Chapter 6

Public Influences on Agrichemical Contamination of Groundwater: Findings, Issues, and Options for Congress

CONTENTS

Boxes

Figures

Tables

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INTRODUCTION

Since the founding of the United States, agriculture has been a mainstay of the economy, and an important component of our cultural heritage. Although the number of farmers has declined over the last 50 years, the food and fiber sector currently accounts for about 18 percent of the gross national product (GNP). Farm production accounts for about 2 percent of total GNP, and farm input industries contribute only another 2 percent. The number of farmers has declined to just over 2 million, or roughly 3 percent of total employment (172).

Between 1970 and the early 1980s, agriculture maintained a favorable annual trade balance while almost all other sectors of the economy faced growing deficits (178); that surplus declined with the rise in the dollar's value and other world economic changes during the early 1980s. Since the dollar's devaluation, which began in 1985, the agricultural surplus recovered substantially, from a low of $5.4 billion in 1986 to $16.4 billion in 1988 (178). In addition, American agriculture has continued to produce a relatively low-priced domestic food supply; on average, Americans spend only 15 percent of per capita income on food whereas other developed countries may spend as much as 23 percent (e.g., Japan—21 percent, West Germany—23 percent, United Kingdom-19 percent, Canada—16 percent) (128).

Maintenance of an abundant and affordable food supply has occurred despite the decline in number of farmers due to the scientific and technological advances occurring largely since World War II. Since that time, farms have become more specialized-moving from a diversity of crop and livestock products toward concentration on one commodity—and more dependent on off-farm inputs. Further, widespread adoption of high-yielding hybrid seeds, commercial fertilizers, and pesticides increased specialization in certain crops, even continuous cropping of a single commodity crop. For certain crops, such as corn, the costs of fertilizer and pesticide inputs exceed all other operating costs (1 12).

Commercial fertilizers and pesticides have been widely accepted given their time and labor savings and relatively low cost, particularly at times when oil and natural gas prices were low. Product cosmetic quality standards and increasing pest resistance also have spurred agrichemical use. Wide recognition of the benefits of agrichemicals may have led to their application in larger amounts than needed, or to more frequent, ''prophylactic' applications to reduce risk and assure consistent crop yields. Few farmers, agricultural researchers, or policymakers were considering the possibility of unnecessary costs associated with wasted agrichemicals; some may have assumed that applying 'a little extra' was still cost-effective in terms of reduced time, labor, and worry. Farmers are likely to welcome assistance and technologies that reduce their operating costs or provide the same benefits of lowered time and labor inputs. However, many will understandably question the need to reduce agrichemical use if this means reduced income or increased management demands or risk.

The United States also has seen an "environmental revolution' occur during this century, emerging into a force of widespread national significance since the late 1960s. Legislation restricting the ''rights' of those degrading environmental quality have been increasingly enacted, following a progression from the more visible to less visible (e.g., end-of-pipe effluent controls to more general protection of surface-water quality); the more attributable to less attributable (point-source pollution to nonpoint-source pollution controls); the more easily blamed ''corporate villains' to less easily blamed "common man" (e.g., industry to farmers and households); and from specific human health hazards to general environmental degradation threats.

The environmental concerns specifically attributed to agriculture have similarly followed a progression: from "on-site," to "off-site" and, today, to ''out-of-sight. Concern over soil erosion's capacity for reducing soil fertility and thus farms' productive capacity has run high since the Dust Bowl era (1930s), prompting substantial Federal involvement in farm and natural resource manage-

ment. Added concerns for surface-water quality, such as sedimentation of navigable waters and lake eutrophication, drove the development of conservation programs leading to those instituted in the 1985 Food Security Act. And today, concerns are arising about agriculture's contribution of invisible chemical gases to acid rain and climate change. Similarly, concerns about agrichemicals, especially pesticides, have moved from restrictions on use of those directly hazardous to their handlers or other farmworkers, to restrictions based on long-term hazards to the consuming population, to wildlife, or to the environment generally.

The current concern about agrichemical contamination of groundwater can be seen, thus, as a natural part of the progression of these trends. As governmental policy and programs address the "easier" environmental concerns, the public enters debate over the harder ones. Each 'era' involves balancing public desire for zero-risk or zero-degradation of the environment, on the one hand, and economic need for chemical use or waste disposal on the other. Because in agriculture at least, achieving zero degradation is impossible, and because agriculture is so important to the continuation of U.S. society and economy, the trade-offs may seem more difficult. Further, because agriculture has been largely exempt from the environmental restrictions placed on industries, it is perhaps facing a more abrupt demand to change. Transition to more environmentally responsible practices may require precipitous changes in traditions and practices. However, this transition is not substantially different from those that have gone before in other sectors: the public wants the benefits of a productive agricultural sector with a minimum of environmental costs.

