Overview of Water Management

Water is an essential component of all agricultural production. Worldwide, 70% of water is used in agriculture. In the United States, agriculture accounts for approximately 80 percent of the nation's consumptive water use and over 90 percent in many Western States.[1] Agriculture is also one of the major polluters of the American water supply.

The supply of adequate water for irrigation and the need to improve water quality in our streams, rivers and lakes will continue to be major environmental, political and economic issues.

Water Usage and Rights

Although, in general, in the United States, the water belongs to the public, the right to use surface water is determined by two divergent systems: riparian water rights and prior appropriation water rights. With the exception of specific agreements between states, the federal government and, the tribal nations, the states control the use of water. Under riparian rights (employed in the Eastern United States), the rights are granted for beneficial uses to those located along the water source. Upstream water users may consume water and deplete streams prior to water reaching downstream users; this has resulted in disputes between types of users and across state lines. States may intervene to control withdrawals.[2]

Prior appropriations water rights (used in the Western United States) are granted for beneficial uses and can be tied to locations away from the source watershed. Prior appropriations rights are based on “first come first serve” allowing those with the oldest claim to use the entire volume of water they claim first, before other claimants have access. If water levels drop below the appropriated rights, the later claimants are cut off. Ground water rights are regulated by the states and vary by state. Regulation of private wells varies greatly by state. Most water rights are controlled by a beneficial use rule, although the definition of “beneficial” may vary. Disputes over rights can be very complicated. In recent years, conflicts between the demands for water usage and environmental protection have become more apparent. Many states now have “in stream” rights that protect bodies of water from withdrawal below a certain level. A good illustrated explanation of these rights is found in United States Committee on Irrigation and Drainage (USCID): *Water Rights in the U.S. and Shortages* by Laura Schoeder.[3]

Farmers are dependent on water for successful production particularly in the more arid western states. Irrigated farms account for over 40% of the value of US agricultural production and, nationwide, the average value of production for an irrigated farm in 2012 was more than three times the average value from a dry land farm.[4] In 2005 five States—California, Nebraska, Texas, Arkansas, and Idaho—accounted for 52 percent of total irrigated acreage.[5] Adequate water rights allow farmers to irrigate and thus reduce the risk of crop failure and increase the yield per acre. This reduced risk, in turn, improves the farmers' opportunity to find the funding needed for yearly operations. Thus, water rights are tightly held.

The requirements of other water users and the need for protecting habitat by maintaining levels in rivers and streams compete with farming needs. On the Klamath River in southern Oregon, farmers and ranchers and tribal populations are in conflict. The courts have ruled that the tribal nations have rights "time immemorial" to protect fisheries. The farmers have a senior right dating from the 1905 Klamath Reclamation Project, but the ranchers of the area have junior rights. When drought conditions occurred in the spring of 2013, the irrigation for the pastures of ranches was turned off because there were insufficient water resources to meet the priority rights to tribal populations and farmers.[6,7]

In Georgia and Tennessee, conflicts between states are occurring over rights to the rivers as the urban demand for water is rapidly growing. The Atlanta area competes with farms and other water users and puts strain on the water supply.[8] In Kansas, drought in 2011 and 2012 placed heavy demands on wells fed by the High Plains Aquifer. Farmers who depended on irrigation, and invested heavily in equipment, will have to rethink their crop selection as well as their farming methods. In some cases farmers have moved to raising animals.[9] A recent modeling study of the impacts of irrigation on the High Plains Aquifer found that so far "30% of the groundwater has been pumped and another 39% will be depleted over the next 50 years given existing trends." The authors indicate that more efficient irrigation methods and changes on agricultural methods have reduced the speed of loss of water from the aquifer and could sustain production. The authors conclude: "Findings substantiate that saving more water today would result in increased net production due to projected future increases in crop water use efficiencies. Society has an opportunity now to make changes with tremendous implications for future sustainability and livability."[10] Modern farm methods recognize the need to conserve and get the most value out of water resources and are moving to more efficient irrigation techniques.

Irrigation

Farmers have been irrigating crops from the beginning of agriculture practices. Since farmers first were able to obtain a bucket they have brought water to their crops. Early agriculture practices took advantage of flooding and gravity to get water to plants. Early irrigation used open ditches and heavy application of water. With these techniques much of the water was lost as runoff and as the result of evaporation. The amount of water applied was only minimally controlled. Modern irrigation is designed to reduce loss of water from evaporation and control application based on soil conditions. With less run off, streams and rivers are better protected from the impacts of erosion.

Modern irrigation techniques provide farmers with significantly more control over the amount of water applied and the ability to target areas that need additional moisture. Examples of new techniques include pivot agriculture (circular applications) and drip agriculture. Sensors allow the farmer to measure the moisture in the soil as well as the fertilizer needs and apply both water and fertilizer in the exact amounts necessary.[11,12] These techniques can be expensive; at present only about 10% of farmers are using sensors and computer techniques.[13] Extension agents and universities across the country have been working with farmers to develop more efficient irrigation programs. The University of Georgia has been working with farmers to develop variable rate irrigation systems for efficient irrigation; however, they note that the cost is a prohibitive factor.[14] Large-scale agriculture is better able to absorb the cost of these new innovations. Funding from state and federal conservation funds make irrigation techniques more available to all farmers and provide incentives for water conservation.[15]

