AGRICULTURE AND WATER QUALITY: OLD PROBLEM, NEW URGENCY

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...[The] fundamental issue here is the recognition and acknowledgement that, no matter what, agriculture disturbs the natural environment. The real issue is how much disturbance society will accept; not whether it will accept any at all.

The bottom line is that farmers need to understand that there will indeed be a cost to pollution abatement and that it may well be their responsibility to accept those costs in moving quickly to meet society's objectives for protection of environmental quality.

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All sectors of the agricultural community need to face up to a number of basic realities. First, the pressures will increase as the public demands that more emphasis be placed on environmental quality.

Second, there are legitimate concerns about the health and environmental effects of agricultural chemical use. Our past assumptions are being proved incorrect with each discovery of a chemical in groundwater.

Third, the farm and rural sector has a lot to gain or lose in the environmental debates and must now become a part of them.

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When traces of agricultural chemicals show up in well water, chances are the news media and the public health authorities will show up as well. The public response to media reporting of groundwater contamination incidents has been substantial; a 1986 Harris poll reported that 86 percent of Americans surveyed considered drinking water contamination to be a serious problem (Reichelderfer and Hinkle).

The concerns of consumers about their drinking water are reflected in the fact that sales of bottled water in the United States tripled between 1976 and 1988, reaching nearly $2 billion yearly (Castleman).

The reason for widespread public concern is simple enough: groundwater is a source of drinking water for almost 50 percent of the United States population (Batie, Cox, and Diebel). Agricultural sources of contamination have become the object of concern because agricultural chemicals have been found in groundwater in several highly publicized instances around the country. The presence of agricultural chemicals in groundwater has resulted in large public expenditures for remedial measures.

In one instance, the offending pesticide had its registration cancelled, effectively banning its further use (Carriker). Such instances, though isolated, have sufficed to call public attention to agricultural uses of chemicals and to create concerns over the safety of drinking water supplies.

The growing public concern about agriculture and water quality has been accompanied by an increasingly negative view of agriculture and the land grant colleges on the part of the public. Farmers are being admonished by people of substantial political influence to take responsibility for agricultural impacts on the environment. President Bush has endorsed a Federal initiative to protect groundwater resources from fertilizers and pesticides, stating explicitly that, ultimately, "...farmers must be responsible for changing production practices to avoid contaminating ground and surface waters" (Offutt, p. 138).

Recently, the agricultural research establishment has been criticized for dragging its feet and for failing to give sufficient emphasis to adverse impacts of agriculture on the environment. For example, Senator Fowler (D-Georgia) has chastised the USDA for failing to take "adequate steps" to educate farmers about the possible consequences of polluting water supplies with pesticides and fertilizers, adding that USDA is providing "very little guid-
ance" in the area of alternative farming methods ("Senators Criticize USDA's Efforts to Protect Groundwater," p. 17). A report by the National Research Council, entitled *Alternative Agriculture*, says that research from land grant universities and the USDA has failed to address adequately "the integration of study results essential to the adoption of a number of alternative farming methods as unified systems," and to "...adequately integrate the results of this research into production systems" (National Research Council, p. 138). Initiatives related to alternative agriculture do not always have the support of the state colleges of agriculture (Batie). People who, for a variety of reasons, feel that major changes are needed in agricultural practices often perceive that college of agriculture administrators are apologists for established agricultural interests and are reluctant to consider proposals for research in alternative technologies. They say the land grant interest in alternative technology is tentative, cautious, and out of step with the times.

Although agricultural impacts on water quality have been recognized for several decades, the current emphasis on agricultural contamination of groundwater and the increasingly negative view of agriculture and the land grant colleges projected by the news media and by policymakers attach a heightened sense of urgency to the issues. Why are elected officials and others in society dissatisfied with the efforts of the USDA and land grant universities to resolve issues concerning agriculture and water quality? Why has the land grant establishment and the agricultural community failed to marshal a response to water quality concerns that meets with the respect and the approval of society? The main thesis of this paper is that there are "hidden obstacles" to communication about the relationship of agriculture to the environment and about the appropriate role of land grant universities and the USDA in resolving agriculture-related water quality problems. If this thesis is valid, the manner in which issues are conceptualized and information is presented may need to reflect heightened sensitivity to those obstacles to communication if agriculture and the land grant establishment hope to maintain (or to reestablish) their credibility with the public and with policymakers.