While it may be impractical to deal with all cross-cutting environmental and agricultural issues at once, going to the other extreme and dealing just with groundwater out of the context of the surrounding environment may lead to inappropriate actions. More specifically, laws that address only a fragment of the hydrologic cycle will fail to address problems completely, and may inadvertently create new problems (1 18), that will give rise to further public demand for change. Because nonpoint-source groundwater contamination is largely beyond reach of remedial actions, prevention of groundwater contamination is the only means currently available of safeguarding a major environmental resource.

Similarly, it is impractical to expect that U.S. agriculture solve its associated environmental problems instantly. A comprehensive approach to the cross-cutting issues of agriculture and the environment will take time to develop, to implement, to evaluate, and to adapt to ever-changing conditions. Thus, development of policies today to deal with agrichemical contamination need to be made with consideration of how these policies, and the changes in U.S. agriculture that they foster, will fit into the larger picture of environmental and economic change taking place in this country. This requires a long-term view, and an analysis of the institutional capacity for foresight and for change.

Summary of Obstacles to "Solving the Problem"

Prevention or minimization of groundwater contamination from agricultural sources is fraught with barriers, some of historical precedent and others inherent to complex systems. Obstacles to preventing agrichemical contamination of groundwater have been shown to include the following:

- *Inherent obstacles (see* chs. 2 and 3), such as the nonpoint-source character of contamination, complexity and variability in site characteristics, close linkages of groundwater with other resources and resource issues, and uncontrollability of important factors such as weather.
- *Intrinsic obstacles (see* ch. 4), deriving from the functioning of agriculture within natural cycles that cannot be halted; and the systems nature of U.S. agriculture, such that pest control and nutrient management cannot be separated from other elements of farming, or from management of off-site resources.
- ***Extrinsic obstacles (see*** ch. 5), deriving from the diverse characteristics of farms and farmers, the nature of the current structure of U.S. agriculture, and the nature of agricultural and economic policies.

In each of these are significant areas where insufficient knowledge inhibits development of clear-cut policies. Thus, legislation that endeavors to be a cost-effective approach to reducing agrichemical waste or contamination of groundwater must be designed for high levels of uncertainty. Further, three cumulative lag times may make changes in groundwater quality unnoticeable for decades: 1) lag time of chemicals already applied and moving

through the soil profile to appear in groundwater; 2) lag time in research to develop and make available practices, especially if highly site-specific; and 3) lag time in adoption of practices and transition of farm management.

Several conclusions derived from this assessment have clear policy implications. First, agriculture is a national, strategic resource (13); the agriculture sector of the economy is and will continue to be a mainstay of the U.S. economy and society. Moreover, it can be considered a strategic industry in that loss of the capacity to supply basic commodities to the domestic population could be considered a threat to national security. Options that severely reduce the U.S. capacity (in terms of amount of productive farmland, of farmland productivity, or of number of skilled farmers) to produce food to feed the domestic population are clearly adverse to the interests of society.

Agriculture also is characterized by significant natural and farm diversity: no technological "black box" exists that can be universally adopted to solve agrichemical contamination of groundwater. Moreover, agrichemical will not, in the foreseeable future, be entirely replaced by other technologies or management practices. Although we are entering a new, and potentially revolutionary era in U.S. agriculture, with a concomitant change in focus from mechanical and chemical technologies to biological/biotechnological, and informational technologies (162), its ability to resolve the problems created by current practices is not yet defined. Environmental problems could be addressed by changes in bioengineering and information technology such that agrichemicals, as they currently exist, may eventually be rendered a minor part of U.S. agriculture. Still, strong forces are driving change in agriculture requiring changes in the form and use of agrichemicals today.

Agrichemical contamination might be addressed by simply banning (canceling registration and prohibiting new registration) all pesticides detected in groundwater (or groundwater and surface water) to date, or those fulfilling agreed-upon criteria for "leachers." However, this policy could not include nitrate, the most common agrichemical groundwater contaminant, which derives from multiple (including natural) sources, and is necessary for sustaining agricultural production. In addition, banning all chemicals appearing in groundwater could result in cancellation of ''non-leachers' '—pesticides that arrived in groundwater through point sources. Such a policy of banning pesticides without any consideration of the potential impacts of exposure (human, animal, or ecosystem) to agrichemically-contaminated groundwater, is likely to be a politically untenable solution placing potentially unnecessary and therefore unacceptable burdens on farmers.

Only point sources of agrichemicals are readily amenable to regulatory actions, given difficulties and high costs of monitoring and enforcement for nonpoint-source pollution. Further, the historical dependence on incentives and voluntary adoption of changes in farming practices implies that sweeping regulatory actions will be controversial and not easily instituted. Finally, the combined dearth of necessary knowledge and the need to make assumptions and generalizations in national policy, disallow any simple policy solution. There are no simple answers: reducing agrichemical losses or contamination of groundwater likely will require a combination of new or modified programs involving education, incentives, technical assistance, technology research and development, and regulation.

Call to Action on Agriculture and the Environment

A growing public concern about risk to safety, health, and the environment combined with an apparent growing public distrust of governments abilities to minimize or eliminate these risks is spurring demands that Congress, and Federal and State governments take action on agriculture and the environment. The growing urbanization of the U.S. population, and thus of Congress, will likely result in more vociferous or numerous arguments that agriculture address its associated environmental problems.

