POTENTIAL FACTORS AFFECTING AGRICULTURAL WATER RESOURCES MANAGEMENT

Jonathan E. Jones

Over the next 35 years (to 2050), there will continue to be significant progress in the way that American farmers and ranchers manage surface water and groundwater resources, in terms of both the quantity and the quality of the water that they use. Many factors will encourage (and often mandate) rigorous management of agricultural water, including, as examples:

- Increased demand worldwide for food, particularly as poor countries become more affluent and water consumption for food increases (global agriculture consumes 92 percent of all freshwater used annually) (Perkins, 2012).

- Increased demand for water for nonagricultural uses

- Increased frequency in the severity and magnitude of drought, in response to global climate change and other factors.

- Declining groundwater levels over large, sometimes multistate areas, such as the Ogallala aquifer.

- Increased prices for reliable water supplies and transfers from agricultural to other uses.

- More-rigorous water quality regulatory requirements at the federal, state, and local level, often in the context of comprehensive, watershed-based requirements, such as total maximum daily loads (TMDLs), along with legal and administrative decisions on water quality issues involving nutrients, sediment, bacteria, pesticides and other pollutants.
- The steady evolution of federal and state water laws and interstate compacts (such as the Colorado River Compact of 1922), equitable apportionment decrees and treaties.

- Economic drivers, including increased recognition and acceptance of the "true" value of water.

- Utilization of innovative water conservation strategies, including management of return flows, improved water delivery systems, improved utilization of surface, sprinkler and micro irrigation systems, tailwater recovery, irrigation scheduling, land leveling, conservation tillage, crop selection and farm/ranch management practices.

- Growing interest in sustainable agricultural practices, including ecological insect and weed management, grazing, conservation tillage, cover crops, crop/livestock/landscape diversity, nutrient management, on-farm energy conservation and production, and whole-farm approaches [Sustainable Agriculture Research and Education (SARE) Program, www.SARE.org].

- Increasingly innovative water use/sharing agreements that will be reached between the agricultural community and other water users such as municipalities, power generators, industry and recreational interests (for in-stream flows), such as interruptible water supply agreements, water banking, conjunctive use and others.

AGRICULTURAL WATER QUANTITY MANAGEMENT

As stated by Irmak *et al.*, in 2011:

- As available water resources become scarcer, more emphasis is given to efficient use of irrigation water for maximum economic return and water resources sustainability. This requires appropriate methods of measuring and evaluating how effectively water extracted from a water source is used to produce crop yield. Inadequate irrigation application results in crop water stress and yield reduction. Excess irrigation application can result in pollution of water sources due to the loss of plant nutrients through leaching, runoff, and soil erosion.

- High irrigation efficiency translates into lower operating costs, improved production per unit of water delivered, and improved environmental benefit and management.

Research conducted by Colorado State University (2003) (Waskom, 1994) indicates that surface (gravity flow) irrigation systems experience significant improvements in efficiency if such BMPs as ditch lining, land leveling, surge irrigation, and tailwater recovery are adopted, while for sprinklers, changing nozzle configurations, height or droplet size to minimize runoff and increase the uniformity of water distribution, along with the use of lower water pressures within or below the crop canopy rather than spraying water high into the air, can be effective. Micro irrigation, including surface drop, subsurface drip and micro sprinkler, can be 70-95 percent efficient.

Increasingly sophisticated and reliable systems are being developed to improve farm water efficiency by scheduling irrigation based on soil moisture and plant evapotranspiration requirements. The utilization of global positioning system (GPS) and geographic information system (GIS) technology is facilitating this. Proper irrigation scheduling can achieve water savings of 20-35 percent, based on research conducted at Colorado State University and the University of Nebraska (Colorado Foundation for Water Education, 2004).

Other strategies that will be increasingly employed to improve irrigation efficiency include land leveling (minimizing variations in field contours to facilitate more uniform distribution of water), conservation tillage (various methods that leave at least 30 percent of the soil surface covered by crop residue or stubble), crop selection (including planting several crops with different peak water requirements in order to distribute irrigation over a longer time span), delaying irrigation until crops reach critical water requirement stages, and, in some cases, switching from irrigated to dry-land crop production (Colorado Foundation for Water Education, 2004).