**A LOOK BACK**

Water quality concerns are not new in our history. Reasonable people have been making and writing articulate observations about agriculture and water quality for several decades. In 1919, the Indiana Food and Drug Commissioner had this to say:

the water in a well is nothing but water which falls on the surface of the ground and, after leaching all the organic matter with which it comes in contact, collects in a man-made cavity. ...The farm well, originally pure, is often enough subject to the baneful influence of barnyard, privy vaults and kitchen wastes (Barnard, p. 552).

Beginning about thirty years ago, the public has been fed a steady diet of articles with titles such as "Is Your Drinking Water Safe?" and "Time Bomb in our Tap Water" in such magazines as *Reader's Digest*, *Good Housekeeping*, and *U.S. News and World Report*. In 1960, Alvin Toffler, who later wrote the book *Future Shock*, wrote an article entitled "Danger In Your Drinking Water," in which he identified a troublesome group of new contaminants [including] insecticide, pesticide, weed killer, fertilizer, and other agricultural chemicals and poisons which are, in one way or another, beginning to get into our water sources (Toffler, p. 128).

Between 1956 and 1960, sales of important agrichemicals quadrupled. According to the scientific analysis of the time, "the traces of these substances found in the water are far below toxic levels. They are measured in parts per billion" (p. 128). Toffler warned, however, that normal treatment does not remove the contaminants, and that science offers no conclusive answer to the question "what is the cumulative impact of these chemicals, singly or in combination, on human beings who drink them?" (p. 128).

The effect of agriculture on water resources was recognized early on. However, the perceptions and urgency of environmental issues in general and water quality in particular have become more focused over time. In the 1940s and 1950s the *Journal of Soil and Water Conservation* published over a dozen articles on drainage—how to install tile in order to cultivate "areas with too much water." In a 1946 breakdown describing land uses in the United States, 127 million acres were characterized as having "too much water." To the extent that ecologists understood the linkages between wetlands and equilibrium in natural systems forty years ago, their ideas had limited influence on farmers' elaborate plans to tile wetlands to create cropland. Ecology and production agriculture were separate realms. Farmers and other people with economic and political power could "dismiss ecologists as impractical visionaries...as perhaps well-meaning but completely unrealistic" (Briggs, p. 5).

that help explain today's concerns over the safety of farm chemicals and the importance of water quality issues on the public policy agenda. Many people remember *Silent Spring* as a sensationalized, emotional plea against DDT killing robins in the suburbs. Twenty-eight years later, however, *Silent Spring* stands out as well written and well documented. In Carson's words:

> It is not my contention that chemical insecticides must never be used. I do contend that we have put poisonous and biologically potent chemicals into the hands of persons largely or wholly ignorant of their potentials for harm...I contend, furthermore, that we have allowed these chemicals to be used with little or no advance investigation of their effect on soil, water, wildlife, and man himself (Carson, p. 12).

Carson asked people to question their faith in science, technology, and power, and offered an alternative ideology (Dunlap). She urged people to recognize their ultimate dependence on the process of nature. She urged people to realize that it would be better to work with, rather than against, ecological forces.

The environmental concerns so eloquently stated in *Silent Spring* began to be reflected in the farm press during the 1970s. *Successful Farming* magazine published a four-part series entitled "Pollution Is a Dirty Word" in 1971. The series discussed pesticides, fertilizer and erosion, animal wastes, and agrichemical residues in foods.

Nobody wants to pollute—especially farmers, who own, control, and use more natural resources than any other industry. But the chances for pollution are inherent in farming today, ...

Individual mistakes in using agriculture's input materials can hurt the whole industry. But if individuals can't use them responsibly, chances are the government will deny their use at all (Sanders, p. 23).

Many of these messages from the past could easily have been written today. If our rhetoric has been correct for decades, then why is there a new sense of urgency about agriculture and water quality today? If we have recognized these problems for decades, why has the agricultural community failed to prevent the problems and to avert what now appears to be a political crisis? Rachel Carson would probably approve of the modern interest among many people, including some farmers, in systems of farming that reduce chemical use, use less energy, reduce soil erosion, and reduce the likelihood that farming will contaminate water supplies. But why do venerable institutions for agricultural research and education seem unable to gain recognition for leadership in the solution to agriculture's environmental woes?