Changing Views of Public Risk

Public concern over agrichemical contamination of groundwater illustrates the extent to which perceptions of risk are changing. While the presence of agrichemicals in drinking water have been shown to have some association with disease and mortality, public surveys have shown that contaminated groundwater commonly is believed more risky than other conditions suggested by some scientists to be more hazardous to personal health (e.g., indoor air pollution). Individual and, thus, societal decisions about risk may depend more on the conditions of exposure

than on knowledge about the probabilities of adverse outcomes. For example, people tend to accept risks if they are self-imposed or if they are familiar. However, agrichemically contaminated drinking water involves an involuntary risk; one associated with a resource for which there are no substitutes (i.e., water), with unfamiliar multisyllabic chemical names, and with uncertain and far distant consequences (6).

The public's understanding of relative risks often is called ''perceived risk" to distinguish it from a scientifically determined ''real, ' or ''measured risk. " A common response to a disparity between "perceived" and "measured" risk is to call for increased communication with and education of the public (64). Further, claims are often made that the public is ignoring risks much more hazardous than those appearing in the press and on television, and thus their attention should be redirected towards the ''real' risks, presumably allowing the ''perceived' risks to sink low on lists of concerns: to end a ''constant squishing of ants while the elephants run wild" (85).

However, risk assessment, and thus risk management, cannot be value-free (19). The difference between ''measured risk" or "relative risk' and ''perceived risk' may lie in the relative differences between public and scientific estimates of values, or differential knowledge about the extent and strengths of values. For example, economists continue to try to thrust natural resources conservation into economic terms, whereas the public seems to care more that tap water has no additives than about the monetary trade-offs involved in resource protection versus economic development. Thus, the obverse may be true, the scientists and decisionmakers may need to listen more closely to the public's risk assessment.

Because the decisions about the risk of adverse impacts from consuming contaminated groundwater include societal valuations as well as scientific determinations, they involve ''transcientific' questions-questions that cannot be answered by science alone. And, because such questions involve consideration of values, and differing values are held by different groups in society (e.g., consumers, producers, urban environmentalists), risk management and communication decisions must be negotiated between those concerned and those who govern the process that decides and acts on the risk. Clearly, the public is unwilling to wait until scientific inquiry provides all the facts necessary to determine an uncontroversial, measurable level of risk. Instead, it is calling on Congress to meet a challenge 'posed by policy-related science issues, characterized by uncertain facts, disputed values, high stakes, and a need for urgent decisions" (19).

When organizations are perceived to be ignoring the values voiced in the debate, the public has a tendency to lose faith in the ability or willingness of the organization charged with minimizing risk, and may undertake risk management on its own. For example, information about potential risks from consuming apples treated with a growth regulator (Alar) prompted people to seriously reduce their consumption of apples, causing apple growers to lose nearly $25 million over a 2-month period in 1989 (173). Such unanticipated changes in consumption can have far more adverse impacts than a gradual shift in production practices in response to public concerns.

The oft-repeated statement that the U.S. food supply is the most safe, most varied, and cheapest in the world is now being countered by public pronouncements that belie a trust in the safety, and a willingness to ''sacrifice' variety and low prices to regain perceived safety (cf: 61). A recent news report cited a demonstration against aerial spraying of malathion to combat the Mediterranean fruit fly (the "Medfly") resolving into a chant to "Just say no to oranges! (99). California orange growers may lose substantial amounts of money by ignoring the Medfly, but they may lose as much by ignoring the public.

Growing Distrust in Bureaucracies

Consumers may increasingly take risk management into their own hands as trust in the government's capability to protect them from unacceptable risk declines. For example, discovery that EPA's estimate of the percentage of apples treated with Alar was incorrect, and its later cancellation of the use of Alar due to disclosure of additional health risk information, only fueled a g-rowing public concern that government organizations may be unable or unwilling to provide the level of safety demanded by the public. Similarly, EPA's database on the impacts of pesticides depends on studies conducted and data generated by the chemical companies who stand to gain by registration of the chemicals. This has long been a suspected source of conflict of interest (cf:

Photo credit: U.S. Department of Agriculture, Agricultural Research Service

The Mediterranean fruit fly (Medfly) damages numerous types of fruit crops. Malathion spray programs used for Medfly control in California have caused considerable controversy.

48), and another reason for public distrust of government assurances of safety.

> As water resources problems in this country grow increasingly complex and interrelated, so too have the institutions and the programmatic and regulatory cures devised by government. Fragmentation, excessive ''red tape, ' and lack of incentives for innovation have called into question the problem-solving capacity of our institutions. . .. The problem centers on the inability of governments to collectively translate beliefs into tangible results. If left unattended, this problem will continue to seriously weaken both the credibility and performance of government services at all levels (86).

