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"The Third Way"[1]: Accommodating Agriculture and Urban Growth

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Summary

Arizona faces growing strains on its limited water supply as urban growth competes for land and water resources against agricultural uses. Often this issue is posed as one prevailing over the other, but, in fact, there is a "third way." We can actually improve crop yields by using less water, and by reviewing crop choices can also improve economic gains.

Allowing and encouraging agriculture in central Arizona to transition to higher value urban uses seems a foregone conclusion, given the projected population growth and relative value of agriculture to the state's economy. It may not be, however, the right policy choice. Building on arable acres removes that land permanently from producing food and fiber at a time when increased production worldwide is a necessity. Maintaining Arizona agriculture at some robust level should be a priority for all of us. Arizona agriculture can supply food needs as well as contribute to solving a global food crisis. It provides open space and for Yuma and Pinal counties especially, the main source of economic activity. Farms can provide a flexible buffer for water supplies during times of serious drought. To do this, while continuing to grow amidst a changing climate, requires that we all become more efficient in the way we use water, including and especially, agricultural water use. It is in our interest to construct a state agricultural water policy based on smarter urban growth, more efficient water use, and a commitment to agriculture that reflects local and global markets while operating in an arid landscape.

[1] "The Third Way" is frequently used to describe a kind of centrist pragmatic politics. Here the term is used to suggest a middle way to think about agriculture and water policy. See Third Way (centrism) at www.en.wikipedia.org/wiki/Third_Way_(centrism).

"One need not look far to see troubled times ahead."

- *Grand Canyon Institute Report, "Arizona at the Crossroads"*

Water planning by established farmers is driven more by commodity prices than concern that water will be sufficient.

Policy changes that would assist farmers in investing in new technologies include property tax breaks for farmers who invest in water-saving irrigation systems and developing financing mechanisms through water districts whereby they invest in farmer's water-saving technology and in return get access to the water saved.

Introduction

The start of this year, 2012, heralded Arizona's 100th birthday and sparked some terrific conversations about past and future water policy in our state, spurred, in part, by three reports issued at the end of 2011, including the Grand Canyon Institute's (GCI) *Arizona at the Crossroads.* These reports suggested that Arizona's water resources will be stressed by the year 2035, and will most likely be insufficient to support all present uses if no changes are made. The University of Arizona's Water Resources Research Center annual conference held in January, "Urbanization, Uncertainty and Water: Planning for Arizona's Second Hundred Years," focused on the theme of Arizona's future water sufficiency, hosting panels of experts discussing a range of subjects, including water for food. The question of whether we would "run out" of water before our second centennial elicited an underlying theme that Arizona would need to "give up" its water intensive agricultural sector in support of growing urban needs. [2] It is not that Arizona is unique in having so much of its water dedicated to agriculture – growing food and fiber anywhere requires a large amount of water. The issue is how

[2] Karen L. Smith, *Arizona at the Crossroads: Water Scarcity or Water Sustainability?*, Grand Canyon Institute, September 7, 2011, www.grandcanyoninstitute.org; University of Arizona, Water Resources Research Center 2012 Conference, "Urbanization Uncertainty and Water: Planning for Arizona's Second Hundred Years," January 24, 2012, www.cals.arizona.edu/AZWATER. The other two water policy reports issued in 2011 include the Morrison Institute's *Watering the Sun Corridor*, August 2011, www.morrisoninstitute.asu.edu and the final report of the Water Resources Development Commission, October 2011, www.azwater.gov . More recently, Grady Gammage, Jr., a senior fellow at the Morrison Institute, wrote that matching up sustainable water supplies with a growing population of about 9 million in the tri-county area known as the Sun Corridor would require transfer of at least 500,000 acre-feet of water currently dedicated to agriculture, without further efficiencies. See "Let's Talk Water," April 2012, www.MorrisonInstitute.asu.edu .

an arid region growing drier by the day can afford to sustain such activity. Indeed, as the GCI report noted, "One need not look far to see troubled times ahead."[3]

Other recent water policy work conducted by graduate students and faculty within Arizona State University's School of Sustainability focused specifically on Arizona agriculture and water demand, as agriculture here, as elsewhere around the country and world, currently consumes about 70 percent of the available water resources.[4] A Decision Center for a Desert City Water/Climate briefing in December 2011 showcased an agricultural perspective on water use and the future, highlighting among other issues the temporal disconnect in the planning time horizon for water use that exists between established farmers (1-5 years) and new urban development that must comply with the Assured Water Supply program within the Active Management Areas or AMAs (100 years). [5] The shorter time perspective for water planning by established farmers, the panelists acknowledged, is driven more by commodity prices than concern that water will be sufficient or available; it underscores the significance of short-term profit maximization to behavior. The focus of the cotton grower, for example, is on whether there is sufficient water available for the next few months, for that crop in the ground to mature. The number of acres planted and irrigated in any given year is driven by expected prices for that year's harvest. Affordable water availability for the grower is a necessary, but not the only significant input, into the decision to farm; the cost of water pales in comparison to other production expenses in the farmer's calculus. For example, an average farm of 500-999 acres had annual production expenses averaging nearly $71,457 for gasoline, fuels and oils, but paid $48,593 for farm utilities, which includes electricity (including any power for groundwater pumping), telephone charges, internet fees and water purchased in 2007 for irrigation purposes, livestock watering, etc. [6] This is not to suggest that farming as an economic activity

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[3] Smith, *Arizona at the Crossroads*, p.3.

[4] Arizona Department of Water Resources, *Arizona Water Atlas, Volume 1*, 2010, pp.61-63, www.azwater.gov. The annual volume of water pumped and diverted during the period 2001-2005, the most recent period for which there is complete information, was approximately 7.65 million acre-feet, and the amount used for agricultural purposes during the same period was about 5.6 million acre-feet. The agricultural sector within the United States and worldwide consumes between 70 percent-80 percent of available water supplies. See United Nations, Food and Agriculture Organization, *The State of the World's Land and Water Resources for Food and Agriculture: Managing Systems at Risk,"* Rome, 2011, p.9, www.fao.org/nr/solaw/en/ .

[5] Arizona State University, Decision Center for a Desert City Water/Climate Briefing, "Cotton, Condos and Climate: Agriculture and Arizona's Water Future," December 6, 2011. Panelists included Paco Ollerton, Pinal County cotton grower, Jim Holway, Sonoran Institute, Brian Betcher, Maricopa-Stanfield Irrigation District, and Joe Sigg, Arizona Farm Bureau. The Arizona Department of Water Resources regulates the Active Management Areas or critical groundwater management areas outlined in the seminal Groundwater Management Act of 1980. The Assured Water Supply Program within the AMAs requires new development to demonstrate a 100 year water supply before a plat can be recorded and lots sold. No such assurance of water supply is required for any other economic sector.

[6] United States Department of Agriculture, National Agricultural Statistics Service, 2007 Census of Agriculture, Arizona State and County Data, Table 58, "Summary by Size of Farm: Production Expenses," updated December

lacks sophisticated investment calculation as part of farm planning; large acreage farms are multi-million dollar investments. For established farmers within irrigation districts, however, concern for adequate and inexpensive water supplies is not at the forefront.

In contrast to a one-five year farm plan, new urban development occurs over a period of several years and must provide evidence of sufficient sustainable water resources for that growth for 100 years before the first shovel of dirt can be turned. Water availability therefore becomes a key initial ingredient to a development's financial viability, making the value of that water very high. More than one of the panelists mused over the future of Arizona agriculture in an era of growing economic and climate uncertainty, and the press of urbanization, wondering whether farming would be viable by 2030, when urban water resource availability is predicted to fall short of demand requiring a water transfer from agriculture. If anything, the panel's thinking provided indirect affirmation of the policy direction concerning water and agriculture the state has taken since 1980, using growth pressures (land use restrictions) and regulatory constraints (water allocations) to shift water use from agriculture to urban growth.

