**Water pollution, Aquifer Depletion, and Containment Facilities**

We face the challenge of increasing agricultural production on a global basis to feed a growing population, yet doing so in such a way that is sustainable into the distant future. According to the UN, global food production uses nearly 1/4 of all habitable land on earth, accounts for more than 70% of fresh water consumption, and produces more than 30% of global greenhouse gas emissions. It also accounts for 80% of deforestation and is the largest single cause of species and biodiversity loss. This deforestation is also a major contributor to climate change. Farming can degrade water quality with the discharge of excess nitrogen and agricultural wastes into our streams, rivers and groundwater.

The industrialization of agriculture has made it possible to produce much more dairy, meat and eggs on a given amount of land. According to an article in Time magazine, each American farmer feeds over 155 people worldwide. However, all this increased efficiency can mean using pesticides, petroleum based fertilizers, genetically modified seeds, and large amounts of water for irrigation as well as energy for mechanization and processing. Organic farming is generally more sustainable. According to the University of California Sustainable Agriculture Research and Education Program, "sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. . . . A systems perspective is essential to understanding sustainability. The system is envisioned in its broadest sense, from the individual farm, to the local ecosystem, and to communities affected by this farming system both locally and globally."

For livestock and grain crops such as corn and soybeans, however, yields are 25% lower with organic farming than with conventional agriculture, according to a joint study by McGill University and the University of Minnesota published in Nature magazine. The difference in yield between organic and conventional farming of fruits and vegetables is only 5%, however. The downside to organic is that more land is needed to produce fewer crops. According to the study authors, "Today's organic farming practices are probably best deployed in fruit and vegetable farms, where growing nutrition (not just bulk calories) is the primary goal. But for delivering sheer calories. . . conventional farms have the advantage right now. . . . We will need to deploy different kinds of practices (especially new, mixed approaches that take the best of organic and conventional farming systems) where they are best suited -- geographically, economically, socially, etc."

The green revolution brought about by modern, industrial agriculture is due in large part to the use of synthetic fertilizers which replenish the nitrogen in the soil at a faster rate than occurs naturally, thereby greatly increasing yield. However,

applying fertilizer in excess of plant needs can result in nitrogen and phosphates leaching into waterways, causing serious pollution. The “dead zones” found in places like the mouth of the Mississippi River in the Gulf of Mexico are due to this excess run off, and the resulting lack of oxygen in the water.

Erosion not only reduces the productivity of the soil due to loss of micro-organisms and plant nutrients, but sedimentation caused by erosion also negatively impacts water quality. Improved tillage practices, riparian buffers and windbreaks can mitigate erosion, but it remains a very serious problem.

Best soil management practices identified by the Natural Resources Conservation Service, an arm of the U.S. Department of Agriculture are promoted via state agencies and universities. The current emphasis is on disturbing the soil as little as possible using no till practices and diversifying crops. The “healthy farms” movement proposes mitigating erosion as well as pollution resulting from synthetic fertilizers by growing and rotating more crops, especially oats, alfalfa and other legumes that augment nitrogen levels in the soil; and using more cover crops such as rye or clover to plant in soil that would otherwise be bare, thereby reducing soil erosion and holding nutrients in the soil. Cash incentives can be effective in encouraging soil conservation practices, and there are Federal and State programs in place which can cover up to 87% of the cost to implement many practices. In recent years, however, crop insurance subsidies have been exempted from basic conservation requirements, a strong disincentive to implement them. Linking conservation practices to crop insurance is under consideration as part of a new farm bill. Yet another disincentive is the fact that nearly 40% of farmland is rented, and renters tend to be less motivated to invest in such measures.

The other major source of water pollution from agriculture is the modern containment facility for livestock, whether it be poultry, cattle or hogs, termed AFOs. CAFO’s (concentrated animal feed operations) are defined by the Environmental Protection Agency as AFO’s with the potential to impact water supply. In some cases the animal waste can be recaptured for fertilizer. An appropriate waste management system can limit runoff. However, the mere size of some of these facilities makes it difficult to manage the waste in such a way as to avoid pollution of both surface and ground water. More animals are being raised in CAFO’s or AFO’s because their environment can be controlled, diets can be uniform and more livestock can be raised using less land. Consumer demand for affordable, uniform meat products incentivize raising animals in concentrated facilities.