Farmers and ranchers have a variety of incentives to pursue more water-efficient irrigation equipment and management techniques – some incentives are economic, including potential increases in crop yields, reduced energy and pumping costs, and time savings associated with less labor-intensive systems, while other incentives include improved water quality, storage of water in reservoirs for release when it is most needed or preservation of water in deep aquifers for future generations (Colorado Foundation for Water Education, 2004).

Between now and 2050, it is likely that there will be more interruptible water supply agreements, which have become popular in prior appropriation states. Under an interruptible water supply agreement, the lending water right owner (typically a farmer or rancher) agrees to lease water to another water user, although the lease can operate only, perhaps, three out of ten years. Another approach involves water banking, a strategy that is designed to help farmers and municipalities survive water shortages. Essentially, water banking allows farmers to obtain compensation for their storage rights without being forced to sell them. Through a water bank, farmers can store water they do not plan to use until another user leases it, thus facilitating speedy, low-cost temporary water transfers (Colorado Foundation for Water Education, 2004).

AGRICULTURAL WATER QUALITY MANAGEMENT

Water quality regulatory requirements and legal decisions will profoundly affect farming practices between now and 2050, particularly since the USEPA indicates that four of the top six causes of impairment in the United States (by number of 303(d) listings) are associated with agricultural runoff, including pathogens, nutrients, sediment and organic enrichment/oxygen depletion. To address these impairments, the U,S. Environmental Protection Agency and state agencies will continue to implement total maximum daily loads (TMDLs) as the primary regulatory mechanism. TMDLs are likely to increasingly affect agriculture in the future. Similarly, judicial and administrative decisions and new laws and regulations will significantly affect how farmers and ranchers manage their discharges to receiving waters. American farmers and ranchers are increasingly adopting wide-ranging BMPs to address water quality issues, such as:

- terraces
- tailwater recovery
- strip cropping
- grazing management
- grassed waterways
- filter strips
- cover crops
- conservation tillage and crop residue management
- composting
- barnyard/feedlot runoff management
- integrated pest management
- no tillage/strip tillage
- fencing and livestock exclusion
- nutrient management

An important publication that projects the future of agricultural water quality management is titled *How to Build Better Agricultural Conservation Programs to Protect Water Quality: The National Institute of Food and Agriculture—Conservation Effects Assessment Project Experience* (Soil and Water Conservation Society, 2012). The authors and editors of this publication conclude that to continue to improve agricultural water quality, the following steps are necessary:

1. Developing better incentives, including funding, flexibility, and ease of management and developing more convincing ways to demonstrate benefits.

2. Improving educational channels by encouraging more interpersonal contact between conservation agencies and farmers and respecting the need to include farmer-to-farm contacts.

3. Improving communication, coordination, and program effectiveness among federal, state. and local agencies and watershed/environmental organizations.

4. Allowing more local control over how conservation funds are allocated.

The authors also emphasize that conservation practices are a business decision and that farmers respond to:

- Being able to easily see the benefits of a conservation practice (e.g., terraces and grassed waterways).

- A perceived need for the practices (e.g., can they see the pollution?).

- Cost-effectiveness of the practice and ease of use.

- How well they trust the company promoting the practice.

- How flexible the conservation practice standards were.

The authors (Soil and Water Conservation Society, 2012) state that conservation practice adoption is a complex, multivariate decision, not a binary option, for farmers who must implement and maintain the practices. Farming is a business, and the economics and time management requirements of conservation practices must be recognized. Education must be tailored to work with farmers on a one-to-one basis and must be provided through highly coordinated efforts between extension and the USDA NRCS, along with their soil and water conservation district affiliates to be effective.

In summary, American agriculture will continue to implement innovative, multifaceted practices and programs related to water resources management. Given the economics of agriculture, however, this will be challenging and it will be essential to encourage the cooperation and coordination of the regulatory community, farmers/ranchers, agribusiness and the public to assure that this happens.

REFERENCES

Colorado Foundation for Water Education, 2004. Citizens Guide to Colorado Water Conservation. ISBN 0-9754075-2-X.

