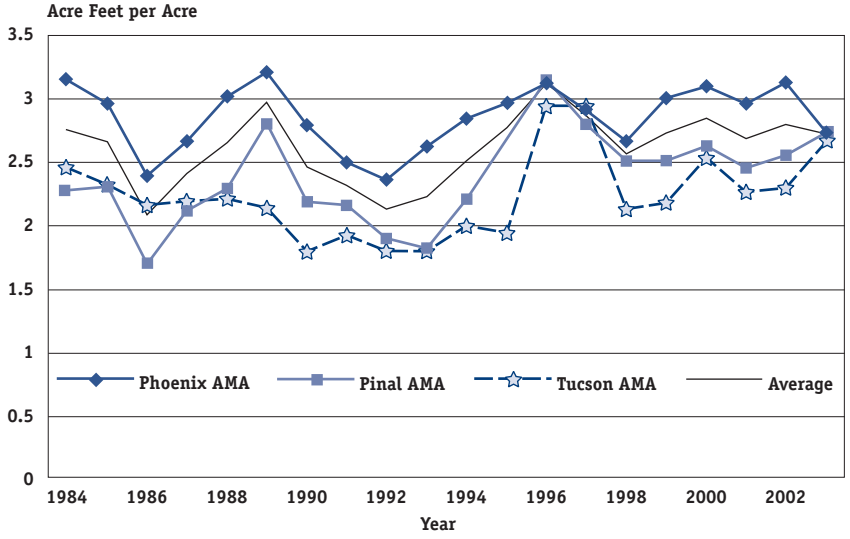

Source: Arizona Department of Water Resources

Fig. 4 Per Acre Water Use in Agriculture

did not create significant incentives for on-farm water conservation practices and technologies. While many growers have adopted water conservation practices and technologies over the past twenty-five years, factors other than the management plans have been largely responsible. The GMA changed the political environment, but the management plan provisions did little to change the economic incentives or water management decisions of most agricultural business managers. Many water experts interviewed for this study concluded that education (e.g., irrigation management) and economic incentives (e.g., tax credits, cost shares, prices) may be lower cost and more effective tools for achieving desired water conservation goals in the agricultural sector. AR

Final results from this study will be available in September 2005. Please contact Paul Wilson (pwilson@ag.arizona.edu) for a copy of the final results and for any other questions concerning this research project. This work is supported by the University of Arizona, Technology and Research Initiative Fund (TRIF), Water Sustainability Program.

Some Highlights from the 2003 Farm and Ranch Irrigation Survey

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Results of the 2003 Farm and Ranch Irrigation Survey (FRIS) were first made public in November 2004. The 2003 FRIS is the sixth survey devoted entirely to the collection of on-farm irrigation data for the United States. The 2003 FRIS—a follow-on survey to the 2002 Census of Agriculture—provides an extensive and comprehensive picture of irrigation practices and water use at the national and state level. Here we present just a sample of the types of information for Arizona available online from the survey.

Background

The United States Constitution requires that a census of population be conducted every 10 years. In 1840, the census began collecting more detailed information about agriculture. Irrigation data have been collected from farms and ranches in the census of agriculture since 1890. The 2003 survey is the most recent, but surveys from 1998 and 1994 are also available online.

Changes in Irrigated Acres

Acres receiving irrigation applications in Arizona fell over 4 percent between the 1998 and 2003 surveys. Figure 1 shows changes in irrigated acres for selected crops in the state. Grains, cotton, and orchards and nuts experienced the greatest declines in acreage, while vegetables, alfalfa, other hay, and corn silage had gains in acreage. The 1996 farm bill increased planting flexibility, allowing growers to substitute between field crops without being penalized with lower commodity program payments. The growth in Arizona's dairy industry has contributed to the growth in alfalfa, hay, and corn silage production in the state. Between 1998 and 2003, Arizona dairy herds increased by 18 percent and milk production increased 35 percent.

Applications and Application Rates

In 2003, 836,587 acres in Arizona were irrigated with applications of 3.75 million acre feet of water. An acre foot is the amount of water needed to cover an acre, one foot deep in water. One acre foot equals 325,851 gallons and 1 million gallons equals 3.07 acre feet. Applications are respondents' estimates of water applied to crops and do not measure total water withdrawn from surface and groundwater sources. By way of comparison, the U.S. Geological Survey estimates that 6 million acre feet were withdrawn for irrigation in 2000. Applications also do not measure conveyance losses, return flows of irrigation water back to aquifers and water bodies, or consumptive use—the amount of withdrawn water lost to evaporation, plant transpiration, and incorporated into products or crops.

