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IRRIGATION WATER
NOT FOR DRINKING
AGUA PARA RIEGO
NO PARA TOMAR

SECTION 2: Background

Agricultural Water Security

In our nation's drier climates and drought-stricken regions, agricultural water users face tremendous pressure to make available additional water sources for municipal and domestic consumption. USDA is attempting to resolve how and where this "new" water will emerge.

USDA began the search in 2004 by hosting the Agricultural Water Security Listening Session in Park City, UT. This listening session brought together nearly 100 top research, education, and extension professionals with engineers, water managers, and water providers to address how USDA Research, Education, and Economics (REE) programs could help resolve this critical problem. The final report from the Listening Session (Dobrowolski and O'Neill 2005) provided a definition for Agricultural Water Security:

Maximizing the efficiency of water use in agriculture and associated communities to continue or expand the supply of water for domestic water consumption, ecosystem services, energy production, recreation, and aesthetics.

In 2005, REE proposed creating a comprehensive program for Agricultural Water Security that addresses six key themes from the listening session:

- biotechnology;
- irrigation efficiency;
- drought mitigation and preparedness;
- economics and marketing;
- general water conservation; and
- wastewater reuse for agricultural, rural, and urbanizing communities.

These six key themes form the foundation for REE's future program planning on Agricultural Water Security.

Water Issues in Agriculture

Water is critical to maintaining human health and well-being; protecting and sustaining sensitive ecosystems; producing food, fiber, and energy into the future; enhancing recreation and aesthetics; and providing for the long-term security of people and nations.

Providing enough water to meet human demands across the nation is challenging water policy makers—due primarily to water being viewed as a human entitlement, delivered below cost, and used inefficiently (O'Neill and Dobrowolski 2005). Of the 147 countries ranked for water efficiency by the World Water Council, the United States ranked last, where inefficiencies at times reach 50 percent (NCSE 2004). Furthermore, population growth is expanding the demand for water; globally, farmers are irrigating five times more land than at the beginning of the 20th century to feed this growing population. Overall, withdrawals for agriculture doubled and domestic and industrial uses quadrupled between 1950 and 1995 (Postel 1997).

In the United States, population growth and changing values have increased demands on water supplies and watersheds, resulting in water use and management conflicts, particularly in the Western states where populations are expected to increase 30 percent in the next 25 years. Irrigation is the largest *consumer* of fresh water in the United States, with 42 percent lost due to evaporation, etc. Thermoelectric power generation removes the largest proportion of fresh water (52 percent) but much of that water returns to water bodies.

Across the country, agricultural needs often are viewed as being in direct conflict with urban needs and with demands to sustain or improve ecosystem services, recreation, and tourism. Water issues being debated across the nation include enhancing supplies with new storage facilities, expanding existing infrastructure, funding for water reclamation and reuse, and lowering water consumption. As a result, a growing number of communities are seeking federal assistance, actions, and permits related to water supply augmentation through desalination, reservoir expansions, or redirection of operations and water reuse projects—all with program elements that inexorably link to agriculture and USDA (Cody and Hughes 2007).

Much of the potable water that humans use in sinks, toilets, washing appliances, and industrial applications enters the wastewater stream. After treatment, it is discharged to lakes, oceans, and rivers. When this wastewater is intensively treated, it can be returned to the source communities as reclaimed water to irrigate agriculture. Non-potable reclaimed water can offset and preserve potable water supplies for other potentially higher-order uses. For years, wastewater discharges were accepted as a means to maintain minimum in-stream flows. Treatment technology investment required to meet stringent discharge limits resulted in more communities and businesses that targeted other uses for treated wastewater as a means for partial cost recovery. As competition for water supplies intensify, the use and acceptance of reclaimed wastewa-

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Water Issues in Agriculture (cont'd)

ter for landscape and agricultural irrigation also will increase, leading to a need for dual water systems that are integrated fully into community and rural water supplies (EPA and USAID 2004).

The widening gap between supply and demand is often made up with marginal resources, especially reclaimed municipal wastewater, which is becoming an increasingly important source of water for agricultural in water-short countries like Israel (25 percent of the total agricultural water in 2000, and projected to be 37 percent in 2010, and 46 percent in 2020). The land area in Israel irrigated with treated wastewater is rising continuously—5,100 hectares (ha) in 1975, 16,300 ha in 1985, and 36,300 ha in 1994. Currently, about one-third of the wastewater from the metropolitan Tel Aviv area is treated at a tertiary level, and about 50 percent as secondary or near-secondary treatment. Many advantages arise from the use of wastewater in agriculture, including

- treated wastewater can serve in the long run as a key component to agriculture and might provide for continuity of domestic U.S. agriculture;
- the supply of wastewater is highly reliable relative to quantity (not necessarily with respect to quality) and increases with population growth;
- the cost of treating secondary wastewater is generally low in relation to the cost of fresh water from unconventional water sources (e.g., desalination); and
- the option of allocating wastewater to irrigation is the best and cheapest option for wastewater disposal, from the viewpoint of environmental conservation; accordingly, it can be the preferred disposal alternative for municipalities.

