conflict between agricultural interests and urban needs due to anticipated low river flows.
- Lake Powell in Utah is half full and could experience partial drying by fall 2004.
- This the sixth consecutive year of drought in Montana.
- Floridians are anxiously awaiting summer rains to reduce the wildfire potential brought about by an abnormally dry spring.
- The Georgia Environmental Protection Division announced year-round conservation-based restrictions on outdoor water use.

USDA's Federal Crop Insurance payments alone for drought losses have averaged $462 million annually (33 percent of total payments) since 1989. More than half of the total $4.1 billion in 2002 crop insurance indemnity payments, or some $2.5 billion, was for drought-related causes. In 2003, those indemnities were approximately $3.2 billion—of this amount about 45 percent is attributable to drought-related losses.

Background Information for Agricultural Water Security Listening Session

Recognizing these challenges, there is a growing need for agricultural and economic research and education to address these critical questions posed by citizens and producers around the nation, before, during, and after water crisis. **Water availability and scarcity issues are not going away in the future.**

The Research, Education/extension, and Economics mission area (REE of the U.S. Department of Agriculture (USDA) must proactively develop a coordinated effort to conduct necessary research and education/extension programs on water supply, allocation and distribution—Agricultural Water Security. Six relevant topical areas have been identified including : **rural/urban water reuse, general water conservation, irrigation efficiency, water marketing, drought risk assessment and preparedness, and biotechnology.** These topical areas overlap agencies within several mission areas of USDA as well as other cabinet-level departments including the U.S. Departments of Interior (Bureau of Reclamation), Commerce (National Oceanic and Atmospheric Administration), Energy (Environmental Management and Science), Defense (U.S. Army Corps of Engineers), Homeland Security (Emergency Preparedness & Response) and cabinet rank Environmental Protection Agency (Water Program), and by congressional act of incorporation the National Academy of Sciences (DBASSE, Earth & Life Sciences, Engineering & Physical Sciences). Before we commit energy and resources to the coordination of an Agricultural Water Security effort, REE will be discussing with our extra-departmental partners and others:

- The relevance of USDA's research, education/extension, and economic efforts involving water supply, allocation, and distribution issues—Agricultural Water Security—and
- A basis for expanded USDA research, education/extension, and economic programs in Agricultural Water Security that take full advantage of partnerships with other Federal and State agencies.

What is being planned?

A two-day listening session hosted by the REE mission area is being held September 9-10, 2004, to define:

1. What are the top priorities for Agricultural Water Security?
2. What impact can REE agencies have regarding Agricultural Water Security?

Discussions during the listening session will refine our thinking in terms of our six topical areas and prioritize, reorganize, and strategize future activities for the mission area. The listening session will help us to define our niche—what role does USDA play in water supply, allocation and distribution? We will listen to discussions involving invited individuals from USDA (CSREES, ARS, ERS, NASS, NRCS, FSA, RD, RMA, USFS), extra-departmental partners, national academy members and other university experts, the Western Governors Association, Agricultural Experiment Station Directors, water education/extension NGOs, private water-related associations, water conservancy districts, rural and urban utilities, national centers, regional, state and local government agencies.

What outcomes can we expect?

1. Assessment of the current capabilities of the USDA-REE agencies (ARS, CSREES, ERS, and NASS) to address research, education/extension, and economic needs;
2. Determination of the USDA program needs that might be fulfilled by a coordinated USDA effort of research, education/extension, and economics for Agricultural Water Security;
3. Determination of the gaps in existing knowledge of agricultural research, education/extension, and economic efforts;
4. Identification of strategies and opportunities that will advance USDA research, education/extension, and economic efforts and provide products and solutions to USDA customers, stakeholders, and partners; and
5. Identification of commonalities among the topical themes and described some of the necessary steps to move USDA towards national programming in Agricultural Water Security.

Agenda for the Listening Session on Agricultural Water Security

Wednesday September 8, 2004

1:30-3:30 PM	Facilitators Meeting	*Yarrow Hotel Ivers Room*
3:30-5:00 PM	Speakers and Discussion Leaders Meeting	*Yarrow Hotel Hearst Room*
5:00-7:00 PM	Early Registration	*Yarrow Hotel Lobby*

Thursday September 9, 2004

7:00-8:15 AM	Registration	*Yarrow Hotel Lobby*
8:15-9:00 AM	**Opening Plenary Session**	*Yarrow Hotel Summit Ballroom A* Dan Kugler, CSREES, Moderator
	Welcome	Jack Payne, Utah State University
	Overview	Rodney J. Brown, Deputy Under Secretary for USDA-REE
	Meeting Logistics	Dale Bucks, ARS
9:00-10:00 AM	**Establishing the Current Status**	Al Dedrick, ARS, Moderator
	Status of Education/Extension	Jim Dobrowolski, Washington State University
	Status of Economics	Dave Sunding, University of California, Berkeley
10:00-10:15 AM	**BREAK**	
10:15-10:35 AM	National Academy of Sciences Report on Water Resources Research	George Hallberg, CADMUS Group
10:35-11:25 AM	Status of Research	Bert Clemmens and Dan Upchurch, ARS
11:25-11:45 AM	Human Dimensions: Water and Agriculture	Bill Hallman, Rutgers University
11:45-1:20 PM	**Lunch and Introduction of Discussion Leaders and Facilitators**	*Yarrow Hotel Summit Ballroom C* Mike O'Neill, CSREES
	Table Group Discussion: Desired Future State for Water Issues in 2025. Table Group Callout	