That said, approximately 4.5 acre feet were applied per acre on Arizona's irrigated crops and pastures in 2003. Application rates (acre feet per acre or AF/acre) vary substantially by crop and year. Figure 2 compares application rates for selected Arizona crops for 1998 and 2003, the two most recent FRIS years. Rates vary from 2.5 AF/acre for barley in 1998 to 5.8 AF/acre for alfalfa in 2003.

Application rates also vary greatly by irrigation technology. Sprinkler and drip systems can apply water more efficiently than gravity systems. Gravity flow systems are the dominant irrigation systems in the state. With gravity systems, water is conveyed to the field using open ditches or pipe, and released along the upper end of the field through siphon tubes, ditch gates, or pipe valves. About 90 percent of Arizona's acreage was irrigated with gravity systems, while farms relying solely on gravity systems accounted for 68 percent of irrigated acreage. Farms relying solely on sprinkler irrigation applied an average of 3.4 AF/acre but accounted for only 8 percent of irrigated acres in the state. Farms relying solely on drip irrigation also applied 3.4 AF/acre on average, but accounted for less than 2 percent of irrigated acreage.

Water Use Varies by Farm

In 2003, 699 farms—25 percent of farms in the state—applied 500 or more acre feet of water each (figure 3). These farms applied 97 percent of Arizona's irrigation water. The remaining 75 percent of farms (2,078 in all) applying less than 500 acre feet accounted for 3 percent of all irrigation applications. Farms applying 2,000 acre feet or more accounted for 16 percent of farms, but 89 percent of irrigation water applied. Because farms vary so much in their contribution to overall water use, one must exercise care in measuring farm-level irrigation behavior. To get a clear picture of