Does it matter that Arizona agriculture goes away or is sharply diminished to free up water supplies for growth? Economic sectors that support urban life are the main economic drivers within Arizona, but there is also an important and increasing global role for production agriculture to provide the needed food for a burgeoning population. Additionally, the growing demand for locally produced food and the community desire for open space within and near urban areas question the proposition that our choice must be either a world with agriculture or one without it. There is a "third way" of looking at the water for people or water for food choice, one where all users are more efficient in how water is used and stretch available supplies to support production agriculture and accommodate urban expansion. The conversation about water, growth and agriculture in central Arizona needs to shift in a direction where agriculture and growth can co-exist.

How Does Arizona Farm?

The total value of Arizona's agricultural sector production in 2010 was estimated at just under $4 billion, a small part of Arizona's nearly $254 billion state economy.[7] A relatively small

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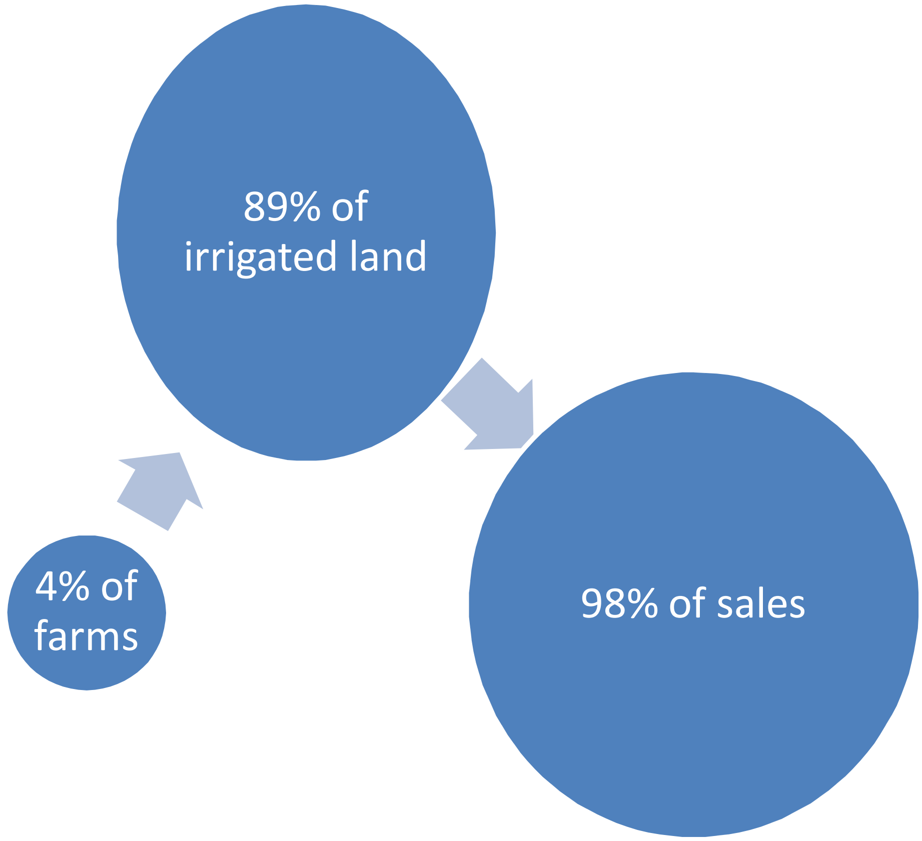
2009, www.nass.usda.gov , hereafter Census of Agriculture. The Census of Agriculture is conducted every five years, with the most recent containing data from 2007. The Census for 2012 will be available in 2013.

[7] United States Department of Agriculture, National Agricultural Statistics Service, Arizona Field Office, 2010 Annual Statistics Bulletin, www.nass.usda.gov/Statistics_by_State/Arizona/Publications/Bulletin/10bul/main.html The value of agricultural sector production is the gross value of the commodities and services produced within a year and does not include any multiplier effect. Arizona ranks second nationally behind California in production of lettuce, cauliflower, broccoli, spinach, cantaloupes, and honeydew melons, and third behind California and Florida



number of Arizona farms (about 650) generate both the products and revenue the agricultural market provides; while small in number, they are large in size, with 89 percent of all irrigated acreage in farms greater than 500 acres, and nearly 60 percent of that in farms larger than 2,000 acres.[9] They account for nearly 98 percent of all agricultural sales. The total number of farms in Arizona has held fairly steady over recent years at about 15,500, but only slightly more than 5,000 or 32 percent are irrigated; the remainder is dry-farmed. Over 80 percent of Arizona farms are small farms at 49 acres or less and of those, nearly 65 percent are 10 acres or less.[10]

The most recent agricultural census (2007) incorporates statistics for American Indian agriculture within the overall agricultural census results, so irrigated acreage for tribal enterprises is captured within the numbers for Arizona irrigated acreage. This helps inform the relative significance of tribal agriculture to the Arizona agricultural context, and the use of tribal

in production of principal vegetables. See also United States Bureau of Economic Analysis, Gross Domestic Product by State, www.bea.gov .

[9] Census of Agriculture, Table 10: Irrigation: 2007 and 2002. In 2007, 654 farms irrigated nearly 780,000 acres of land. The total irrigated acreage in Arizona that year was about 876,000. Steven Manheimer, *Arizona Agriculture by the Numbers*, www.azfb.org/featured-articles/arizona-agriculture-by-the-numbers.html. Accessed 14 May 2012.

[10] Census of Agriculture 2007, Table 10, "Irrigation: 2007 and 2002." The Census of Agriculture defines "irrigated land" as "all land watered by an artificial or controlled means, such as sprinklers, flooding, furrows or ditches, sub-irrigation and spreader dikes, including supplemental, partial or preplant irrigation." See Appendix B, p. B-14.

water for agricultural purposes within the overall water budget for the state. About 75 percent of Arizona's small farms (1 to 9 acres) are American Indian operated while 92 percent of all farms 500 acres or more are operated by whites.[11] These statistics don't capture trends resulting from the most significant water rights settlement to date, the Arizona Water Settlements Act (2004), which provided substantial amounts of water (more than 600,000 acre-feet) and federal funds to assist the Gila River Indian Community expand its agricultural operations, among other uses. Results of the 2012 Agricultural Census will provide more information relative to any shift within Arizona of the number of large farms and irrigated acreage operated by American Indians.

Within Arizona, the four counties with irrigated acreage over 100,000 acres are La Paz, Maricopa, Pinal, and Yuma, with Cochise (68,000 acres), Graham (28,000 acres) and Pima (36,000 acres) significantly behind.[12] Crops produced on these irrigated acres were mostly alfalfa and hay, cotton, wheat, vegetables and orchards; alfalfa and hay are high water consumptive use crops (5 or more acre-feet/acre), cotton and orchards are medium water consumptive use crops (3-5 acre-feet/acre) and vegetables and wheat are considered low water consumptive use crops (less than 3 acre-feet/acre). These three counties produced more than $2.5 billion in market value of agricultural products, with Yuma County focused on growing the most economically valued crop, vegetables.[13]

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[11] USDA, 2007 Census of Agriculture, 2007, Table 54, "Selected Farm Characteristics by Race of Principal Operator." The census includes separate categories for American Indian, Asian and Black or African-American; Hispanic operators are included within the White classification.

[12] While Cochise and Graham counties each have a large part of the county total acreage in farms, only a small part of that acreage is irrigated. For example, Cochise County has more than 824,000 acres in farms, but only 68,000 acres irrigated; Graham County has more than 1.3 million acres in farms, but only 28,000 acres irrigated. See Census of Agriculture, Table 1: County Summary Highlights: 2007.