**HIDDEN OBSTACLES TO COMMUNICATION**

One plausible hypothesis was offered by Stan Dundon in a 1982 paper entitled "Hidden Obstacles to Creativity in Agricultural Science." Dundon introduced the concept of rival "paradigms" as a way to characterize different world views that, by their nature, inhibit communication between adherents to different paradigms and that create obstacles to creativity within a paradigm. He uses, as an example, the effect of the discovery of the herbicide 2,4-D on the entire research area involving weed control. In 1944 two USDA scientists discovered that 2,4-D could kill 98 percent of the clover in golf turf, leaving the turf undamaged. In 1943 (the year before their discovery) there were only 49 citations under "weed" in the USDA *Bibliography of Agriculture*. By 1949 there were 600. The weed science establishment had begun to flourish. It focused its efforts on elaborating the success of 2,4-D. Many new compounds were discovered and much fine tuning of herbicides ensued.

Clearly a paradigm had been established for applied weed science—a paradigm based on chemical controls. Dundon notes that scientific work within such a paradigm is dynamic, directed, and, due to past success, colored with optimism and usually backed with administrative support. It is therefore rewarding to the scientist who contributes to it, both intellectually and in terms of career prospects. On the other hand, other approaches to weed control, such as mechanical cultivation or biocontrol, are viewed as riskier, are less favored by administrators (who after all must have success stories), and therefore eventually shunned by the research establishment.

This phenomenon makes it difficult for the research establishment to accept suggestions for new ways of achieving the mission—in this example, the mission of weed control. As new faculty are hired and graduate students are trained, the expertise of the research establishment, the tools of the trade, and the theory become focused on those required by the dominant paradigm. The disciplinary journals become specialized and the definition of relevance and acceptability are defined in terms specified by the paradigm. By definition, ongoing, mission-oriented research includes the goal in the paradigm (in this example, chemical control of weeds) so that new goals pressed on the institution from the outside...
(chemical-free agriculture) will appear foreign not only to the scientific paradigm but also to the concrete equipment and personnel orientations of the institution.

One result of the exclusionary effects of this phenomenon, in Dundon's view, is that budgetary requests from research administrators to Congress are confined to program maintenance—maintenance of the programs tied to the dominant technological paradigm. If Dundon is correct about this tendency, his hypothesis may explain why politicians criticize the USDA and, in turn, land grant universities for not aggressively pursuing funding for alternative agriculture research.

Dundon insists that the technologies widely employed and supported by the agricultural research establishment have, for several decades, been predominantly "nature-dominating" technologies. The conventional production approach stresses productivity and increased yields, using intensive inputs in the form of commercial fertilizers, pesticides, supplemental irrigation, and petroleum-powered farm equipment. This approach is in sharp contrast to the "nature-accommodating" approaches that apply biological technologies so that sustainable agriculture can exist within the constraints of the natural resource base (Dundon, p. 860).

The nature-dominating proclivities of the USDA-land grant establishment might not pose an issue for society were it not for the fact that the establishment has enjoyed a virtual monopoly on both public funding for agricultural research and on access to the advice-givers to whom farmers turn for information about farming practices. The result, in Dundon's view, is a domineering research establishment that is hooked on "nature-dominating" technologies, and for reasons not even apparent to the researchers themselves, is resistant to outside demands for new, more environmentally benign approaches to food and fiber production. This combination of circumstances is an interesting explanation for the apparent recalcitrance of colleges of agriculture in the face of growing public demand for new farming methods that reduce adverse impacts on the environment.

Whether or not we accept Dundon's hypotheses about the role of paradigms, it is clear that the body politic is trying new methods of influencing the research agenda. The President's new budget contains a multimillion dollar package for agricultural research on a competitive grants basis, in addition to the normal outlays in formula funds to the land grant colleges of agriculture. The explicit reason given for this additional grants program is to break the near-monopoly of the colleges of agriculture on public research funding. Some states, such as Arizona, Iowa, Connecticut, and Minnesota, have allocated state monies to land grant universities to support programs targeting Integrated Pest Management or alternative agriculture research.

