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## **AGRICULTURE AND GROUNDWATER QUALITY: THE ARIZONA EXPERIENCE**

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In May of 1986 the Arizona legislature passed what many believe to be the country's most stringent law to reduce groundwater contamination. Sections of the law refer directly to agriculture, including agricultural pesticide and fertilizer use and feedlot operations. The new law, called the Environmental Quality Act (EQA), was fashioned by a governor-appointed committee of environmental and industry representatives after well contamination, documented by more sophisticated and frequent testing, had been reported in the media and become an issue of high concern to Arizona's citizens.

Arizona is one of the fastest growing states. Between 1981 and 1987 its population grew by 2.8 percent per year, compared to a U.S. growth rate of 0.78 percent. Nearly three-fourths of the population lives in the Phoenix and Tucson metropolitan areas. Maricopa County, which is the largest of the state's fifteen counties and includes the Phoenix metropolitan area, is also the state's largest agricultural producer and contains many agriculturally based communities. As Phoenix grows, it spreads onto former cropland and uses the underlying aquifer for urban water demands.

All Arizona cropland is irrigated and agriculture uses more than 80 percent of all water used in the state. Some 60 percent of irrigation water is groundwater. Most towns and nearly all farms rely on groundwater for human consumption.

Arizona crop farmers use chemicals intensively. Data for 1982 (U.S. Department of Agriculture 1984, pp. 378, 421-22) indicate nitrogen used for crops averaged 57 pounds per acre for all U.S. agriculture, 83 pounds per acre in Iowa and 180 pounds per acre in Arizona.

Pesticide use is also heavy. Data for 1985 and 1986 indicate the Lake States and Corn Belt spent \$10 per acre for chemicals (other than fertilizer) for corn production (U.S. Department of Agriculture 1986, p. 34). The cost of herbicides, insecticides and defoliants for cotton production in Maricopa County, Arizona's largest cotton producer, was nearly \$52 per acre (Hathorn and Farr, p. 40).

There is some limited evidence of well contamination in Arizona. A recent study by the Arizona Department of Health Services indicates 173 wells in Maricopa County, 72 of which were used for drinking, contained volatile organic chemicals. In Yuma County (another major agricultural county) 61 wells contained volatile organic chemicals and 45 of these were used for drinking (Woodard). Some 30 percent of well contamination in Maricopa County was attributed to agricultural activities and 99 percent of well contamination in Yuma County was attributed to agricultural activities.

A 1987 U.S. Department of Agriculture (USDA) study (Nielsen and Lee) suggests that nitrate contamination is a problem in some areas of Arizona. In that study, Maricopa County is identified as having high nitrate levels and 10,000 to 40,000 people using private wells. In adjoining Pinal County, Arizona's second largest agricultural county, in which up to 10,000 people are using private wells, groundwater nitrate levels are considered moderate.

As in other states, agricultural groundwater contamination varies greatly from one area to another.

First, there are vast differences in the intensity of agricultural activity ranging from vegetable production, which uses high levels of fertilizer and pesticides, to cattle ranching where the stocking rate is perhaps four to six head per section. The intensive irrigated agriculture occupies a very small percentage of Arizona's total area. Only about one million acres are irrigated, but these areas tend to be nearer the population centers.

Second, the depth to groundwater, and therefore the significance of groundwater contamination, varies greatly from one area to the next. In agricultural areas of Yuma County along the Colorado River and Maricopa County along the Gila River, groundwater may lie only a few feet below the earth's surface and is more susceptible to contamination. In many agricultural areas, however, including the Aguila, Rainbow Valley, Harquahala and Queen Creek areas of Maricopa County, groundwater is 500 to 600 feet deep. Contamination in these areas is less likely.