[13] Ibid, Table 25 "Selected Crops Harvested" and Table 2, "Market Value of Agricultural Products Sold Including Direct Sales, 2007 and 2002;" USDA, NASS, Arizona Annual Crops, 2009-2011, February 22, 2012, shows the high value of all lettuce crops at nearly $830 million on 64,000 planted acres. Conversely, more than 280,000 acres were planted in alfalfa and other hay with a production value of $484 million. For consumptive use of these crops, see "Consumptive Use and Other Needs by Crop," Appendix 4A, Phoenix and Pinal AMAs Third Management Plan, www.azwater.gov . The consumptive use values are based on crops reported grown during the five year period 1975-1980 and provide the basis for the irrigation groundwater allotment granted to farmers in the Phoenix and Pinal AMAs under the Groundwater Management Act. The consumptive use values for crops grown in Yuma County are similar. For an excellent study on the value of water in agriculture, see Bonnie Colby, Elizabeth Schuster, Lana Jones, and Michael O'Donnell, *Understanding the Value of Water in Agriculture: Tools for Negotiating Water Transfers*, August 2011, http://ag.arizona.edu/arec/pubs/facultypubs/Value percent20of percent20Water percent20in percent20Agriculture percent20Colby percent202011.pdf, accessed 28 June 2012.

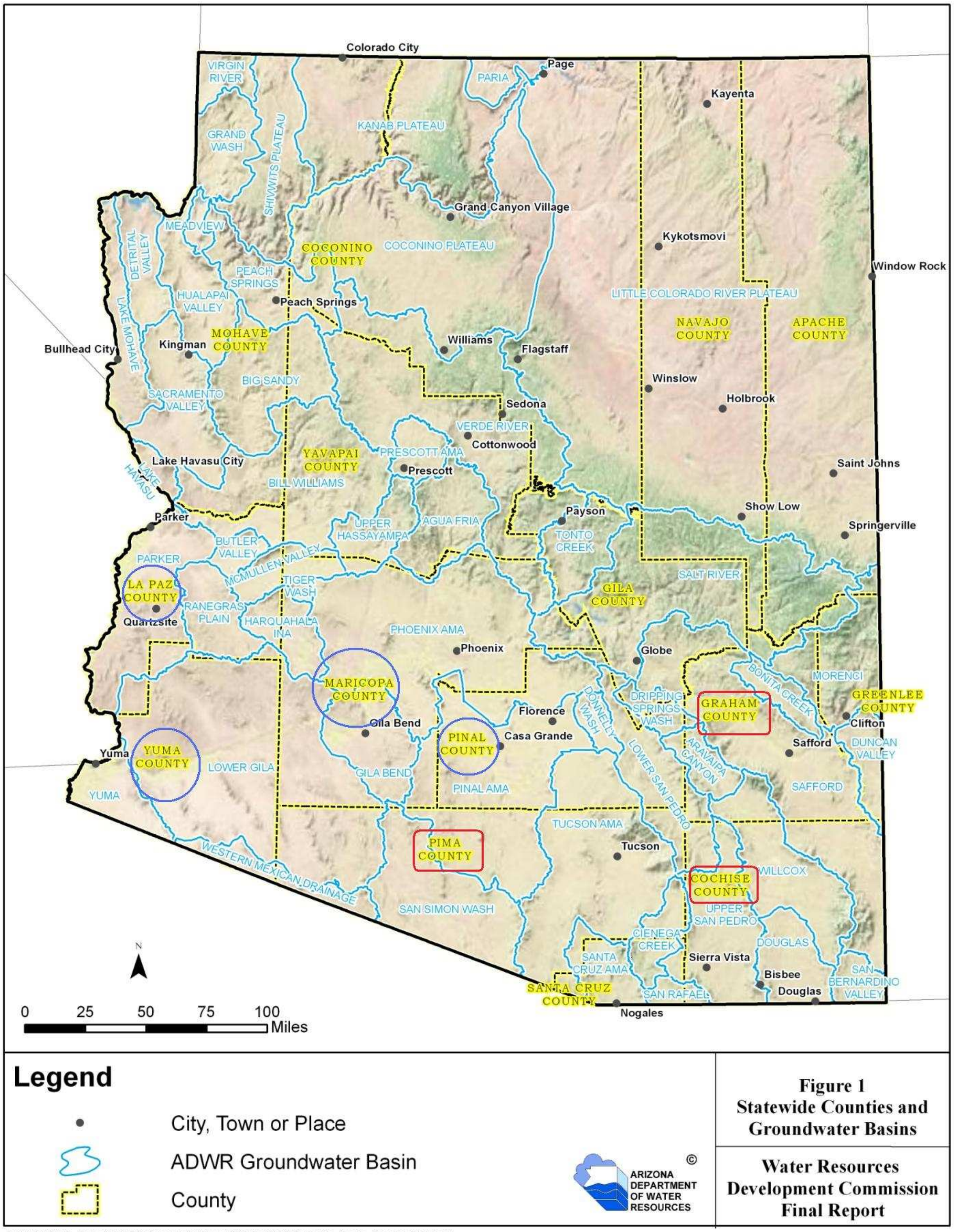

Figure 1
Statewide Counties and Groundwater Basins

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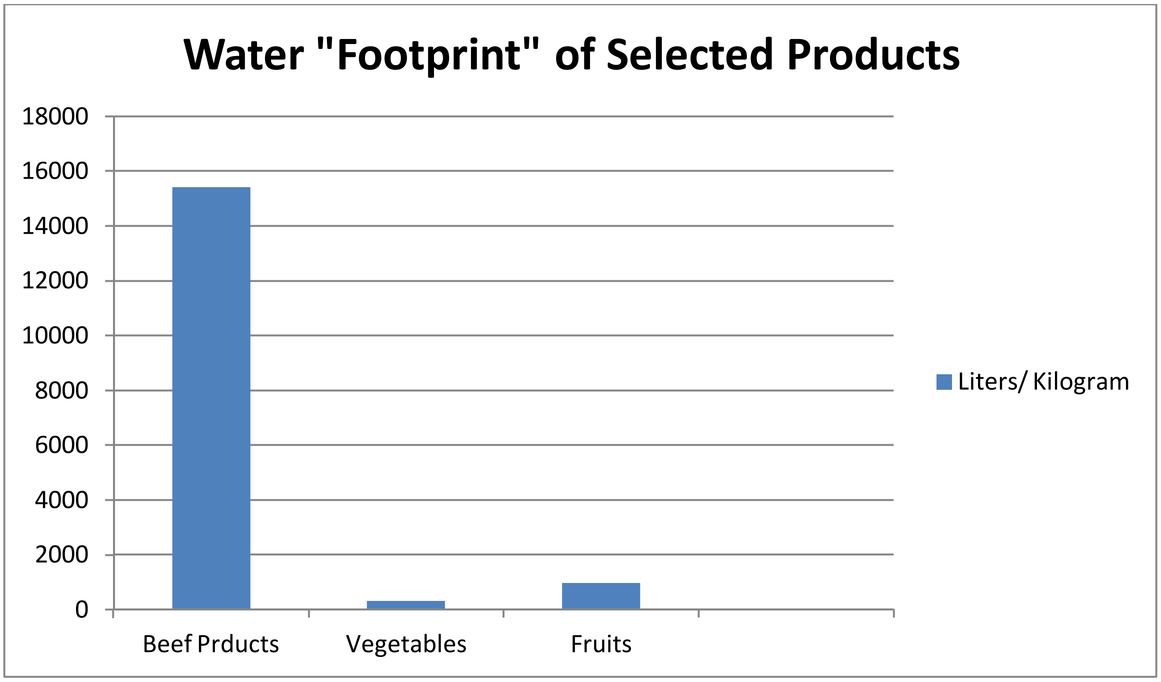

Livestock operations contributed more than one-third of the total value of Arizona's agricultural production in 2010 (about $1.4 billion out of $3.9 billion). While the census does not account for the amount of water consumed by cattle feeding operations and dairies, the Arizona Department of Water Resources considers these producers to be industrial facilities and assigns water allotments and efficiencies accordingly.[14] Maricopa and Pinal counties constitute only 14.5 percent of Arizona farms with livestock, poultry and their products yet contribute 74 percent of the state's market value of those products, including more than half (564,779) of the state's inventory of cattle and calves. In Pinal County, livestock operations alone contributed 71 percent of agricultural commodity sales for the county. [15] Conservatively, these animal production operations consume several thousand acre-feet of water annually. When combined with the need for high water consumptive use alfalfa and hay crops for livestock feed, the total water consumption picture for beef products is the highest of all food at 15,415 liters/kilogram. In contrast, the total water footprint of vegetables is 322 liters/kilogram and fruits 962 liter/kilogram.[16]

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[14] For cattle feedlots, the amount of water allowed is 30 gallons per animal per day, and for a dairy, 105 gallons/day for a lactating animal and 20 gallons/day for a non-lactating animal. Pinal AMA Third Management Plan, 2000-2012, Chapter 6-9, "Cattle Feedlot Operations," and Chapter 6-8, "Dairy Operations," www.azwater.gov . See also USDA, National Agricultural Statistics Service, Arizona Field Office, 2010 Annual Statistics Bulletin.