Agricultural non point source (NPS) pollution is the leading source of pollution into rivers and lakes, the third largest source of contamination in estuaries, and a major contributor to pollution of groundwater resources. The “healthy farms”

movement proposes reintegrating livestock and crops, so that what otherwise can be a dangerous pollutant can naturally increase soil fertility.

The EPA is the agency most responsible for pollution control. Management of water runoff is addressed through the Clean Water Act (CWA.) However, most agricultural regulation and cleanup is delegated to the states, which in turn have adopted policies that largely rely on voluntary compliance with best management practices. CWA grants have been designated to control NPS, and other governmental programs provide technical assistance and economic incentives to implement NPS pollution management practices. In recent years legal battles between environmental groups insisting the EPA do more to address the impacts of CAFO's, on the one hand, and agricultural interests resisting more regulation, on the other, have led to a stalemate. The current LWVUS position states that "the federal government should have the major role in setting standards for environmental protection and pollution control" and that "the federal government should enforce standards if other levels of government do not meet this responsibility."

Modern farming has also been made possible by massive irrigation projects, whether it be in California's Central Valley or the Great Plains. Some of the needed water is made available through aqueducts and reservoirs that bring water from wetter to dryer areas, such as the Central Valley Project. In other cases, groundwater is used for irrigation. In California, agriculture consumes more water than all other domestic, energy-related and industrial uses combined, even though better management and conservation practices have decreased agricultural water consumption somewhat in recent years. In 2010, 60% of water used for agriculture was from surface water, and 40% from groundwater.

In general, farmers are using water more efficiently than in the past, and it is important to continue to apply water more precisely because excessive irrigation can concentrate pesticides, nutrients, pathogens and salts, negatively affecting water quality. Examples of new technology include pivot agriculture (circular applications), drip agriculture, sensors allowing farmers to measure moisture and fertilizer needs, and crop specific irrigation. However, these new technologies can be quite expensive, and one possible unintended consequence of applying less irrigation water is a reduction in aquifer replenishment.

If more water is "mined" than can be replenished naturally or through discharge efforts, serious problems result. Mining underground water from aquifers simply means withdrawing the water at a faster rate than it is being replenished. This is also called "overdraft." In coastal areas this can lead to saltwater intrusion, which is when overdraft causes groundwater levels to be below sea level, thus degrading the aquifer and making it too saline for domestic or agricultural uses.

In the Pajaro Valley in Santa Cruz County the aquifer is being overdrawn by over 12,000 acre feet per year, and approximately half of the basin has groundwater levels at or below sea level. Saltwater has moved several miles inland. Mitigation has resulted from a managed aquifer recharge program that consists of recycling projects and from recharging the aquifer with recaptured storm water runoff.

Another problem with groundwater is subsidence. If water is drawn down too quickly without recharging the supply from a source such as recycled water or excess water during wet years, the aquifer can collapse, causing the ground to subside and making it essentially impossible to recharge. This is a more serious problem in the southern part of California than in the north. In the Santa Clara Valley Water District a successful subsidence abatement program has been initiated using managed aquifer recharge.

In the Oglala aquifer of the American Great Plains the problem is simply tremendous overuse. This valuable groundwater resource extends over many states -- southern South Dakota, Nebraska, eastern Colorado, Wyoming, New Mexico, western Kansas, Oklahoma and Texas -- complicating jurisdictional issues. Predictions are that if water is mined at the current rate, 70% of the aquifer's water could be depleted in the next fifty years, and this part of the country would be suitable only for crops that can be grown with local rainfall.

If increasing demand for agricultural products, especially from animal sources and the grain needed to produce them, can only be met with conventional industrial agricultural practices, then sustainability will become an increasingly difficult challenge. Finding the right balance to feed the world in a way that is sustainable for the long term may require considerable research, public education and changes in public policy. Water and nitrogen inputs will have to be applied more efficiently to reduce pollution, and limited resources of land, fertilizer and water will need to be managed more wisely.

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