Secondary wastewater contains nutrients such as nitrogen, phosphorus, and potassium, which may save on the use of chemical fertilizers. However, this advantage is conditional on proper quantities and timing of water and nutrients, since bad timing or providing these nutrients in excess may negatively affect yields.

Utilizing reclaimed water reduces or eliminates the demand for potable water, economic consequences during drought, and the need for additional potable water sources and infrastructure; helps maintain freshwater in-stream flows to support ecosystems services; and contributes to a healthy and green environment. California agriculture began using reclaimed water in the 1800s. California established regulations governing the level of treatment, contact with, and use of recycled water. These stringent codes, which require the highest treatment for human contact and parallel pipe infrastructure, help to ensure public and environmental safety.

Currently, four states include water reuse in their official water policies: California (calling it "recycled water"), Florida, Hawaii, and Washington. This report seeks to identify key opportunities and challenges associated with the use of recycled water in agriculture. We hope to build upon the lessons learned from states where recycled water is used in agriculture and we expect to develop and expand the knowledge base to ensure safe, appropriate application of recycled water in agriculture.

USDA's Current Outlook

Merle Pierson, USDA Deputy Under Secretary for Research, Education, and Economics, highlighted actions for USDA in Agricultural Water Security. He stressed informing and engaging the public and stakeholders in the decision-making process regarding water reuse in agriculture.

We should explore opportunities to match available water quality with appropriate water uses; what water is best for which crops in what place? We need to better understand motivations that inhibit public acceptance of water reuse—always employing the best available science to improve decisionmaking and change behaviors.

At the same time, we should engage stakeholders from multiple communities to seek water management solutions and to make appropriate decisions regarding water reuse. Land-grant institutions and other colleges and universities have developed strong academic programs to address food safety and water quality issues. Today and into the future, the next generation of science and education professionals will need to work on complex issues at the interface between food safety and water quality. Educators also must bring new water management and food safety technologies into the classroom so that students are better prepared to address these topics when they enter the workforce.

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USDA's focus is proactive. We look to the experts in the scientific, economic, sociology, and policy communities to develop tools that will help solve today's and tomorrow's water reuse problems, supported by peer-reviewed scientific research and science-based education and outreach. USDA is committed to being part of the solution. We recognize that the nation's need to produce the necessary food, fiber, and energy must equal its commitment to protect precious water resources. We are committed to expanding the science base to inform policies. That same commitment will also lead us to better tools and technologies to inform decisionmaking at the individual, community, and national levels.

Potential research, education, and outreach in water reuse technology development that REE might attempt

- study the additional costs to farmers who intend to transition to irrigation with recycled water.
- study the elements that comprise approaches to recycled water pricing for use in irrigation (e.g., conveyance, treatment).
- determine whether social benefits exceed the social cost.
- identify what the recycled water volume contains—concentrations of chemicals, which may be hazardous to agricultural yields and to conservation of soils.
- provide a science basis for regulations (health and food safety) with respect to recycled water use for agriculture.
- programs and projects that focus on two principal methods for reducing drainage salinity problems: 1) reducing the amount of irrigation water applied to crops; and 2) reusing the applied water on subsequent, more salt-tolerant crops.

Michael O'Neill, CSREES national program leader in the Natural Resources and Environment unit, focused on specific water-related program areas in CSREES that would support efforts to expand water reuse efforts.

The National Research Initiative (NRI) Water and Watersheds Program focus concerns the development of new knowledge related to water quality impairments and water supply/scarcity concerns. CSREES' National Integrated Water Quality Program (NIWQP) has its focus on creating and disseminating knowledge needed to resolve stakeholder- (farmers, ranchers, homeowners) identified water resource issues. Together the CSREES Water Program identifies major water resource issues, then defines and focuses projects to address those critical and time-sensitive issues. The program provides funding for these projects at the watershed scale for 3–4 years to build a "cohort" of projects around an issue, develops a synthesis of knowledge gained, and identifies the remaining challenges.