[15] Maricopa and Pinal counties combined had about 163,000 milk cows and 25,000 beef cows in 2007. Census of Agriculture, Table 1: "County Summary Highlights."

[16] Water Footprint Network, Animal Product Water Footprints, www.waterfootprint.org/?page=files/Animal-products Accessed 26 May 2012. This equates to about 4,078 gallons of water for every 2.2 pounds of meat. For

Other trends illuminated by the census include an increase in direct marketing activities from farm to consumer, either through direct sales to grocery stores or via farmer's markets, and in organic farming, although the economic value of those activities is small relative to traditional commodity agriculture. [17]

The census confirms what has long been held anecdotally: Maricopa, Pinal and Yuma counties have the most irrigated agriculture and animal production operations, produce the most value of the agricultural sector, use the most water consumed for those economic activities at about 5 million acre-feet , and simultaneously, face the greatest pressure on water resources from urbanization within Arizona. Based on the numbers alone, allowing and encouraging agriculture in central Arizona to transition to higher value urban uses seems a foregone conclusion. It may not be, however, the right policy choice.

Agriculture Water Policy

The authors of the state's seminal Groundwater Management Act of 1980(GMA) that created AMAs believed the transfer of water from farm to town was a necessary condition for successfully managing Arizona's future urban growth. By prohibiting any new agriculture within the AMAs and prescribing an allotment of groundwater for irrigation on defined acreage, an Irrigation Grandfathered Right (IGFR), based upon crops grown between 1975 and 1980, the GMA encouraged urbanization of farm land. The most rapid conversion has occurred within Maricopa County, which includes the Phoenix AMA where 130,000 acres of cropland have changed to urban uses since 1984. Urbanization has also occurred within the Pinal AMA, but at a slower pace, and total cropland acres in Pinal County actually increased slightly between 2002 and 2007.[18]

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vegetables, this equates to about 85 gallons for every 2.2 pounds of product and for fruits, 254 gallons for every 2.2 pounds.

[17] Census of Agriculture, Table 2, "Market Value of Agricultural Products Sold Including Direct Sales, 2007 and 2002;" Manheimer, *Arizona Agriculture by the Numbers*. In 2007, sales of agricultural commodities sold directly to consumers were $5.3 million and organic production was valued at about $48 million. It will be interesting to see how the market value numbers for direct use and organic products changes in the 2012 agricultural census as anecdotally, farmers markets in urban areas and the "Arizona Grown" marketing campaign appears to have increased in the past few years.

[18] Arizona Department of Water Resources, *Arizona Water Atlas. Volume 8,* 2010, p.79; Manheimer, "Arizona Agriculture by the Numbers." New acreage can be farmed outside the AMA boundaries within Pinal County. The total cropland acres within Pinal rose 1.5 percent between the 2002 and 2007 censuses even as the total number of irrigated acres declined slightly. This is possibly the result of some conversion of pastureland to crops.

> The products grown here in the Desert Southwest are chosen for market profitability; they have not needed to reflect the low water consumptive use characteristics typical for an arid region. … Water policy decision makers chose to regulate agricultural water use primarily through land use (that is, no new acreage for agriculture in AMAs), and not through "market" prices.

Even with changing land use trends, agriculture continues to consume large volumes of water in both AMAs; in 2001-2005, more than one million acre-feet in the Phoenix AMA and about 975,000 acre-feet in the Pinal AMA were used annually.[19] Historically, western water policy, including within Arizona, has been to subsidize the cost of water and electricity used for agriculture, and to a much lesser extent, the on-farm irrigation infrastructure. There has been no real incentive for agricultural producers to be efficient in their water use as surface water from the federal reclamation projects and the power generated at federal dams for groundwater pumping makes water inexpensive to obtain; this is also true for municipal uses. The products grown here in the Desert Southwest are chosen for market profitability; they have not needed to reflect the low water consumptive use characteristics typical for an arid region. To effect the water transfer from agriculture to growth, water policy decision makers chose to regulate agricultural water use primarily through land use (that is, no new acreage for agriculture in AMAs), and not through "market" prices for water and power.[20]

Outside the AMAs, groundwater use is not regulated by the state and is not managed as tightly. There are no limits based on agriculture's use of water. Within the Lower Colorado Region, which encompasses Yuma, Gila Bend and the Indian communities along the Colorado River, agriculture is the dominant economic sector and consumes 2.8 million acre-feet of water annually, nearly half of that from the Colorado River. Yuma County is the nation's

[19] *Arizona Water Atlas Volume 8,* p.63. These totals include water for Indian agriculture: 213,900 acre-feet in the Phoenix AMA and 141,400 acre-feet in the Pinal AMA.

[20] There is a plethora of works published on the water and power subsidies in the West, but two of the best include Donald Pisani, *Water and American Government: The Reclamation Bureau, National Water Policy and the West, 1902-1935,(*Berkeley, CA: University of California Press, 2002), and Norris Hundley, Jr., *Water and the West,* (Berkeley, CA: University of California Press, 1975). Farms pumping their own groundwater average costs of about $129/acre for electricity (water is free, but well infrastructure is not) and those obtaining water from off-farm suppliers like the USBR and other irrigation districts average costs of about $29/acre-foot; farmers pay additional per acre costs for irrigation district expenses. See Federal Ranch and Irrigation Survey 2008, Table 20: Energy Expenses for On-Farm Pumping of Irrigation Water and Table 22: Expenses for Irrigation Water for Off-Farm Suppliers.

winter vegetable capital, and its average annual agricultural sales top $1.3 billion.[21] Because of its primary use of Colorado River water, farm lands here are often seen as a logical water "buffer" for the metropolitan areas of Phoenix and Tucson; if severe drought causes deep cuts to Arizona's Colorado River allocation, the thinking has been that farmers here will be compensated appropriately to fallow land for short periods of time to free water supplies for water providers to support urban uses.[22]

Work recently reported by the United States Bureau of Reclamation's (USBR) Colorado River Basin Study group, which is examining future water supply and demand issues in the Basin, suggests that agricultural water demand in Arizona will drop substantially under all its projected scenarios, by as much as 400,000 acre-feet annually through a reduction in irrigated acreage as early as 2035. The principal driver for the reduced demand is urbanization, leading to a physical loss of irrigated acreage and pressure for the transfer of water.[23]

Acreage dedicated to agriculture has declined within Maricopa and Yuma counties since 2002 and in Maricopa County in particular, reflecting the change in value of farm land compared to the expanding urban footprint in that location; the USBR futures study suggests this trend will accelerate. For Yuma County, the decline in irrigated acreage results from a combination of factors, including increased urbanization, low crop prices and a perceived labor shortage.[24] Water resource planners are relying on the continuation of this process of shifting water from growing food to ensuring reliable water supplies for municipal and industrial purposes within the context of an ever changing and drier climate. These scenarios do not consider, however, urban growth taking place in smarter ways or significant increases in water use efficiency across all sectors. [25]

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[21] Ibid, *Arizona Water Atlas Volume 7,* pp.51-59.