Increasing Urbanization of the American Public and of Congress

U.S. agriculture has changed significantly since the onset of the ''chemical revolution. During the Depression, farm families still made up one-third of the U.S. population, and Federal government involvement in agriculture, already well-entrenched, expanded to include even more wide-ranging programs. In the 1980s, however, the budget crisis and ballooning payments to farmers, consumer concerns about food and drinking water safety, and increasing concern about environmental quality led urban interests and their representatives to reexamine the Federal role in agriculture (135).

The number of congressional districts considered "farm-oriented" totaled only 46 (out of 435) in 1986 (72). This number is expected to drop further with congressional district reapportionment after the 1990 census. Urban interests have historically tended to be more strongly ''consumerism' and ''environmentalist" than agricultural interests (cf: 135).

While Congress and governments may prefer to defer decisionmaking on agrichemical contamination of the environment until more information is available, or until a path of incremental changes in institutions, policies, and programs can be clearly determined, it seems unlikely that the current public clamor for action will subside. Actions to gain needed knowledge, to develop technologies with potential to reduce agrichemical contamination of groundwater, and to increase adoption of such technologies already are underway, promulgated by Congress, by Federal agencies, and by State and local government agencies. However, institutional structures and interrelationships among these institutions, which were designed for or have evolved to address other purposes, seem likely to hinder development of an integrated, comprehensive approach to reducing agrichemical contamination of groundwater or to reducing the adverse impacts of agriculture on the environment.

Overarching Barriers to Preventing Agrichemical Contamination of Groundwater

Protection of the Nation's groundwater resources has become an issue of pressing concern to the public, to Congress, and to many Federal, State, and local agencies. Agencies and organizations at all levels are undertaking programs designed to affect a farmer's choice of technology, and thus the potential for introduction of agrichemicals into groundwater. Consequently, to the earlier list of obstacles to preventing agrichemical contamination of groundwater must be added the overarching barriers-the *meta-obstacles-posed* by organizational histories, structures, and interrelationships that determine policies and programs affecting farmers' decisions. These overarching barriers include:

- rapidly *changing perceptions **of** agriculture and environment* and lack of expressly defined goals in either area;
- *multiplicity **of** organizations* involved and difficulty defining relative roles or coordinating efforts;
- complex and *entrenched missions and operating procedures* of agencies and programs, especially those with long histories, that commonly hinder incorporation of or directly conflict with new missions or goals; and
- *declining human and financial resources* available to all levels of government, with concomitant concerns over dilution and duplication of effort, and over ***inadequate information*** availability, reliability, and accessibility for decisionmakers at all levels of the public sector.

Each of these has myriad policy implications that Congress could address.

CHANGING PERCEPTIONS OF AGRICULTURE AND THE ENVIRONMENT

Introduction

Water circulates continuously through the hydrologic cycle (ocean, atmosphere, and land); movement of water from surficial sources to groundwater or oceans and vice versa is a common attribute of the cycle. Agrichemical contamination of water can originate at various phases of the cycle. The route of contamination commonly is difficult to determine, highlighting the need for an integrated approach to development of groundwater protection schemes.

The 1980s witnessed an expansion of the traditional view of agriculture to include concerns over a broad spectrum of adverse environmental impacts attributed to conventional agricultural production practices. Agriculture's environmental externalities—"those costs borne by society and not reflected in market prices for commodities' '-exist, although they remain largely unexamined and unquantified (34).

> The environmental problems facing society and agriculture particularly may be largely attributed to the absence of a market for environmental quality. Society and farmers may in fact place a greater value on alternative uses for agricultural land than can be generated through commodity markets (104).

The Conservation Title (XII) of the 1985 Food Security Act (FSA) represented the initiation of this expanded approach to the development of agricultural policy (34,50). This Title contained a significant environmental component and clear identification of agriculture's responsibility for maintaining the resource base. Further, the creation of the Low-Input Sustainable Agriculture research program, and changes to other titles of the omnibus farm bill, indicate the tone is set for increasing legislative mandates related to agricultural impacts on the environment.

Adverse off-site impacts from agricultural production (e.g., soil erosion, groundwater contamination) may have large price tags, particularly when viewed in the light of recurrent commodity surpluses. Monitoring costs of potentially contaminated rural water-wells alone may range from almost $1 billion to $2 billion or more (174,1 17,34). Similarly, a 1985 study estimated that soil eroded from agricultural lands into surface waters costs $3 billion to $13 billion annually ($6 billion midpoint; 1980 dollars) (34). Although farmers may be bearing the costs of loss of farmland productivity due to erosion, and some may face the costs of contaminated water supplies, for the most part the environmental costs of agricultural activities are not borne by farmers, but by society.