Agenda for the Listening Session on Agricultural Water Security

1:30-2:45 PM **First Breakout Session—Strengths/opportunities**

Drought Mitigation & Preparedness (Green)	*Yarrow Hotel Ski Shop*
General Water Conservation and Management (Orange)	*Yarrow Hotel Ivers Room*
Biotechnology (Blue)	*Yarrow Hotel Hearst Room*
Irrigation Efficiency and Management (Yellow)	*Yarrow Hotel Kearns Room*
Water Marketing Distribution and Allocation (Purple)	*Yarrow Hotel Alpine Room*
Rural Urban Water/ Reuse (Grey)	*Yarrow Hotel Judge Room*

KEY QUESTION: What are USDA's current strengths that would move us forward towards our desired future state (e.g., through cooperative research, education/extension, and economics programs)?

2:45-3:00 PM **BREAK**

3:00-4:15 PM **Second Breakout Session—Gap Analysis**

KEY QUESTION: What are the gaps in existing knowledge in agricultural research, education/extension, and economics and barriers that prevent us from achieving our desired future state?

4:30-5:30 PM **Breakout Session Reports** — *Yarrow Hotel Summit Ballroom A*
Peggy Caswell, ERS,
Moderator

5:30-7:00 PM **Social and Cash Bar** — *Yarrow Hotel Mountain View Room*

6:30 PM-until **Debriefing Session** — *Yarrow Hotel Ivers Room*
Discussion Leaders, Facilitators and Steering Committee

KEY QUESTIONS: What worked? What problems developed?
Do we need to change anything for the second day?

Agenda for the Listening Session on Agricultural Water Security

Friday September 10, 2004

8:00-8:30 AM	**Plenary Session: Overview**	*Yarrow Hotel Summit Ballroom A* Rick Kestle, NASS, Moderator
	Overview and Comments	Patti Dobrowolski, Alchemy LLC
8:30-9:30 AM	**Third Breakout Session—Three Bold Steps and Stakeholder Engagement**	
	KEY QUESTION: What are the three key strategies and key strategic partners that will help us bridge from the current to the desired future state (e.g., collaborative/cooperative research, education/extension, and economics projects)?	
9:30-9:45AM	**BREAK**	
9:45-11:30AM	**Fourth Breakout Session—Scenario Planning**	
	KEY QUESTION: You and your team have a green light from USDA to create a strategy and agenda for research, education/extension, and economics to achieve the desired future state. What strategic alliances and partnerships are critical? Suggest a plan/strategy and substantiate your choices/decisions.	
11:30-2:00 PM	**WORKING LUNCH**	*Yarrow Hotel Summit Ballroom C*
11:45-12:45 PM	**Final Reports from Breakout Sessions**	Dale Bucks, ARS, Moderator
12:45-1:45 PM	**Commonalities and Next Steps**	Mike O'Neill, CSREES, and Jim Dobrowolski, Washington State University, Moderators
	KEY QUESTIONS: What are the commonalities among topical themes? What strategies would be considered "low-hanging fruit" and which would require more time and effort? What strategies could be successful and why would you choose them?	
1:45-2:00 PM	**Closing Remarks**	**Rodney J. Brown, Deputy Under Secretary, USDA-REE**
2:00-3:00 PM	Steering Committee Meeting with Facilitators	

Purpose and Expected Outcomes

USDA-REE Agricultural Water Security Listening Session,
September 9-10, 2004, Yarrow Inn, Park City, Utah

Purpose:
To determine the relevance of USDA's research, education/extension, and economic efforts involving water supply, allocation, and distribution issues — Agricultural Water Security — and

To develop a basis for expanded USDA research, education/extension, and economic programs in Agricultural Water Security that take full advantage of partnerships with other Federal and State agencies.

Expected Outcomes
By the end of the workshop, participants will have:

- ✔ Assessed the current capabilities of the USDA-REE agencies (ARS, CSREES, ERS, and NASS) to address research, education/extension, and economic needs;
- ✔ Determined the USDA program needs that might be fulfilled by a coordinated USDA effort of research, education/extension, and economics for Agricultural Water Security ;
- ✔ Determined the gaps in existing knowledge for agricultural research, education/extension, and economic efforts;
- ✔ Identified strategies and opportunities that will advance USDA research, education/extension, and economic efforts and provide products and solutions to USDA customers, stakeholders, and partners; and
- ✔ Identified commonalities among the topical themes and described some of the necessary steps to move USDA towards national programming in Agricultural Water Security.