[22] See Colby, et al, *Understanding the Value of Water in Agriculture*. This is an important "guidebook" to assist those who need to purchase water to value the water used in agriculture, a methodology called the Net Return to Water.

[23] United States Bureau of Reclamation, *Colorado River Basin Water Supply and Demand Study: Technical Memorandum C – Quantification of Water Demand Scenarios,* May 2012, p. C-24, www.usbr.gov/lc/region/programs/crbstudy/ttechupdates.html .accessed 18 May 2012.

[24] William J. Moody, "Yuma Area Agriculture," at http://www.asfmraaz.com/papers.html. Mr. Moody is an appraiser and provided this presentation in 2012 to the Arizona Chapter of the American Society of Farm Managers and Rural Appraisers.

[25] Smart growth discourages leap-frog growth onto desert or peri-urban agricultural lands, favoring denser development within existing urban boundaries where possible. This makes better use of infrastructure and in Arizona's case, water resources. Absent as well from much of this discussion and planning is the idea that we must also find water for environmental purposes. It needs to be included within the conversation, and hopefully work underway at the University of Arizona Water Resources Research Center will bring this issue to the table.

Arizona Agriculture and Global Food Security

> As the global population heads for more than nine billion people by 2050 (under medium growth projections), the world is rapidly becoming urbanized and wealthier. Food preferences are changing to reflect this, with declining trends in the consumption of staple carbohydrates, and an increase in demand for luxury products – milk, meat, fruits and vegetables – that are heavily reliant on irrigation in many parts of the world. The production efficiency of animal products is lower than for crops and so extra primary production from pastures, rangelands and arable farming is needed to meet food demands. Future global food demand is expected to increase by some 70 percent by2050, but will approximately double for developing countries. All other things being equal (that is a world without climate change), the amount of water withdrawn by irrigated agriculture will need to increase by 11 percent to match the demand for biomass production.[26] ---*Climate Change, Water and Food* Security

Increased food production globally is critically necessary to feed the 9 billion people expected to live on the planet by 2050 and to diminish the severe undernourishment of more than a billion people today who lack sufficient food. Recent reports indicate that the world's agricultural production will need to double by 2050 to keep up with the population demands; even with that, one person in twenty still risks being undernourished, equivalent to 370 million people. The world has yet to meet that rate of production. As the Food and Agriculture Organization of the United Nations recently stated, "For nutrition to improve and for food insecurity and undernourishment to recede, future agricultural production will have to rise faster than population growth. This will have to occur largely on existing agricultural land. Improvements will thus have to come from sustainable intensification that makes effective use of land and water resources as well as not causing them harm."[27]

Once valuable agricultural land transitions to urban growth, it typically can't return; its value for food production is permanently lost to roads and buildings. Moreover agricultural production must grow within the context of climate change and less freshwater available for its use, making a difficult challenge even more so. Improved agricultural efficiency and securing "more crop per drop" will be a necessity worldwide. "More and better food has got to be our mantra. . the world must try to meet rising demand without growing agriculture's environmental footprint, and we've got to grow more crops without using more gallons of water in this time of climate change," said Richard Morrison, member of a long-standing Arizona farming family. [28]

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[26] Hugh Turral, Jacob Burke and Jean-Marc Faures, *Climate Change, Water and Food Security*, Food and Agriculture Organization of the United Nations, Rome, 2011, p.xvii, www.fao.org/docrep/014/i2096e/i2096e.pdf .

[27] United Nations, Food and Agriculture Organization, *The State of the World's Land and Water Resources for Food and Agriculture, Summary Report,* 2011, p.4.

[28] Several reports speak to the issue of food security in a rapidly growing world, including Water for Food, a Global Institute of the University of Nebraska, *Proceedings of the 2010 Water for Food Conference,* Lincoln, Nebraska, May 2-5, 2010; and Global Harvest Initiative,*2011 GAP Report: Measuring Global Agricultural Productivity*, www.globalharvestinitiative.org/index.php/2011-gap-report/ accessed 19 May 2012. Richard Morrison, chairman

The world's food crisis affects countries and regions differently, but it remains clear that the most productive agricultural regions globally will need to increase the amount of food and fiber available either for export to countries with a deficit or for their own country's/region's consumption. And they must produce it, in many places, using less water than before.

Can Arizona be part of the global food solution? Arizona has not been a large global exporter of agricultural commodities at $670 million (the United States exported $108.6 billion in 2010), but it is an important producer regionally and nationally for lettuce, vegetables, fruit and nuts. Its export potential has been constrained by global trade policies that add tariffs to the price of agricultural products, making them unaffordable. It is unlikely, at current levels of production that Arizona could contribute in a meaningful way to meeting the global demand for food and fiber without additional changes to trade agreements that reduce or eliminate barriers to free trade and provide better access to markets. Arizona agriculture saw the benefits of the North America Free Trade Agreement in its increased exports of cattle and beef to Mexico. Other agreements, such as the Central America-Dominican Republic Free Trade Agreement and the Free Trade Agreement with Australia saw growing numbers of Arizona vegetables and vegetable products available for export. New trade promotion agreements with Colombia and Panama provide increased export opportunities for Arizona vegetables, dairy, cattle and beef, and cotton products. [29] Elimination of trade barriers, establishing fair scientific and technical standards for crop and animal export and increasing Arizona's access to global markets for profitable export of agricultural products could make it more attractive for farmers to increase production for global markets and contribute to the global food solution.[30] This only makes sense for Arizona, however, if agriculture can produce these products more efficiently, increasing crop yield and using less water than today.

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of ASU's Morrison Institute for Public Policy Board of Advisors and a member of a multi-generational Valley farming family, recently spoke to a local East Valley group on the issue of global food security. See *Wrangler News*, May 19-June 1, 2012, p.15.

[29] Arizona's top agricultural exports in 2008 were cotton ($148 million), wheat and products ($103 million), vegetables and preparations ($100 million), live animals and meats ($62 million) and fruits and preparations ($44 million). See United States Department of Agriculture, Foreign Agricultural Service, September 2009, "Trade and Agriculture: What's at Stake for Arizona?" www.fas.usda.gov/info/factsheets/WTO/states/az.asp . See also fact sheets on how Arizona farmers will benefit from other trade agreements at www.fas.usda.gov/info/factsheets/Colombia/Arizona_CTPA_09-11.pdf and www.fas.usda.gov/info/factsheets/Panama/Arizona_PTPA-september percent202011.pdf accessed 19 May 2012.

[30] Increasing exports of United States agricultural products is a major goal of the current Administration and the United States Department of Agriculture's Foreign Agriculture Service Strategic Plan, FY2012-2016 lays out specific objectives to advance the goal, www.fas.usda.gov. Recently, Secretary of Agriculture Tom Vilsack testified before Congress on authorizing permanent normal trade relations with Russia, enhancing the ability of U.S. farmers, particularly in the Pacific Northwest, to export food and animal products to that country. See United States Department of Agriculture Transcript of Testimony of Secretary Vilsack to the U.S. Senate Committee on Finance, June 21, 2012, available www.usda.gov/wps/portal/usda/usdamediafb?contentid=2012/06/0205.xml&printable=true. . . accessed 11 July 2012.

Is Agriculture's Only Role a Water Buffer for Urban Uses?

Is there value to having food locally grown and accessible directly even if the contribution to state prosperity and jobs is currently minimal? Could Arizona export more food and fiber if international trade agreements and government supports, including state assistance, provided better access to international markets? Does the open space that agriculture provides in urban settings contribute value?

The answer to all three questions is an unqualified yes.[31]

Saving just 10 percent of the water currently dedicated to agriculture could mean water available for urban uses in support of 2 million additional people.