Land-use and production practices of U.S. agriculturalists are now under scrutiny by the public-at-large; detections of agrichemicals in groundwater have served to catalyze public and political action. As a result, new socially-determined values have been identified to which the agricultural sector (producers, institutions, etc.) will need to respond (1 1). Despite ambiguous identification of the extent of agrichemical contamination of groundwater or of the realm of potential adverse impacts that may be generated by this occurrence, agricultural production practices are seen as a serious source of contamination (11),

Agricultural technologies and policies that have encouraged heavy chemical use and resource consumption are now perceived as having promoted agriculture's current economic and environmental problems. It has been suggested that broad changes in policies and production approaches will be needed to address these problems (34). The current legislative debate seems to focus on mechanisms to promote the integration of agriculture and environ.

mental concerns, with extremes falling into two major categories: 1) those believing that continued or increased agrichemical use would be environmentally catastrophic, and 2) others arguing that nonchemical production practices would render most of U.S. agriculture economically unviable. Neither situation is likely; reducing agrichemical losses and thus the adverse environmental effects of agricultural production is not necessarily incompatible with economic competitiveness (140,159).

The ability of the current agricultural system to reduce the adverse environmental impacts of agricultural is under question (162). A recent, report by the National Research Council identified a need for significant enhancement in the research and development efforts funded through the U.S. Department of Agriculture (USDA) as well as needs for multidisciplinary approaches to research and problem solving (1 13). The technological base from which researchers may draw potential solutions is increasing, with major emphases on biotechnology and information technologies. Ultimately the benefit of these advances to agriculture will be determined by how well they are integrated into a systems approach to agricultural production; one that incorporates productivity, economic viability, and environmental and public health protection.

Changing Definition of Public Trust Resources and Property Rights

Federal, State, and local governments exert substantial influence on agricultural land-use directly through such actions as property taxation, purchase or transfer of development rights, farmland preservation and right-to-farm laws, or more indirectly through environmental requirements or agrichemical-use restrictions (53,58). Governments also have established public interests in "privately-owned" resources such as surface water, wetlands, and endangered species, and some analysts have suggested that this may eventually extend as far as soil quality (9), or nature itself (147). The definition of a resource, and how it may be used, changes as knowledge and socially recognized values evolve.

The nature of property rights-an owner's accepted rights to control, use, or otherwise dispose of property-to natural resources has changed considerably since the publication of Rachel Carson's *Silent Spring in 1969 (25).* The rapid growth in land-use regulations and resource protection programs illustrates the accelerating social concern for ecological integrity. In relation to wetlands, an important part of the hydrologic cycle, recent court cases have affirmed that:

> Private land owners own a slice of an ecosystem-if not affirmatively obligated to protect the ecological role of their land, owners nonetheless do not have the right to alter the land's natural integrity by using it in a way that is incompatible with that role (84).

Court decisions have applied the public-trust doctrine-that the States hold certain resources in trust for certain public uses—to virtually any public use associated with surface water resources (e.g., navigation, fishing, recreation, aesthetics) (194,65). However, the U.S. Supreme Court recently recognized Federal authority to supercede historical States' primacy over the hydrologic cycle in its decision that Federal water law extends to protection of the lands that affect surface-water quality (84). Should the same principles be extended, for example, to groundwater recharge areas, agriculture and other development activities could be restricted beyond simple evaluation and registration of chemicals.

Inclusion of Agriculture in Environmental Stewardship

Under a new view of agriculture as an industry, liability for adverse environmental consequences generated by the activities undertaken in production has become an issue of broad public concern. Identification of responsible parties and degree of responsibility is a major point of debate. Is agriculture to be defined as a "strategic industry" such that the burden of liability is to be shouldered by all those who share in the benefits derived from its conduct (e.g., the taxpayer)? Or will a strict "polluter pays' approach be used? Likely, some compromise of these two extremes will evolve.

Historically, precedence has led to exemptions of specific agricultural activities from certain environmental protection acts. For example, irrigation return flow water is specifically excluded as a potential point source contamination route in the Clean Water Act.

However, the President's Water Quality Initiative specified that "farmers are ultimately responsible for avoiding contamination of water resulting from management practices they apply to the landscape' (165). Identification of agriculture as an industry with off-site environmental responsibilities is a new

concept for many producers, particularly with regard to responsibility or liability for environmental contamination. Further, many practitioners view the water-quality issue largely as an information problem to be addressed through minor changes to extant agricultural policies and programs, major emphases on research, and little regulatory involvement. Most agriculturalists view actions to reallocate property rights as unnecessary (1 1).

For many years, farmer surveys and farm organization representatives have indicated strong opposition to regulatory approaches in agriculture (130). Environmental regulations in agriculture have been viewed as threats to U.S. agriculture's ability to provide an adequate food supply for meeting domestic and export needs (cf: 59). However, farmers and farm organizations do not hold uniform views regarding environmental regulation. More recent surveys indicate that some farmers may have moderated their opposition to regulation, particularly in relation to agrichemical use (95,130). Farmers thus may be distinguishing between regulations with clear personal health and safety implications and those which they perceive to be poorly thought-out reactions to exaggerated or poorly documented environmental problems. Thus, representation of all farmers as being uniformly opposed to regulation fails to accurately portray the diversity of opinion among farmers or the varied reactions to a broad array of possible regulatory approaches.