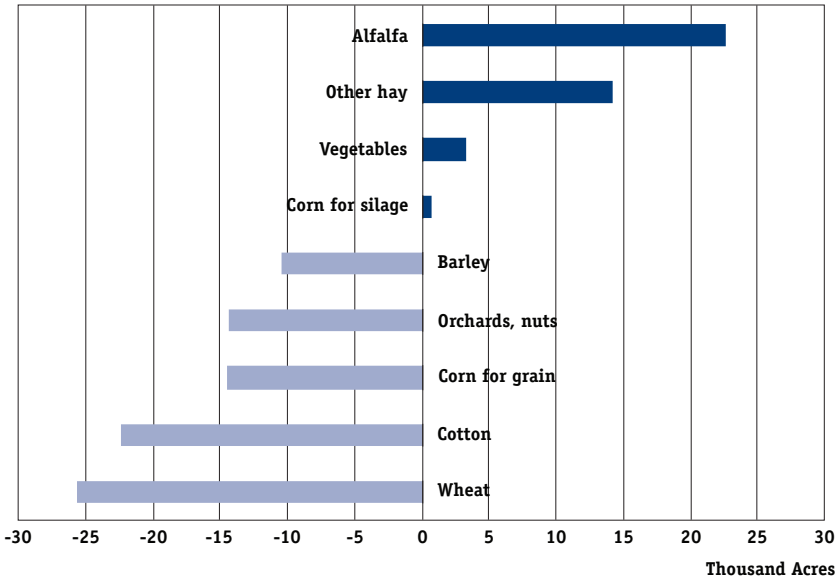

Fig. 1 Change in Harvested Acres for Selected Arizona Crops, 1998–2003

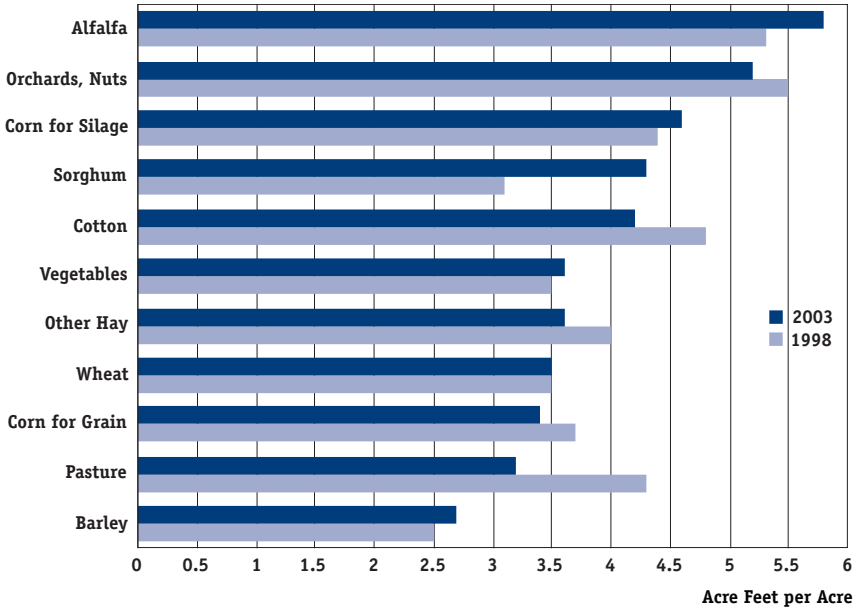

Fig. 2 Water Application Rates for Selected Arizona Crops, 1998 and 2003 (Acre Feet per Acre)

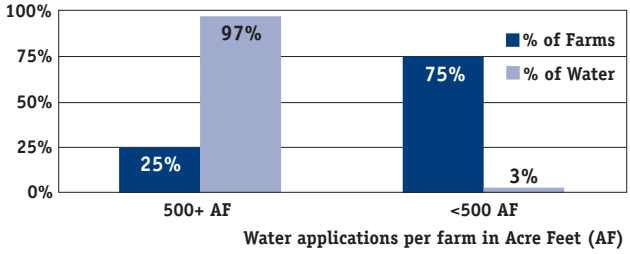

Fig. 3 One-Quarter of Farms Apply 97% of Arizona's Irrigation Water

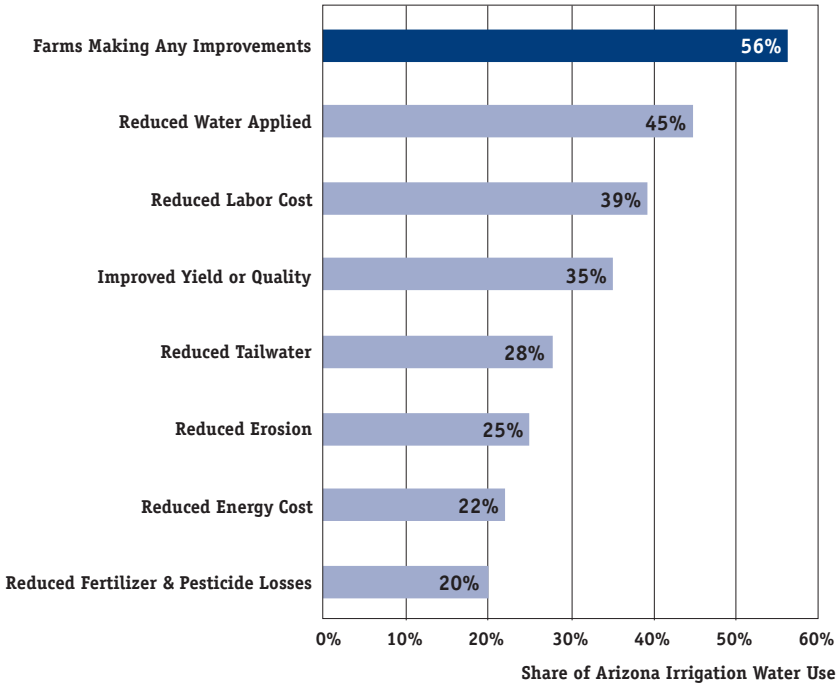

Fig. 4 Effects of Conservation Improvements in Previous Five Years (by Share of Arizona Irrigation Water Use)