If Arizona's urban growth will only be possible if Arizona agriculture is substantially diminished, our state will lose a significant part of its heritage and economic diversity, and the potential to become part of the solution to global food insecurity. Valuable land dedicated to food and fiber production will be lost permanently. Additionally, from a water resource management perspective, the flexibility inherent in production agriculture in large farming operations (reducing the number of acres harvested in any given year or modifying the crop mix to include reduced consumption may be a viable proposition given the right price for the water) allows valuable options for short-term water transfers in times of drought. There are other issues besides crop risk that may prove to be barriers to water transfers, however, and they include the maintenance and retention of a skilled farm labor force.[32]

But the numbers forecasted for urban growth in Arizona's most populous counties, which are also the most productive for

[31] Arizonans consistently state their desire to balance population growth with preserving Arizona's environment and open spaces, to which agriculture contributes. See *The Arizona We Want*, Gallup Arizona Poll sponsored by the Center for the Future of Arizona, 2009. www.thearizonawewant.org/pdf/The_Arizona_We_Want.pdf. For more on the effect of trade agreements, see USDA, Foreign Agricultural Service, "Trade and Agriculture: What's at Stake for Arizona?"

[32] Colby, et al, *Understanding the Value of Water in Agriculture;* Richard Morrison raised the idea of maintaining a skilled labor force on farm as a good reason why a farmer would choose not to fallow land in a short-term arrangement, personal correspondence with Richard Morrison, July 1, 2012. An example of projects to shift agricultural water to urban uses for short-term periods can be found in Shaun McKinnon, "For farm water rights, planners ready to deal," *Arizona Republic*, 26 October 2009: A1.

Arizona agriculture, and the water requirements for that growth are daunting; mid-range estimates for the population in Maricopa, Pinal and Pima counties by 2035 are 8.6 million.[33] The Morrison Institute's *Watering the Sun Corridor* report states average annual current uses of water in those three counties are more than 3.2 million acre-feet, but suggests sustainable water supply availability of about 2.4 million acre-feet; this recognizes more water is currently used than is supportable. Urban uses consume about 1.3 million acre-feet; about 2 million acre-feet of water annually goes to commercial agriculture. The report asserts our per capita urban water uses are inefficient, averaging over 200 gallons per capita per day (GPCD); more can be done here to reduce wasteful water use and stretch urban supplies, but the future demise of commodity agriculture in central Arizona may be on a road from which there is no easy turning around.[34]

The "Third Way": the Power of Water Efficiency

In the Grand Canyon Institute's report *Arizona at the Crossroads*, several policy recommendations for more efficient water use, including modifying water demand, considering water as an economic good, and creating innovative financing mechanisms for water infrastructure, are detailed and there is no need to repeat them here.[35] These efforts should begin irrespective of what transpires in the future for Arizona agriculture. But Arizona agriculture must also use water more efficiently, especially in central Arizona, if we are to maintain a vibrant agricultural economy and accommodate urban growth; a drier, more populated future Arizona cannot support more than 70 percent of its water supply in agricultural use. Saving just 10 percent of the water currently dedicated to Arizona agriculture in Maricopa, Pinal and Yuma counties could mean about 500,000 acre-feet of water available for urban uses in support of 2 million additional people.[36] While this is a simplified calculation and the real savings would be less than this, it does demonstrate the scope of what is possible.

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[33] Water Resources Development Commission, Population Working Group Summary of Findings, July 13, 2011, www.azwater.gov. The 2011 population of the three counties is about 5.2 million.

[34] Grady Gammage, Jr., "Water: Are We Running Out?", *Let's Talk Water, A Series on the Future of Arizona's Precious Resource,* April 2012, www.MorrisonInstitute.asu.edu

[35] *Arizona at the Crossroads* argues for policy initiatives to: maximize Arizona's reclaimed water resources; improve useful information on water use and price at appropriate levels wasteful water use; to modify Arizona's surface water laws for environmental purposes; to examine innovative, market-based approaches to water allocation and management and to secure a reliable funding mechanism for Arizona water infrastructure. See Karen L. Smith, *Arizona at the Crossroads: Water Scarcity or Water Sustainability?*, Grand Canyon Institute, September 7, 2011, www.grandcanyoninstitute.org

[36] As noted earlier in this paper, the combined water use for irrigated agriculture in Maricopa, Pinal and Yuma counties is about 5 million acre-feet of water. The average consideration of urban water use is about 1 acre-foot of water for a family of 4 people. Ten of 5 million acre-feet is 500,000 acre-feet, divided by 4 people provides the 2 million additional people calculation.

As with any sector of the economy, there are efficient producers and inefficient ones. Inefficient use of irrigation water can and does occur for several reasons, but in Arizona, the Natural Resources Conservation Service of the United States Department of Agriculture believes most water is wasted simply because too much is applied to the field. To improve irrigation efficiency on the ground, these experts believe four things are required: to know crop water needs, soil characteristics, water flow and field configuration. [37] With that information in hand, a farmer can make decisions about land leveling, irrigation technology, and methods of irrigation and management that will improve efficiency.

Arizona is not alone in its need to find more efficient ways to use water across all economic sectors. California has embraced agriculture as an important aspect of its future economy, acknowledging that water needs to be used more efficiently and demonstrating a willingness to help farmers grow "more crop per drop," planning for a drier future even while continuing as a world leader in agricultural production. Research conducted in 2009 by the Pacific Institute investigated three key agricultural irrigation technology and management tools to conserve water.[38] Chief among them was improved irrigation scheduling, using local climate and soil information through an integrated network of automated weather stations to estimate crop water requirements, allowing farmers to more precisely irrigate to meet crop water needs. The California Irrigation Management Information Systems (CIMIS)[39] is an integrated network of automated weather stations throughout the state that provides information needed to estimate crop water requirements. A study of its effectiveness concluded its use increased crop yields 8 percent and reduced water use by 13 percent on average.[40] Costs for this irrigation scheduling service vary depending upon the equipment used and the amount of automation. Equipment and labor can run $15/acre and $20-$30/acre for full private irrigation consultants using probes, sensors, weather instruments and meters, satellite collection of information and application software to evaluate and design a unique irrigation schedule sent directly to the farmer to match precisely the water needs of crops.[41] Using scientific irrigation scheduling like this would reduce the amount of water that is wasted by its over-application to fields, but it does require a water delivery system that can provide irrigation on demand.

[37] United States Department of Agriculture, Natural Resources Conservation Service, "Improving Irrigation Water Use Efficiency", January 3, 2012, www.az.nrcs.usda.gov/news/releases/Irrigation-Efficiency.html .
[38] Heather Cooley, Juliet Christian-Smith and Peter Gleick, *Sustaining California Agriculture in an Uncertain Future*, July 2009, p.46, www.pacinst.org/reports/california_agriculture
[39] CIMIS is a joint effort of the State of California and the University of California. The CIMIS does not yet have a broad reach across all agricultural regions of the state, but is sufficiently constructed in California's Central Valley to provide data for analyzing its potential effectiveness.
[40] Cooley et al, *Sustaining California Agriculture,* p.46,
[41] Ibid, p.48.

Despite the promise of technology-based irrigation scheduling, many California and Arizona farmers still primarily rely on visual inspection or personal experience to determine when to irrigate. Soil and/or plant moisture sensors, computer models, daily evapotranspiration reports and scheduling services, while proven effective, are still fairly uncommon, suggesting as the Institute noted, significant room for improvement.[42] In Arizona, just two percent of farms reporting methods used in deciding when to irrigate used a soil moisture sensing device, three percent used a government or commercial scheduling service, about two percent used reports on daily crop water evapo-transpiration, and less than one percent used plant moisture sensing devices and or computer simulation models.[43] Irrigation scheduling services requires the ability to deliver water on demand, and many irrigation districts in Arizona and California lack the kind of infrastructure required to deliver water in this way: the ability to perform flexible scheduling with supervisory control systems and constructing regulating reservoirs to hold excess water ordered, but not used, for short periods of time. Yet the promise of greater water efficiency and increased crop yields is alluring, making irrigation scheduling viable for established irrigation districts with the ability to provide on-demand service.