The agricultural production technologies in vogue during the past couple of decades are changing and will no doubt be modified further in the years to come. To label today's colleges of agriculture as completely unresponsive and to assert that all the agricultural technologies they promote are "nature-dominating" would be an overstatement and would be a disservice to many researchers and teachers within these institutions. The general tone of the public discussions about agriculture and water quality, however, make clear the perception that serious differences of opinion exist.

It is also clear that the land grant establishment is not the only group hampered by "hidden obstacles to creativity." "Alternative agriculture" is not a technology readily understood and ready for application in the thousands of site-specific and commodity-specific circumstances wherein people currently earn their livelihood by farming. In fact, it is quite likely that the "hidden obstacles to creativity" are as much a problem for the critics of the land grant establishment as they are for the establishment itself. If the establishment has been slow to "get the message," it is entirely possible that its critics have not always delivered a clear message about how to make the transition from conventional to alternative farming methods, nor have they provided incentives that make a difference in farmer's decisions. Many of the benefits ascribed to alternative agriculture are what we in economics have referred to as public goods—those that benefit society but that cannot be appropriated by farmers. Perhaps this is why alternative agriculture has not caught on with farmers and with the land grant establishment with the same fervor that 2,4-D did.

The most extreme critics of current agricultural research and education efforts call for a fundamental redefinition of "good science." In this context, it is useful to consider that the National Research Council's definition of alternative agriculture is any system of food or fiber production that systematically pursues such goals as the following:

—Reduction in the use of off-farm inputs with the greatest potential to harm the environment or the health of farmers and consumers;
—Profitable and efficient production with emphasis on improved farm management and conservation of soil, water, energy, and
biological resources.
(National Research Council, p. 4)

The striking aspect of this definition is that it sums up what most land grant researchers feel their work is all about. The difficulty in communication therefore must reside in numerous details and assumptions about the goals of agricultural research and agricultural production.

For example, a colleague in the Soil Science Department specializes in the study of pesticide behavior in soils and water. His applied focus is to develop more refined guidelines for pesticide use that will minimize the likelihood that pesticides, properly applied, will find their way into the groundwater. In his view, and in the view of his administrators, this work is in the best tradition of research in the public interest. Unfortunately, his work finds no favor at all among individuals whose view of alternative agriculture means "chemical-free" agriculture.

SO WHAT ARE WE TO DO?

In the broadest sense, and in the long run, society needs environmental quality and a viable agriculture. For compelling reasons we must have both. Few dispute this assertion, but the disagreements arise at the margin—in terms of commodity-specific impacts of pesticide regulations, site-specific impacts of restrictive zoning for well-head protection, and the host of issues relating to who stands to gain and who stands to lose as society changes the way it relates to agriculture and water quality.

The divisive issues will go unresolved unless the barriers to communication that result from differing paradigms are successfully identified and eliminated. Some immediate steps to address the current issues of agriculture and water quality should include seminars and workshops that contrive to find people who hold differing perspectives and help them to understand one another. Clearly not everyone is willing or able to appreciate views contrary to his or her own. Conducting this type of "paradigm-clarification" will be difficult to do without evoking the charge that the process itself is inherently subversive.

In our extension programs with farmers and others we probably need to pay more attention to the explanation for why government regulates wetlands conversion, wastewater discharges, or consumptive water use. The rationale for government intervention for environmental protection may not be as obvious to farmers as we presume it to be. By the same token we must be energetic in our efforts to dispel erroneous assumptions about agricultural impacts on the environment when we know these assumptions to be false or exaggerated.

Efforts should be made to propose specific problem-solving research projects, avoiding the tendency to address only hypothetical problems or to focus exclusively on ongoing disciplinary research. A lobbyist for land grant colleges said recently that congressmen need to pass legislation that helps people and solves problems. There is a greater willingness to consider special funding for clearly specified problem-solving research projects than to increase formula funding in the hope that the system will generate useful results.

In short, there is a critical role for education. Forums must be provided for discussions about human values, the implication of technological paradigms, and the associated differences in beliefs and perceptions that influence the ease with which adversaries are able to communicate with each other about important issues of mutual concern. Fulfilling that educational role will be a productive step toward eliminating the "hidden obstacles to creativity" in agricultural research. Perhaps more importantly, it will allow us to find and eliminate the "hidden obstacles to communication" about the issues that seem to divide us.

REFERENCES