Trends suggest that agricultural producers no longer will be exempt from environmental responsibility. Whether any assignment of liability will be in response to Federal or State legislative actions or some combination of these however, has yet to be defined. Legislative action at the State level indicates the beginning of an era of environmental law that will affect agricultural practices (140), Landmark State initiatives exist that clearly identify polluter liability based on current "best" scientific knowledge. These have come despite the dearth of knowledge of potential adverse health effects from long-term exposure to contaminants at specific levels.

Connecticut, for example, applied strict liability for groundwater contamination, whereby the polluter was responsible for damages regardless of the level of care exercised. The State is not required to prove fault, negligence, or harm. After a court finding that the owners of five of Connecticut's largest and most profitable farms were liable for frees and provision of potable water to injured parties, the Connecticut Governor's Task Force on Pesticides and Ground Water recommended that strict liability remain in force, and that those potentially liable (including golf course owners, etc.) make mandatory contributions to a self-insurance fund. The latter proposal was not adopted although the law was revised to ***reduce the*** burden if:

- agrichemical applications were made properly;
- the applicator is an active agricultural practitioner and the agrichemical was used for agricultural purposes;
- plans to minimize contamination potential are implemented by the applicator; and
- complete records of agrichemical applications have been maintained (12).

Still, under the revised law, farmers and chemical companies remain liable to some extent for contamination.

Detections of agrichemical contamination of private and public wells in California led to development and passage of Proposition 65 that clearly establishes polluter liability for contaminating water with chemicals known to cause cancer, birth defects, or reproductive problems in humans. Under this initiative, water contamination is defined as chemical content beyond what is considered the scientifically safe level. Proving its safety is the burden of the polluter. The Proposition applies to businesses with at least 10 employees (31,12).

A key advantage of policies emphasizing polluter liability is that much of the enforcement and monitoring responsibility falls under the purview of private parties, while under a no-fault approach, responsibility lies with public agencies. However, disadvantages of placing responsibility in the hands of private parties largely lie in the lack of incentives for: 1) monitoring, 2) research on groundwater issues, and 3) development of educational or preventative approaches to mitigate potential contamination. This construct becomes active once damage has occurred, and relies on the judicial system to mediate and determine liability and required compensation on the part of the polluter. In these cases, the burden of proof falls on the plaintiff (12).

Similarly, the precedent for liability for wrongful or negligent acts leading to water contamination currently exists. Criminal provisions exist within

numerous Federal environmental statutes, largely related to: 1) knowing or willful violations, 2) negligence, 3) misrepresentation of information to regulatory agencies, 4) disclosure of proprietary or confidential information, and 5) conflict of interest (1 16). Certain pieces of legislation (e.g., Clean Water Act) contain specific reference to punishment for release of pollutants into clearly identified water bodies or conduits thereof (e.g., ocean, sewer systems, etc.). Certain groundwater ' 'conduits' or ''tributaries' may fall under this Act (196), and thus penalties may apply.

Cross-Media Pollution and Media-Specific Programs

The final form and fate of agrichemicals are determined by their interaction with the agroecosystem in which they are applied. Certain cycles exist that are essentially unalterable within an agroecosystem and these cycles affect how inputs move and behave and where they ultimately will be deposited.

Environmental fate of agrichemicals may be affected by many factors including type and method of input, management approach, and the physical and biological attributes of agroecosystems. For example, nitrogen that is not taken up by an actively growing crop may have a variety of fates including: runoff (potential surface water contaminant), leaching (potential groundwater contaminant), volatilization (potential atmospheric contaminant), and immobilization (temporarily sequestered in organic matter). Reducing the potential for loss via one mechanism to one medium cannot ensure that loss to another medium will not occur. Thus, agricultural practices designed to conserve a specific resource (e.g., groundwater, atmosphere, soil) may in fact adversely affect another, particularly given the cyclic nature of certain contaminants (e.g., nitrogen) or contamination pathways.

Agricultural and environmental policy largely have been predicated on impacts affecting a single medium (e.g., air, surface water, groundwater), single sources (end-of-pipe industries, agriculture point source, etc.), or even single organisms (e.g., endangered species). While increasing recognition of the cross-media nature of contamination argues for development of a more systematic, comprehensive approach to environmental protection, the broad array of potential sources, routes, and impacts of contamination make development of such policies and programs difficult.

Currently, approaches to address agrichemical contamination of groundwater focus on regulatory approaches based on chemical attributes, development of risk assessment methodologies, and research on transport and fate of potential contaminants. While these factors warrant incorporation in environmental management approaches, the resultant Federal programs have not led to an integrated approach but rather, seem to exacerbate the existing fragmentation (132).

Prevention v. Remediation

Prevention has been asserted to be more effective (economically and technically) than remediation in agrichemical contamination of groundwater (cf: 117), and may be the more cost-effective approach to controlling all forms of 'environmental externalities. ' The Science Advisory Board for EPA has called for a more pro-active, preventative approach to environmental pollution (102).