Colorado State University, 2003. Colorado High Plains Irrigation Practices Guide. Colorado Water Resources Research Institute, Colorado State University, Special Report 14.

Perkins, Sid, 2012. Is Agriculture Sucking Fresh Water Dry? Science. http://news.sciencemag.org/2012/02/agriculture/sucking-fresh-water-dry.

Irmak, Suat, L.O. Odhiambo, W.L. Kranz, and D.E. Eisenhauer, 2011. Irrigation Efficiency and Uniformity, and Crop Water Use Efficiency. University of Nebraska-Lincoln Extension, EC732.

Soil and Water Conservation Society, 2012. How to Build Better Agricultural Conservation Programs to Protect Water Quality: Conservation Effects Assessment Project Experience, Deanna L. Osmond, Donald W. Meals, Dana L.K. Hoag, and Mazdak Arabi (Editors). The National Institute of Food and Agriculture, Soil and Water Conservation Society, www.swcs.org.

Waskom, Reagan M., 1994. Best Management Practices for Irrigation Management. Colorado Water Resources Research Institute, Colorado State University Bulletin XCM-173 (August).

AUTHOR LINK Jonathan E. Jones
Wright Water Engineers, Inc.
2490 W. 26th Ave, #100A
Denver, CO 80211
(303) 480-1700

E-MAIL jonjones@wrightwater.com

Jonathan E. Jones, P.E., D.WRE is the Chief Executive Officer and President of Wright Water Engineers, Inc., in Denver, where he has worked for almost 33 years. He is a licensed professional engineer in 13 states.

❖ ❖ ❖

WATER RESOURCES IMPACT

WHERE THE LAND AND WATER MEET: COASTAL RESOURCES OVER THE NEXT 50 YEARS

Eric J. Fitch

In the United States (U.S.), coastal population is large. If you count only the counties that are on the shorelines of the oceans or the Great Lakes, one finds 39% or 123.3 million of the overall U.S. population in less than 10% (275,351 mi^2) of the nation's land area. If one counts the Coastal Watershed Counties (just under 20% of the land area or 511,971 mi^2), then the coastal U.S. population rises to 52% or 163.8 million people all of whom are in harm's way. Population projections have coastal population growing to 134 million by 2020. Finding a definitive number in terms of coastal population globally is a bit more difficult, but if one uses a 200 km (124.274 mi) buffer, over 3 billion people or roughly half the world's population live in the coastal zone. Two things that are definitely true about global population are that it is growing faster than inland areas and that it is concentrating in urban areas.

Why is the growing, urbanizing nature of coastal population such a concern? Fundamentally it boils down to what is happening with the heat budget of the oceans and atmosphere. Higher concentrations of CO_2 and other greenhouse gases are trapping more heat in the atmosphere and by transference into the world's oceans. As water heats in the oceans, physical expansion of the water contributes the first factor to sea level rise. Next, climate change is accelerating glacial melt in many of the mountain ranges of the world and suspended ice cap melting particularly in Greenland and Antarctica. (There is comparatively little impact from the melting of Arctic ice because the cap largely is suspended in the Arctic Ocean and adjacent seas and thus the water is already displaced when it changes from ice to liquid form.) This addition of water also leads to sea level rise. Coastal areas, especially those built on river deltas, are particularly vulnerable as annual or periodic flooding is arrested by human made dikes, dams, and levees that restrict flooding. No flooding results in little or no deposition of sediment (build-up) while erosion continues apace. In addition, some coastal areas have mineral (oil, natural gas, sulfur, etc.) withdrawals that result in a lowering of the seabed and adjacent coasts. In a worst case scenario like the Louisiana Coast, seas are rising, coasts are sinking, sediment is not being deposited in the delta and erosion is taking land away all at an alarming pace. This has resulted in a loss of at least 4,300 ha/10,625.53 ac/ ~ 16.6 sq. mi. per year in recent years in Louisiana. Once

WATER RESOURCES

IMPACT

January 2014 | Volume 16 | Number 1

AWRA AT 50: THE FUTURE OF WATER RESOURCES IN THE UNITED STATES

50th Anniversary AWRA

AWRA

Community, Conversation, Connections

AMERICAN WATER RESOURCES ASSOCIATION