Third, the level of irrigation affects the percolation of chemicals into groundwater supplies and irrigation levels vary from area to area. More than 80 percent of Arizona's cropland uses gravity flow irrigation and applications are often four to six feet per acre per year. But the level depends on a host of factors including elevation, soil type and, importantly, the type of irrigation technology and management employed. Irrigation field efficiencies are often only 55 to 60 percent, but with water saving technologies and management can be sharply improved.

## **The Environmental Quality Act**

For some time, even after there was a perceived groundwater contamination problem, little governmental action was taken to correct the problem. Several agencies, including the Arizona Department of Health Services, the Water Quality Control Council, the Board of Pesticide Control and the Environmental Protection Agency, were theoretically empowered to address the issue. But because of jurisdictional squabbles, underfunding and a lack of clearly defined responsibilities, little was done (Woodard, pp. 1-4). The governor, however, assembled a task force composed of various environmental and industry interest groups and, after three months of intense negotiation and public hearings, their efforts resulted in the passage of H.B. 2518, the EQA. It was signed into law May 12, 1986. Although the EQA was written to protect air and surface water quality too, it places considerable focus on reducing groundwater contamination.

The EQA greatly increased the resources available to the state to address the contamination problem. A new Department of Environmental Quality was created to administer much of the law and is to have eight assistant attorney generals who can bring suit to enforce the law. Provisions are made for a superfund to aid cleanup in the few expected cases in which guilty polluters are not assigned damages.

Under the law, all groundwater aquifers are to be protected to drinking water standards initially. Maximum contaminant levels for drinking water are to be established and then all aquifers monitored. A reclassification of an aquifer to lower standards can be made, but is difficult to accomplish.

A permit is required for all persons who discharge, or own or operate a facility that discharges, into an aquifer. Permits may be either individual or general for a defined class of facilities. Fertilizer and feedlot operations fall under the general permit class and an individual permit is not required unless violations are determined. If a farmer is found to violate restrictions placed on nitrogen use, then he must obtain an individual permit, which has more stringent information and monitoring requirements. All pesticide users, sellers, pesticide advisors and custom applicators must obtain either a license or permit. The new law makes it clear that any person may bring suit for noncompliance with the law against any grower, the state, political subdivisions of the state or the Director of the Department of Environmental Quality.

Separate sections of the law deal specifically with agriculture and provide separately for pesticide and nitrogen issues.

## **Pesticides**

The goal of the pesticide provisions is to prevent all pesticides from reaching groundwater. All pesticides sold, distributed or used in Arizona must be registered with the state. Information on pesticide solubility in water, soil absorption and various measures of dissipation must be provided for registration. The Director of the Department of Environmental Quality, in consultation with the Commission of Agriculture and Horticulture and the Department of Water Resources, is to establish numeric standards for water solubility, soil retention and dispersion of pesticide chemicals. These standards are to be at least as stringent as those set by the Environmental Protection Agency (EPA). The Director of the Commission of Agriculture and Horticulture will use the information provided by registrants and the numeric standards to establish a groundwater protection list of pesticides that do not meet data requirements or exceed the established numeric values. Use of listed pesticides is subject to strict regulation and notification procedures and if the pesticides fail a subsequent test their registration is canceled. Those pesticides harmful to human health, if found in groundwater or found to have moved eight feet below the soil surface, may lose their registration.

In addition to more stringent pesticide licensing requirements, other rules restrict pesticide use. Buffer zones near schools, homes and hospitals are established for highly toxic pesticides. Applicators must receive special training and licensing. And an environmental label on the pesticide container must specify an application that prevents contamination.

## **Nitrogen**

The EQA attempts to reduce fertilizer and feedlot nitrogen contamination of groundwater, but, in contrast to pesticide regulations, the goal is not to reach zero contamination but rather low levels. The EQA places emphasis on the specification and adoption of Best Management Practices (BMP's) as a means of reducing nitrogen groundwater contamination. Farmers or feedlot operators who use the established BMP's cannot be prosecuted for standards violations.