APPENDIX E

Conference Participants

Keith Admire
US Army Corps of Engineers

Randy Allen
Texas Tech University

Rick Allen
University of Idaho

Mark T. Anderson
US Geological Survey

Sharon Benes
California State University, Fresno

Norman Bennett
USDA/Maryland Agricultural Statistics Service

Julie Boardman
Alchemy Consulting LLC

Stephen P. Bowles
WAIMEA Water Services, Inc.

David D. Breshears
University of Arizona

Garry Brown
SWVA

Karla A. Brown
Colorado Foundation for Water Education

Rodney J. Brown
USDA Research Education & Economics

Dale A. Bucks
USDA Agricultural Research Service

John J. Burke
USDA Agricultural Research Service

Bonnie S. Carrig
USDA Rural Development

Margriet Caswell
USDA Economic Research Service

Nancy Cavallaro
USDA Cooperative State Research Education & Extension Service

Donna R. Ching
University of Hawaii

Bert Clemmens
USDA Agricultural Research Service

Steve Connelly
USDA Farm Service Agency

Bill Cook
Executive Director for Ogden City Council

Gary Cunningham
USDA Cooperative State Research Education & Extension Service

John Cushman
University of Nevada, Reno

Tim Darden
New Mexico Department of Agriculture

Allen R. Dedrick
USDA Agricultural Research Service

Sam O. Dennis
Tennessee State University

James P. Dobrowolski
Washington State University, Pullman

Patti A. Dobrowolski
Alchemy Consulting LLC

Virgil Dupuis
Salish Kootenai College

Lisa F. Duriancik
USDA Cooperative State Research Education & Extension Service

Robert G. Evans
USDA Agricultural Research Service

Leonard Fleckenstein
US Environmental Protection Agency

Michael R. Gabaldon
USDI Bureau of Reclamation

Jurgen Garbrecht
USDA Agricultural Research Service

Cassel S. Gardner,
Florida A&M University

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Jennifer Gimbel
USDI Bureau of Reclamation

Shane Green
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Catherine M. Grieve
USDA Agricultural Research Service

L. Earl Griffin
USDA Agricultural Research Service

Gary Grinnell
Las Vegas Valley Water District

APPENDIX E

Conference Participants

George Hallberg
The Cadmus Group, Inc.

William K. Hallman
Rutgers University

Ronald Hardy
University of Idaho

H. Michael Harrington
Western Association of Agricultural Experiment Station Directors

Karen Henry
Wyoming Farm Bureau Federation

Kyle D. Hoagland
University of Nebraska, Lincoln

Gerrit Hoogenboom
University of Georgia, Griffin

Carol C. House
National Agricultural Statistics Service

Ray Huffaker
Washington State University, Pullman

Fen C. Hunt
USDA Cooperative State Research Education & Extension Service

Yvonne Y. Izu
State of Hawaii Commission on Water Resource Management

Earl K. Jackson
Utah State University Extension

Andy Keller
Keller-Bliesner Engineering, LLC

Michael P. Kenna
United States Golf Association

Rick Kestle
USDA National Agricultural Statistics Service

Charles Krauter
California State University, Fresno

Dan Kugler
USDA Cooperative State Research Education & Extension Service

Sheryl Kunickis
USDA Natural Resources Conservation Service

Freddie R. Lamm
Kansas State University

Sue Martin
Communication Strategies

Molly A. Maupin
US Geological Survey

Gail McClean
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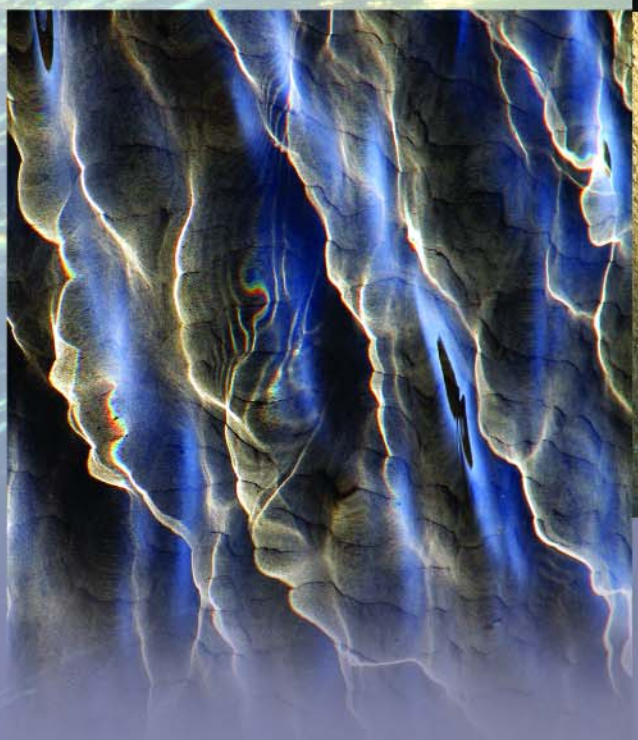

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