As a result of the 2005 Agricultural Water Security Listening Session (Dobrowolski and O'Neill 2005) and subsequent Agricultural Water Security White Paper (O'Neill and Dobrowolski 2005), CSREES chose to build-out three research, education, and extension themes. These three themes (biotechnology, conservation, and water reuse) fit within the research and education challenges (water availability, quantity and quality, water use, and water institutions) described by the National Research Council (2001, 2004) and supported by the U.S. government (OSTP 2004). CSREES' expectations for this conference were the development of new partnerships and opportunities to learn from water reuse professionals,

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USDA Agency Roles (cont'd)

CSREES WILL DOCUMENT IMPACTS AND OUTCOMES BY CHANGES IN ENVIRONMENTAL WATER USE EFFICIENCY, EXPANDED WATER AVAILABILITY, AND HEALTHIER AQUATIC AND ESTUARINE ECOSYSTEMS.

and to identify the need for new technologies linked to the use of recycled water and novel efforts towards water conservation.

CSREES seeks to improve coordination among existing water reuse efforts across USDA and with new partners. Potential federal partners include ARS, the Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and U.S. Food and Drug Administration. Non-federal partners should include the WateReuse Association, land-grant colleges and universities, and other not-for-profit educational groups. Within the Water Program water reuse provides an opportunity to expand the portfolio in the NIWQP.

Evaluation and monitoring effectiveness are critical to maintaining current and seeking additional funding. CSREES will document impacts and outcomes by changes in environmental water use efficiency, expanded water availability, and healthier aquatic and estuarine ecosystems. Social outcomes will be assessed through public acceptance—adoption of existing and new technologies; behavior change through improved knowledge, attitudes, and behavior relative to water use; conservation; and water reuse. Measures of adoption of conservation and water reuse practices must be developed to record increases in the volume of recycled water delivered to the household and farm level; evaluate changes in the market share of raw water and treated water technologies; and the value of water "saved" through various conservation measures or use of treated water. Other indicators linked to outcomes should identify changes in community involvement toward water use and reuse decisions, changes in public policies towards water use and reuse, and data from national surveys of per capita water use, both from the National Agricultural Statistics Service and CSREES-supported evaluation studies.

Mark Weltz presented ARS' water program as focused on integrated, effective, and safe water resources management.

ARS conducts fundamental and applied research on the processes that control water availability and quality for the health and economic growth of the American people and develops new and improved technologies for managing the nation's agricultural water resources. Problem areas focus on water quality ($34.5 million), water quantity ($29.2 million), and watershed management. Agency scientists developed the P-Index. The adoption of this technology has reduced P loadings in water by an estimated 56 million pounds and sediment by 2.1 billion pounds annually with estimated economic benefits to society of more than $600 million per year. They also produced the SITES 2000 Water Resource Site Analysis Program. The Natural Resource Conservation Service (NRCS) and the U.S. Army Corps of Engineers (COE) also adopted this technology to evaluate the safety of the 11,000 aging earthen flood-control structures.

Existing water quality concerns that are the subjects for research include nitrates, phosphorus, pathogens, salinity, toxic trace elements, and emerging contaminants in water. Efforts are underway to develop technologies to reduce contaminant loading from surface runoff, reduce contaminant loading from drained croplands, and quantify and predict the individual farm and net cumulative water and soil quality benefits at the watershed scale from implementing conservation practices.

ARS programs address water quantity concerns such as drought, water availability and delivery, in-stream flow requirements, dam safety and flood prevention, irrigation efficiency, soil erosion, and stream corridor restoration by developing technology to conserve and effectively use water, nutrients, and energy. Scientists continue to develop technologies to safely reuse degraded water, safely recharge aquifers using recycled water and urban runoff, assess and mitigate the impact of drought on agricultural enterprises, accurately quantify and predict water supply and basin water budgets, and develop knowledge to understand ecosystem requirements and feedback mechanisms in agricultural landscapes.

ARS scientists developed wastewater treatment facilities with the capacity to reduce emissions and improve water quality (Fig. 1). Partnerships with federal and state agencies and universities leverage resources and increase agency impact through participation in interagency working groups, the National Research Council, National Science Foundation committees, and professional societies. These partnerships assist ARS with research efforts in water reuse, drought, sustainability of bioenergy production, and water quality credit trading.

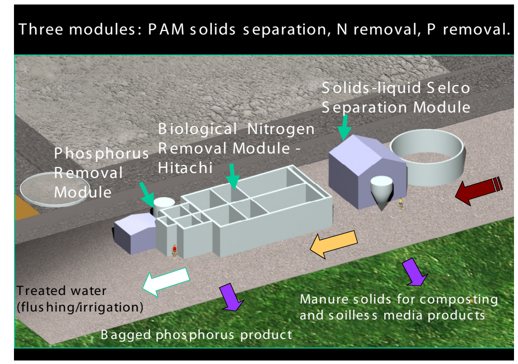

Fig. 1—ARS-designed wastewater treatment facilities with the capacity to reduce emissions and improve water quality.

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