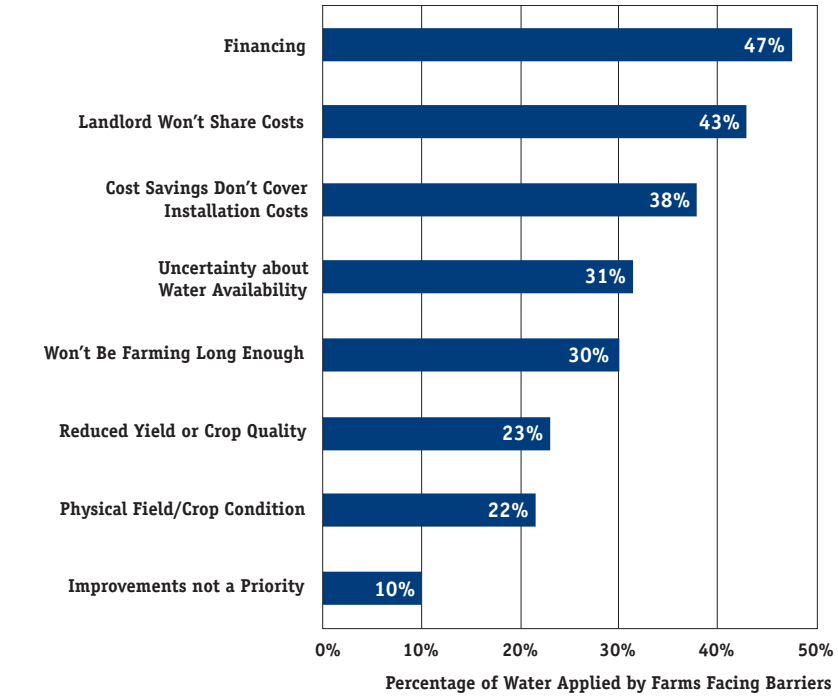

Fig. 5 Barriers to Making Improvements to Lower Energy Costs or Conserve Water (by Percentage of Water Applied by Farms Facing Barriers)

overall water management patterns, it is important to capture the importance of those farmers accounting for most of the irrigation. In the figures we report next, we weight responses by the amount of water applied or the number of acres irrigated.

Irrigation Investments

In 2003, Arizona farms invested over $21 million in irrigation equipment, facilities, land improvement, and computer technology. Of this, $11.2 million went to replace old equipment, $6.7 went to water conservation investments, and $3.2 million went to new expansions.

The survey asks farmers and ranchers if they have implemented any energy or water conservation improvements over the last five years. Figure 4 summarizes responses weighted by the amount of irrigation water farms applied. Respondents that accounted for 56 percent of water applied made conservation improvements in the last five years. Figure 4 also shows what respondents thought the effects of those improvements were. Respondents could choose more than one project and effect. Respondents accounting for 45 percent of water applied made improvements that reduced water applications. Other important effects were reduced labor costs (39%), energy costs (22%) and improved crop yield or quality (35%). The average cost of water purchased from off-farm sources was about $72 per acre (or $16/AF). Irrigation labor costs ran about $47 per acre, while energy pumping costs averaged $25/acre for surface water and $92/acre for groundwater. Investments were also made that improve environmental quality. These include investments to reduce soil erosion (25%), fertilizer and pesticide losses (20%) and tailwater, the runoff from the lower end of an irrigated field (28%).

Barriers to Conservation

Farmers were also asked about barriers to making improvements in conserving energy or water. In all, respondents accounting for 1.6 million acre feet applied—44 percent of the state total—reported facing some barrier to conservation improvements. This is up from 41 percent in the 1998 survey.

Figure 5 shows a breakdown by barrier for those farmers facing constraints. Again, percentages are weighted by water applied. Of farms facing barriers to conservation improvements, the most common barriers are financial. Farms accounting for 47 percent of water applied could not finance improvements. Other economic reasons given were that landlords would not share the cost of improvements (43%) and that reduced costs from conservation would not outweigh the

initial installation costs (38%). Few farmers thought investigating improvements were not a priority (10%), while others cited physical field constraints (22%) and concern about reduced crop yield or quality (23%).

Because irrigation investments require large up-front costs, growers must anticipate farming long enough to re-coup these initial outlays. Other barriers to adoption were uncertainty about future water availability (31%) and operators' belief that they will not be farming long enough to justify improvements (30%). Of 2,777 farms, 63 responded that they will not be farming long enough to justify improvements. These 63 operations applied 486,647 acre feet of water in 2003.