BMP's are to be fashioned by two advisory committees, one for fertilizer and one for pesticides. The law specifically indicates (EQA, Sec. 46) that the College of Agriculture "... shall cooperate with, provide technical and expert assistance and supply data and other necessary information to the advisory committees." Advisory committee suggestions for BMP's are to be submitted by October 1, 1988, and adopted by the Department of Environmental Quality not later than July 1, 1989. In making their recommendations, the advisory committees are to consider (1) "the availability, the effectiveness and the economic and institutional considerations of alternative techniques" and (2) "the potential nature and severity of discharges from

the regulated agricultural activities and their effect on public health and the environment." Failure to follow BMP's may result in loss of the agricultural general permit for the discharger and require the discharger to obtain the more stringent individual permit. Further violations may result in civil penalties not to exceed \$25,000 per day per violation.

### **Policy Effects**

Although most observers believe the EQA will affect agricultural production, the magnitude of the effect depends upon the regulations finally adopted, the response of the chemical industry to regulation and the rigor with which regulations are enforced.

For pesticides, the "numerical values" or acceptable standards for water solubility, soil absorption, field dissipation and other criteria are still to be determined, although they must be at least as stringent as those being used by the EPA. Registrants, meaning chemical manufacturers, must supply considerable information on each pesticide and this information is costly to obtain. There is some concern that with Arizona's relatively small market for pesticides, some chemical manufacturers may simply withdraw their product from the Arizona market rather than incur costly testing for the required information. In an attempt to reduce this potential loss, policy makers are gearing their data requirements to those already established in California and counting that chemical manufacturers will find testing to assure the huge California market a cost worth incurring.

There is some limited evidence that banning certain commonly used herbicides would considerably reduce net crop income. Recent field trials (four replications, randomized complete block design) showed that without prometryn/pendimethalin, seed cotton yields were reduced 54 percent (Chernicky, et al., pp. 39-41) because of weeds. Currently the only recognized, environmentally safe substitute for these herbicides is hand hoeing. It is estimated that would cost \$50 to \$100 per acre (Stedman).

For those who use fertilizers and for cattle feedlot operators, the final impacts depend upon specification of the BMP's, the ability to detect violations and the vigor with which violators are prosecuted.

### **Roles for Extension Economists**

To date, extension has addressed the groundwater contamination issue most directly and primarily through the efforts of one person, a water quality/soil salinity specialist. His program has focused on the physical aspects of the contamination problem—providing educational material on the sources of water quality degradation, principles of water and chemical movement, salinity management and

management options to reduce the amount of chemicals entering groundwater. He has also provided educational materials on the new environmental quality act for industry and extension audiences. Three other extension specialists, also physical scientists, help with applicator training, agronomic research and education on fertilizer management, and research and education on feedlot and dairy waste disposal.

Although the economics specialists have not directly addressed the groundwater contamination issue, some of their applied research and education programs pertaining to the economics of irrigation is quite applicable to the issue of groundwater contamination. Economic information is available and more is programmed to help specify best management practices and to help farmers economically reduce pesticide and nitrogen contamination of groundwater.

First, economic analysis can help specify the most profitable water saving irrigation technologies and thereby reduce leaching of contaminants. Economists, including extension specialists, have actively studied the costs and benefits of laser leveling (Daubert and Ayer), drip irrigation (Wilson, Ayer and Snider) and reduced applications with gravity systems (Ayer and Hoyt). That economic information has been distributed not only to producers to encourage adoption of water saving techniques where profitable, but is also used by the Arizona Department of Water Resources to establish water duties limiting the amount of groundwater farmers can pump.

Second, experiment station data is available showing how yield varies as nitrogen levels vary. Economists will use these data to estimate nitrogen production functions and show the effect on crop profitability of reduced applications.

Finally, budgeting studies of the profitability of changing crop mix in response to new pesticide regulations is underway. Both the production function and the budgeting studies can benefit farmers directly and help in the formation of best management practices.

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