The advantages and disadvantages of remedial treatment of contaminated aquifers has been an issue of much discussion and scientific research. Given current technology it seems that prevention of contamination is more feasible than attempting to reclaim aquifers. In many cases, the technology and science necessary for aquifer clean-up simply may not exist; in others, reclamation of degraded groundwater may be technically feasible but financially prohibitive. Preventative groundwater protection, however, is similar to preventative medicine. While prevention is preferred, it seems it is easier to get attention and allocate funding after problems occur (1 19).

Certain EPA planning documents suggest that aquifers known to be contaminated or unlikely to be used for drinking water should be designated as ''dumping areas,' while pristine aquifers should be maintained as drinking water sources, This strategy, however, presumes sufficient understanding of underground water flow to ascertain that contamination will not move from one region to another (144). It also presumes that the degraded aquifers will not be needed in the future.

New Technological Revolution in Agriculture

New technological tools are becoming increasingly available for application in agricultural production. Advances in biotechnology show promise for affecting current production practices significantly. For example, development of pest-resistant

Table 6-l—Percentage of Scientists by Field at 4-Year Colleges and Universities Receiving Federal Science Agency Support, 1987

Field of science and selected disciplines within fields	Number at colleges/ universities	Percent receiving			
		USDA funding	USDA comp. grants	NSF grants	NIH grants
Agricultural scientists	8,654	63.3	3.2	4.8	1.6
Economics related	1,838	68.1	NA	1.0	0
Plant biology-related	2,511	63.6	NA	6.0	1.5
Biological scientists	40,416	9.5	0.1	15.8	45.6
Agricultural-related biological	6,778	28.2	‹0.2	17.6	19.2
Plant-related	1,098	48.0	NA	29.0	5.5
Environmental scientists	7,375	4.6	‹0.1	35.5	1.5
Hydrology and water resources	293	23.2	NA	27.3	0
Ail scientists	185,746	6.8	0.2	12.1	18.5

SOURCE: National Research Council, *Investing in Research:A Proposal to Strengthen the Agricultural, Food, and Environment System* (Washington, DC: National Academy Press, 1989).

crop cultivars could have a dramatic effect on pesticide use. Similarly, information collection and dissemination techniques show promise for enhancing adoption and use of new technologies and improving application of extant practices (e.g., "how-to" videos). While some of these advances are still in their infancy, others are either on-line (e.g., biocontrol agents) or will be available soon (e.g., drought-tolerant tomatoes). Agricultural production methods certainly will be affected by such changes in available technology.

Although USDA is the major actor in developing and extending agricultural practices to producers, other agencies also invest significant effort in research and technology development related to agriculture (table 6-1) (113). At least one-third of the funding for agricultural research is granted by agencies other than USDA (162). As agriculture's technological base broadens, the possibilities of solutions to problems expands as well. However, it is unclear whether this base is sufficiently broad or whether the current research structure is adequate to address the plethora of environmental concerns related to agriculture (162).

It seems clear that the current public and congressional concern over the adverse environmental effects associated with agricultural production practices is likely to result in policy changes affecting agriculture. This situation offers a unique opportunity to develop policies and programs that integrate agriculture and the environment. New agricultural policy will have to address the changing conditions posed by an expanding agri-technological base and public concern over agricultural impacts on the environment.

An ultimate goal of policy development maybe to create policy that is sufficiently flexible to adapt as these conditions continue to evolve (104). Clearly, multidisciplinary research, development, and extension of agricultural production systems will be increasingly needed. However, the current structure of the agricultural research and education system may not be adequate to fulfill this need.

Setting Goals

The agricultural community has long been criticized for not providing or developing a national plan for agriculture (cf: 161,162,144). Policies and programs commonly are created to address individual, and sometimes temporary problems, with little consideration to the overall impact on U.S. agriculture. As programs are added or changed, the impact of this evolving patchwork is modified, and interactions among the multiple components of agricultural and other policies modify the patchwork in unanticipated and sometimes adverse ways. Even the USDA has recognized the problems with "ad hoc, crisis-oriented policymaking" (161). For effective, long-term agricultural development and maintenance of environmental quality, clear-cut food and agricultural goals are necessary.

A goal is defined as ***the end toward which effort is directed. The*** end point must be definable and, at least in theory, achievable. The oft-stated mission of U.S. agriculture is assumed to be: to provide an ample supply of nutritious food for the consumer at reasonable cost with a fair return to the farmer within an agricultural system that is sustainable in perpetuity. However, this "goal" is open-ended and, therefore, not achievable. Further, it contains many

unquantifiable facets. For example, what is meant by an ''ample supply?' Does it mean production to meet: a) U.S. demands? b) U.S. demands plus economic demands of the world market? or c) U.S. and world market demand plus confessional food to poor countries? How would we know when an ''ample supply' is achieved? What is ''nutritious' food? How is it defined? Is a "reasonable cost' to consumers 15, 20, or 30 percent of disposable income or some other figure? Is a' 'fair return to the farmer" 10, 15, or 20 percent of investment? And would this "fair return" be achieved by: 1995? 2000? or 2500? Is a sustainable system one that tolerates 5, 10, or 15 tons of erosion per acre annually? Does it provide any allowance for or hold any prohibitions on agrichemical contamination of groundwater? (161).