Efficient drip irrigation on market tomatoes can increase yields by 20 percent to 30 percent, carrot yields in the Imperial Irrigation District increased by more than 30 percent.

Combined with more efficient irrigation technology (shifting a fraction of crops irrigated using flood irrigation to sprinkler and drip systems) and regulated deficit irrigation (applying less water to crops during drought-tolerant growth stages to save water and improve crop yield), these three steps demonstrated potential water savings of about 17 percent.[44] Initial investments in efficiency improvements, the Pacific Institute noted, can be offset by a reduction in operation costs and/or an increase in crop revenue: efficient drip irrigation on market tomatoes can increase yields by 20 percent to 30 percent, carrot yields in the Imperial Irrigation District increased by more than 30 percent and growers using the *PureSense* irrigation management system reported yield increases of 20 percent or more. Comparing the costs of converting from flood irrigation to drip/micro irrigation for cotton and almonds in central California suggested the payback period for cotton

[42] Ibid, p.46.

[43] Census of Agriculture, Farm and Ranch Irrigation Survey (2008), Table 36: Methods Used in Deciding When to Irrigate: 2008 and 2003. Of the 2,997 Arizona farms responding to this survey, more than 67 percent used "condition of the crop" as the method used to decide when to irrigate.

[44] Cooley,et al, *Sustaining California Agriculture,* p. 52.

is 1.9 years and for almonds, six months. Even though these examples are California site specific, they are suggestive that investments in water efficiency can be cost effective.[45]

Agricultural Water Conservation in Arizona

The Arizona Department of Water Resources (ADWR) imposes a basic conservation limit for agricultural water use within AMAs, a groundwater allotment based upon the consumptive use of crops grown between 1975 and 1980 irrigating at an 80 percent efficiency factor. This conservation program has not had the kind of results water planners anticipated, in large part because for most farmers the historic crops grown were high water use crops and the program allows for a flexible credit account managing scheme that provides for a carry-over of groundwater not used in any given year for a future year(s).[46]

ADWR offers a more robust and comprehensive agricultural water conservation program, the Best Management Practices program, but this is voluntary and few farms are participating in it.[47] The agricultural BMP program provides a menu of effective water efficiency measures, from water conveyance system improvements to farm irrigation systems, irrigation water management to agronomic management, which, if implemented, would allow farmers to save a significant amount of water and improve crop yields.[48] Eduardo Bautista of the USDA Arid Land Agricultural Research Center and Peter Waller of the University of Arizona interviewed 21 farmers participating in the program to elicit attitudes on motivation and the benefits or disadvantages of the BMP program. The results were illuminating and highlight the challenges Arizona faces if it is to maintain agriculture as an important policy objective and economic

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[45] Ibid, p.61.Payback periods were calculated using the "Drip-Micro Irrigation Payback Wizard that allows farmers to input region, crop type, acreage and water price to determine the payback period from converting from flood irrigation to micro-irrigation. The cost of water used was $46/acre-foot, the average cost of water from the California State Water Project in the San Joaquin Valley.

[46] Sharon B. Megdal, Zachary A. Smith and Aaron M. Lien, *Evolution and Evaluation of the Active Management Area Plans,* January 2008; Eduardo Bautista and Peter Waller, *Evaluation of the Best Management Practices Agricultural Water Conservation Program*, March 2010, available at Arizona Department of Water Resources. The Agricultural Base Conservation Program requirements can be found at Arizona Revised Statues §45-566, and the modified Base Program and Best Management Practices Program at A.R.S. §45-566.02 and within the Third Management Plan available at www.azwater.gov.

[47] Bautista and Waller, *Evaluation of Best Management Practices*, p.11. As of November 2008, 41 operators on 66 farms totaling 36,651 acres were enrolled; 80 percent of those were in Pinal County.

[48] Arizona Department of Water Resources. Phoenix AMA, Third Management Plan, Chapter 4.4 Agricultural Conservation Program Components, modified May 2003. The base conservation program is relatively ineffective because it begins with a historically high water allotment, reduced only to an 80 percent efficiency factor and allows the accumulation of flex credits for additional pumping that can be carried over for several years. The Department's efforts to tighten the efficiency factor further in the Third Management Plan were rejected in favor of the voluntary BMP program; the 80 percent efficiency factor was also set in statute in 2002. www.azwater.gov/Watermanagement/AMAs/ThirdManagementPlanModifications2.htm#Phoenix.

force. They found producers less likely to enroll in the program if substantial investments were needed to improve the existing irrigation infrastructure or if substantially altered irrigation management practices were needed. Farmers with long-term objectives to remain in farming were more likely to enroll in the BMP program; speculative land prices, urban sprawl and short-term land leases were disincentives. The main reason farmers participated was to move out from under the irrigation allotment requirement based on historic crops. The BMP program provides the flexibility to farm whatever crops are profitable on the existing acreage and use whatever amount of water is required. However, this has the potential to actually increase water use if higher consumptive crops are grown than during the historic period if irrigation efficiency measures are not implemented correctly and monitored for compliance.[49]

We should reconsider our water conservation requirements for agriculture within AMAs to favor and incentivize more effective best practices rather than restricting options to the crops that were grown historically. Additionally, we should eliminate the flexible credit accounting program that allows for a carry-over of groundwater not used in one year for use in a subsequent year; groundwater not used should be conserved and stored in the common resource for the future. This will ensure that farmers wanting to farm longer-term will be supported making investments in efficient water management. For farmers to respond to shifting markets and consumer tastes, flexibility is required. They must be able to prepare a farm plan for a given year that has the potential for profit. Yet we know agriculture must use less water if it is to survive within central Arizona. Agricultural producers also need to consider the consumptive use requirements of their products and balance water management and profits over a multi-year planning period; alfalfa grown one year might give way to wheat or vegetables in a subsequent year. As well, we should support university research in finding drought resistant strains of higher water use crops.[50]

[49] Bautista and Waller, *Evaluation of Best Management Practices*, pp.37-42; The United States Department of Agriculture 2008 Federal Ranch and Irrigation Survey showed just 3 percent of Arizona farms used a commercial or government scheduling service and less than 1 percent used soil or plant moisture sensing devices. See Table 36: Methods Used in Deciding When to Irrigate. The main barriers to reducing energy use and/or conserving water were: investigating improvements weren't a priority, can't finance improvements, landlord won't share in the cost. See Table 41: Barriers to Making Improvements to Reduce Energy Use or Conserve Water.

[50] The U.S. Senate recently passed a new farm bill that provides greater support for specialty crop programs like vegetables and suspends the crop support program that over incentivizes production of wheat, corn, cotton and soybeans. If passed, this will now make it possible for a cotton farmer to also grow vegetables on his land in the same year, as an example. This flexibility will help Arizona farmers reduce water use through mixing higher and lower water consumptive use crops. The bill now goes to the House of Representatives. See. S.3240 *Agricultural Reform, Food, and Jobs Act of 2012 (passed 64-35) June 21, 2012.* See also *The New York Times,* June 20, 2012, "Senate Weighs Bill Overhauling Agricultural Programs."

Investing in Agriculture

The good news is we know what technologies and practices help farmers irrigate more efficiently and effectively. The challenge is weaning agriculture off cheap water that allows over-irrigation, in many instances, to helping agriculture invest in water efficient technologies and practices. Water is going to become more expensive, and the time to prepare for a world of reduced and more costly supplies is right now. Arizona is fortunate that there is a substantial amount of expertise within the state to assist farmers with implementing the technologies and practices that will save water and increase crop yields.[51] Money to implement these practices is the chief inhibitor to their wider application.