Farmers have developed innovative methods of capturing water from differing sources. Madison Farms in Echo, Oregon has long-term contracts with a potato processing plant and a power plant to reuse their nutrient rich water providing for both irrigation and fertilizer.[16] This innovative family-owned industrial farm also "uses AR (Artificial Recharge) to collect high turbidity winter flood flow and clean it to potable standards for ASR (Aquifer Storage and Recovery) for summer time irrigation use."[17]

Researchers are looking at many techniques for reducing water use and minimizing environmental impacts of irrigation. Crop specific irrigation techniques should be developed; however, these techniques must allow for sustainable rotational cropping systems. Precision irrigation using sensors and GPS will be needed to maximize efficiency. Use of solar and wind energy and other energy will be needed to reduce fuel cost associated with moving water. New techniques should be developed for field drainage to protect water quality. Irrigation systems should be designed for different weather conditions including humidity. Controls should be put in place to manage salts and trace elements in irrigation and eliminate their harmful effects on soils, groundwater and crops productivity. Best management practices should be put in place for irrigation using wastewater. Using tools such as computer modeling to accurately make predictions can help develop better conservation practices that enhance infiltration, reduce runoff and improve water quality.[18]

The speed of the development of new techniques remains dependent on funding and the priorities of the agriculture community. Research introduces new challenges. For example, a newly identified drawback of controlled irrigation was described in a recent irrigation modeling study. The researchers observed that the efficient use of water eliminated return flow and aquifer replenishment, thus reducing water for downstream use.[19] This study shows the potential for water conservation and increased crop efficiency to be in conflict.

Movement to modern conservation-oriented irrigation techniques not only increases crop production, but also reduces the runoff from agricultural fields that pollute our fresh waters. In 2008, about $2.15 billion was spent on irrigation systems (beyond expenditures for maintenance and repair) on U.S. farms, mostly in the western states. Federal conservation programs provide some incentives for improved irrigation practices; however, most new irrigation activities are privately financed.[20]

Water Quality

Growing dead zones in the Gulf of Mexico, pollution in the Chesapeake Bay, and large algal blooms (an abundant or excessive growth of algae) in Lake Erie have all been attributed to agricultural runoff. Nitrogen and phosphates from fertilizers add nutrients to runoff encouraging algal growth that in turn removes oxygen from the water resulting is dead zones. Pesticides in runoff and from spraying near streams, also impair the streams, including reducing species diversity in aquatic habitats.[21] Removal of trees and shade increase the temperature of the waters, resulting in changing habitat. Sediment runoff clouds water, reduces light penetration and fills in holes thus altering habitat and reducing natural photosynthesis.[22]

Agriculture remains the biggest polluter of waters and, as yet, no consistent nationwide approach to addressing agricultural pollution exists. Thus, problems continue. For example, in 2012, drought in Iowa reduced the crops and excess fertilizer remained in the fields. In spring 2013, rains and snowmelt carried the fertilizer to rivers and streams resulting in high nitrate levels that forced communities to use additional expensive purification processes for all drinking water.[23] Heavy rains and flooding conditions resulted in overflow of manure pits further increasing nutrient levels in water bodies.

The EPA works with the states to regulate and reduce water pollution. As part of the Clean Water Act, states identify waters that are impaired and prepare Total Maximum Daily Loads (TMDL), a measure of the levels of pollution that can occur without impairing the beneficial uses of the water. The state is then required to develop a plan to reduce pollution to the acceptable level. Clean Water Act activities initially targeted industry and large cities with point discharges (through pipe or ditch) to waters of the country. In the early 1990s, attention turned to pollution from runoff. Even more recently farm practices have been brought under scrutiny. Concentrated Animal Feed Operations (CAFOs) are now required to have National Pollution Discharge Elimination System (NPDES) permits based on the size and nature of the operation. The scope and requirements of these permits remain a concern of environmental groups.[24]

As part of the TMDL program, pollution from other agricultural crop production runoff is most often addressed through voluntary programs. States work with Soil and Water Conservation Districts and local farmers using Best Management Practices to reduce runoff and water pollution. Farmers are cooperating in the creation of riparian zones that are designed to act as buffer zones to clean water and remove pollutants. In many areas, streams that had been straightened are being returned to their natural meandering flow. EPA regulation of pesticides includes controlling where spraying can occur and is being tightened in areas where spray could impact fish such as endangered salmon.[25] Farmers have planted shading and changed planting patterns to prevent runoff. Careful control of fertilizer applications has assisted in reducing polluted runoff. In some states and regions such as the Chesapeake Bay Watershed, states are passing regulations to control farm runoff pollution. In Maryland, regulations have been put in place to control pollution from manure and the spread of sewage sludge.[26] In September 2013, “U.S. District Judge Jay Zainey in New Orleans [of the U.S. District Court for the Eastern

District of Louisiana] gave the Environmental Protection Agency six months to decide whether to set Clean Water Act standards for nitrogen and phosphorous in all U.S. waterways or explain why they're not." This ruling could have significant impact on farm practices of states in the Mississippi River watershed.[27]

The regulation of both water rights and water pollution varies on a state-by-state basis. Federal participation has been through the Clean Water Act requirements, research and conservation incentives. Cross-border issues have gone through the court system. Regulators at all levels need to consider whether the current state-by-state approach will work in the face of climate change and population growth.

Recommended Readings

Water Supply

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