Information to Reduce Costs and Conserve Water

The FRIS survey also asked farmers what sources of information they relied upon to reduce irrigation costs or conserve water. Figure 6 provides a breakdown of responses weighted by irrigated acres. Farmers could rely on more than one source. The two most common sources were neighboring farmers (51%) and extension agents and university specialists (48%). Next in importance was staff of USDA's Natural Resources Conservation Service (NRCS) and other federal, state, or local agencies (33%). To a lesser extent, farmers relied on independent consultants, equipment dealers, and irrigation districts. Farmers accounting for 8 percent of irrigated acres relied on electronic (Internet-based) services.

The 2003 FRIS also presents more detailed data about irrigated acreage and application rates by crop, irrigation technology and management practice choice, well depth, and groundwater pumping (and other) costs. AR

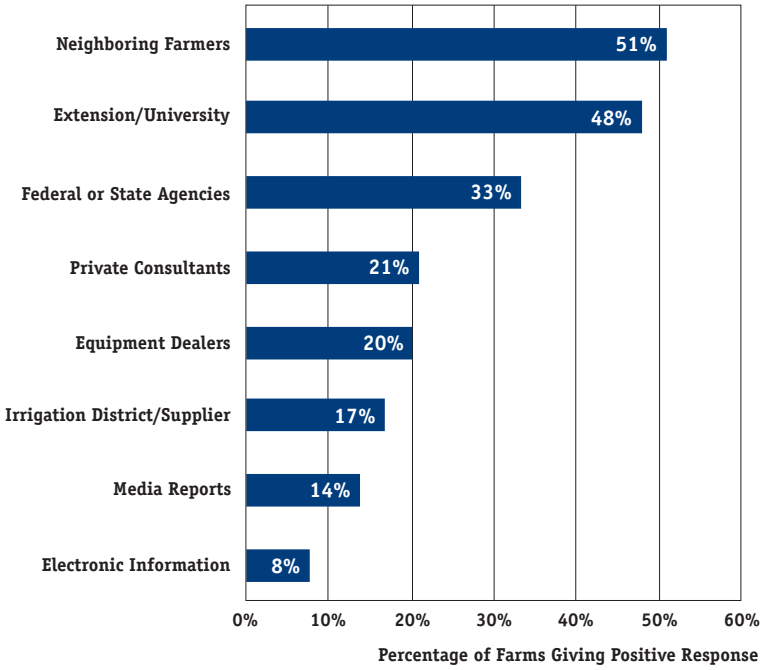

Fig. 6 Sources of Information Relied Upon to Reduce Irrigation Costs or Conserve Water

Online Data Sources

2003 Farm & Ranch Irrigation Survey, Census of Agriculture
www.nass.usda.gov/census/census02/fris/fris03.htm

Water Use in the United States: 50 Years of Water Use Information, 1950–2000
water.usgs.gov/watuse/

Support for this project was provided by the National Oceanic and Atmospheric Administration (NOAA) through the University of Arizona's Climate Assessment for the Southwest (CLIMAS) and was initiated while Dr. Frisvold was on sabbatical leave at the University of Arizona Water Resources Research Center.

A Note on the Cardon Endowment

I would like to begin a tradition of updating our readers on the Bartley P. Cardon Endowment for Agricultural and Resource Economics. The Cardon Endowment provides support for the research, teaching, and outreach work of the Department of Agricultural and Resource Economics and was established in 1997 to honor the recently deceased Bartley "Bart" P. Cardon, former professor and dean of the College of Agriculture and Life Sciences.

Cardon Endowment funds are used to support research in agricultural and resource economics by providing resources directly for research, by providing assistantships and scholarships to undergraduates and graduate students, and by bringing national and international scholars to visit the University of Arizona. Much of the research supported by the Cardon Endowment can be accessed from the Cardon Research Papers in Agricultural and Resource Economics, an online repository for scholarly research. The Endowment also supports academic outreach through this newsletter, the *Arizona Review,* a biannual publication providing economic perspectives on Arizona's agriculture and natural resources; the Arizona Agribusiness Forum (just completing its 20th year); and many other activities and publications.

During the past year the Endowment has supported a wide variety of students, scholars, and projects. Student support includes Ph.D. students Carmen Carrion-Flores, Haimanti

Continued on page 24.