Agricultural water conservation measures are not inexpensive. The Pacific Institute study calculated the initial investment required to convert to the efficient drip irrigation technology at $500 to $2,000 per acre; the average cost of a system converting from flood to drip or sprinkler irrigation is $1250 per acre.[52] Other studies have used a cost of $2500 per acre, reflecting the total cost of a system, including a filtration plant. Amortizing this over an expected life of ten years with an interest rate of 7.5 percent yields an annual cost of $354 per acre.[53] One Arizona farm, the Howard Wuertz family's Sundance Farms in Coolidge has used sub-surface drip irrigation for more than 40 years to farm primarily cotton and wheat. Recently, the Wuertzs began using drip irrigation on alfalfa, both conserving water and increasing yields. The drip system, including filter station and injection system for Arizona alfalfa production costs about $2,000 per acre, according to Wuertz, but pays for itself in three to five years.[54]

The drip system, including filter station and injection system for Arizona alfalfa production costs about $2,000 per acre, but pays for itself in three to five years.

[51] University of Arizona Cooperative Extension has an online irrigation scheduling tool available for download that lacks the robustness of CIMIS application but could be upgraded to provide the kind of information farmers need. Extension also has a wealth of technical expertise in its field agents and university faculty. As well, the USDA Natural Resource Conservation Service has an Arizona Field Office of agents tasked with providing conservation assistance to agriculturalists. See Natural Resources Conservation Service, Arizona Field Office, "We Care About Conservation: 2012 Conservation Planning Campaign," www.az.nrcs.usda.gov/news/releases/We percent20Care percent20About percent20Conservation.html accessed 15 May 2012 and AZSCHED is available as a download at http://cals.arizona.edu/crops/irrigation/azsched/azsched.html accessed 23 May 2012.

[52] Cooley, *Sustaining California Agriculture,* pp.40, 45. The wide range of costs is most likely a result of the different drip technologies, such as surface, buried, subirrigation and micro sprinklers.

[53] Hilary R. Brinegar, Frank A. Ward, "Basin impacts of irrigation water conservation policy," *Ecological Economics* 69(2009), p.420.

[54] *Western Farm Press,* May 18, 2009, www.westernfarmpress.com/alfalfa/drip-irrigation-increasing-alfalfa-yields accessed 25 July 2012. The Wuertzs started AZ Drip Systems, Inc. in 1982 and hold numerous patents on drip and minimum tillage equipment.

Studies performed within New Mexico irrigation districts within the Rio Grande Basin, like Elephant Butte Irrigation District, analyzed the economics of a water conservation subsidy for irrigated agriculture and concluded that a public subsidy of drip irrigation increased gross revenue from crop production, farm income, crop production, land irrigated under drip irrigation and total irrigated land in production. They also demonstrated that, while reducing the amount of water applied to crops, the crop water consumption (ET) increased, both at the per acre level and the total farm area. Caution must therefore be used in estimating the amount of water conserved and available for other purposes.[55] Employing efficient irrigation practices for irrigated agriculture can save water for other purposes, but it is a complex situation with many variables; one need be mindful of this in calculating changes to a region's water budget.[56] Nonetheless, in areas such as Arizona, an area of physical water scarcity with significant competition for water and falling groundwater tables, substantive gains in water productivity are worthwhile and can be achieved.

For the large acreage farms that comprise most of Arizona irrigated agriculture, these irrigation efficiency expenses would be difficult to shoulder alone, although the experience of the Wuertz Sundance Farms shows that the investment can be recovered in a profitable time horizon. Most likely because the cost of water is relatively inexpensive for many farmers, opting to invest in water efficient technologies and services has not been a priority. Since most of Arizona's irrigated farms receive water from off-farm suppliers such as irrigation districts or the Bureau of Reclamation, the average cost per acre-foot of water in 2008 was about $29.[57] Those farmers leasing land would also distance themselves from implementing on the ground infrastructure on acres they don't own if the landlord did not share in the expense. There are a few Arizona farmers, however, who have faced issues of water scarcity because of the peculiar site characteristics and circumstances of their farms, and they have embraced water efficiency measures like land leveling and alternate row irrigation, and drip irrigation technology, with

[55] Brinegar, *et al*, "Basin Impacts," p.423. The subsidy ranged from 10 percent of capital costs to 100 percent of the capital costs to install drip irrigation. Even at the lower subsidy range, less water is used and farm income increases.

[56] In particular these studies note increased water productivity often: diminishes return flows available to downstream users, reduces aquifer recharge and redistributes water within agriculture instead of to urban uses. See Ray Huffaker, "Conservation potential of agricultural water conservation subsidies," *Water Resources Research,* vol.44, W00E01, doi:10.1029/2007WR006183,2008; David Molden, Theib Oweis, Pasquale Steduto, Prem Bindraban, Munir A. Hanjra and Jacob Kijne, "Improving agricultural water productivity: Between optimism and caution," *Agricultural Water Management* 97(2010):528-535; and Delphine Luquet, Alain Vidal, Martin Smith, Jean Dauzat, "More crop per drop: how to make it acceptable for farmers?" *Agricultural Water Management* 76(2005):108-119.

[57] USDA, FRIS, Table 22: Expenses for Irrigation Water from Off-Farm Suppliers, 2008.

good results; they have saved water and increased crop yields.[58] Many have been aided through federal programs like the USDA Farm Bill's Environmental Quality Incentives Program (EQIP), which is a substantial funding source for producers to implement practices like those included within the ADWR BMP program through cost-sharing contracts.

Conclusions

As the Pacific Institute report notes, agriculture is an economic endeavor and as such, individual producers must make choices about investments based on anticipated costs and returns. Water is going to become more expensive. Investments in on-farm efficiency measures can be off-set by a reduction in operation costs and increased crop revenue through improved yields, but the initial investment required can make it prohibitive to begin. Studies in New Mexico show that even a modest subsidy of 10 percent of the capital costs to install efficient drip irrigation pays important dividends in reduced water used and increased farm income as a result of enhanced yields. Arizona should explore the same kinds of policies California is considering to help overcome this barrier.[59] These include:

- Increased federal funding for conservation programs like EQIP.
- Property tax benefits for farmers that upgrade to more efficient irrigation systems. Exemptions could apply to the value added to a property by the irrigation system and would be valid for a period of years.
- Arizona could develop new legal mechanisms by which municipal water agencies and wildlife agencies/organizations could invest in farmer's irrigation systems in exchange for some portion of the water conserved.
- Irrigation systems should be configured to provide water on demand, a necessary condition of many irrigation efficiencies. State and federal government should expand efforts to finance district-wide improvements that provide water to farmers when needed, such as lining and automating canals and distribution systems. Arizona's Water Supply Development Fund administered through the Water Infrastructure Finance Authority along with federal EQIP funding could provide low interest loans. Irrigation districts could implement new water rate structures that encourage efficient use of water. The additional revenue generated from large water users could finance on-farm and district-wide improvements.

[58] The NRCS Arizona Field Office regularly posts success stories of farmers whom they have assisted through expertise and funding. As examples, see EQIP Success Story at www.az.nrcs.usda.gov/news/releases/Florence-EQIP.html and Dripline Irrigation Success Story at www.az.nrcs.usda.gov/news/releases/Victor-Kingman.html accessed 15 May 2012.

[59] Cooley et al, *Sustaining California Agriculture*, p.10

Maintaining Arizona agriculture at some robust level should be a priority for all of us. Arizona agriculture can supply food needs as well as contribute to solving a global food crisis. It provides open space and for Yuma and Pinal counties especially, the main source of economic activity. Farms can provide a flexible buffer for water supplies during times of serious drought. To do this, while continuing to grow amidst a changing climate, requires that we all become more efficient in the way we use water, including and especially, agricultural water use. It makes no sense to continue to subsidize the cost of water for agriculture that serves as a disincentive to use it more efficiently. Instead, it is in our interest to help fund irrigation efficiency improvements to conserve water. Let's create a state agricultural water policy based on smarter urban growth, more efficient water use, and a commitment to agriculture that reflects local and global markets while operating in an arid landscape. We have the tools and the expertise to do so; whether we have the willingness and the resolve is another matter.

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