These and other questions must be answered for a goal to have meaning and to be useful for agricultural policymaking, determining trade-offs in resource allocation, or planning a research agenda. With such questions remaining unanswered, these activities become largely a futile task. Directives that do exist often are so vague that Congress may conclude that directives are being ignored at the same time agencies conclude that they are being addressed (1 19).

Congress has set well-defined, achievable goals in other arenas in the past. Congress set a goal of putting a man on the Moon by the end of the 1960s; the goal was met. Congress has set goals for the level of gasoline consumption for different sizes of cars by certain dates. It should be possible for Congress to set well-defined, achievable, goals for U.S. agriculture as well (161).

In the absence of explicit goals, confusion may exist within the agencies regarding the appropriate direction to take in program development. Agency administrators tend to prefer legislative directives that are brief in length and broad in authority, thus providing a mandate but leaving flexibility to adjust programs as circumstances change. Congress and special interest groups, however, may prefer very specific directives to ensure that the issue of concern will in fact be addressed. Some sort of compromise may be appropriate: a statement of specific goals that includes a certain degree of flexibility and sufficient time prior to evaluation to allow adaptation to changing conditions. In this way a program may be adjusted as necessary, while retaining assurance that there will be real criteria by which to measure agency response (1 19).

The goals of USDA remain undefined and as such complicate identification of priorities; leading to a reactive rather than proactive institution. A recent GAO report noted that significant constraints to coordinated and consistent program implementation exist within USDA (158).

> . . .we believe that the Secretary needs to develop and clearly articulate a management agenda for the Department focused on important cross-cutting issues and improved human resource, information, and financial management systems. GAO management reviews of other agencies indicate that Cabinet secretaries have been able to implement reforms by personally articulating policy and management priorities and by ensuring that the Department responds effectively. The agenda should include a statement of goals, required actions, and management systems to monitor and evaluate achievement of said goals. We believe that such an agenda would be an important first step to ensure that USDA has the appropriate organization, systems, and flexibility to meet its challenges. Further, the next levels of departmental political and career managers must be held accountable for implementing this agenda (158).

Under the existing Federal framework for environmental protection, addressing nonpoint-source water contamination largely depends on increasing the priority of water quality goals contained in programs that are not specifically designed for protection of water quality (8). However, the effectiveness of implementing these program subsections may well depend on agency abilities to set goals, develop an implementation process, and monitor activities to determine success (i.e., the same factors that GAO suggests are lacking in USDA). Additional conditions necessary for success include flexibility to allow adaptation to changing conditions, commitment by implementing officials, and political support (79).

The "T by 2000" program in Indiana is illustrative of the potential effects of environmental goal-setting at the State level. The program seeks to reduce soil loss per acre in Indiana to the soil loss tolerance-limit (''T' or below, and, thus associated sedimentation problems from agricultural and non-agricultural sources by the year 2000. The effort began in 1983 with the establishment of the Soil Resources Study Commission. The Commission

was given the task of assessing State soil erosion problems and relevant policies, laws, and practices. Recommendations developed in this assessment described operational structure, education and research, technical assistance, financial assistance, and regulatory measures needed to achieve this goal. Based on this analysis, legislation was enacted in 1986 to implement the operational structure. With the addition of a lake-enhancement component (controlling sedimentation and nutrient loss to surface water bodies), broad public support was gained leading to approval of funding and allowing partial implementation of educational and technical assistance aspects of the program. The initial two years of the program have been deemed successful (35).

POLICY ISSUE: Lack of Clear, Measurable, Federal Goals for Agriculture and the Environment

Option: Congress could establish clear and specific national goals to protect the physical and biological integrity of the environment generally, and groundwater resources specifically.

No clearly identified Federal goals related to agriculture and the environment exist. This hinders congressional identification of current activities relevant to issues of public concern such as agrichemical contamination of groundwater, and oversight of resource allocation among competing priorities. The precedent for identification of such goals at the State level also indicates a potential for further development of fragmentary environmental protection efforts.

Program leaders within each of the agencies should be able to define the working objectives, goals, and implementation schedules under which they are operating. Each of these agencies and their respective offices should have clear and specific measurable goals that are relevant, integrated, and coordinated towards attainment of explicitly stated national objectives. Each agency should have a published working plan that states how they will reach their goals and their timetable of implementation, Some agencies are already developing goals and implementation plans, but Congress may wish to ensure that all of the agencies take this action, that the efforts are coordinated, and that they adequately reflect the concerns of Congress and the public.

To reach such a set of goals, objectives and timetables, Congress may wish to pursue a more interactive planning process than is normally used. Rather than a mandate, Congress might instruct the respective agencies to submit working goals to which Congress and the public could respond prior to legislative action.

POLICY ISSUE: Need To Ensure Commitment of Administrators to Goals

Option: Congress could clearly express its commitment to goals and priorities during confirmation hearings for administration nominees.

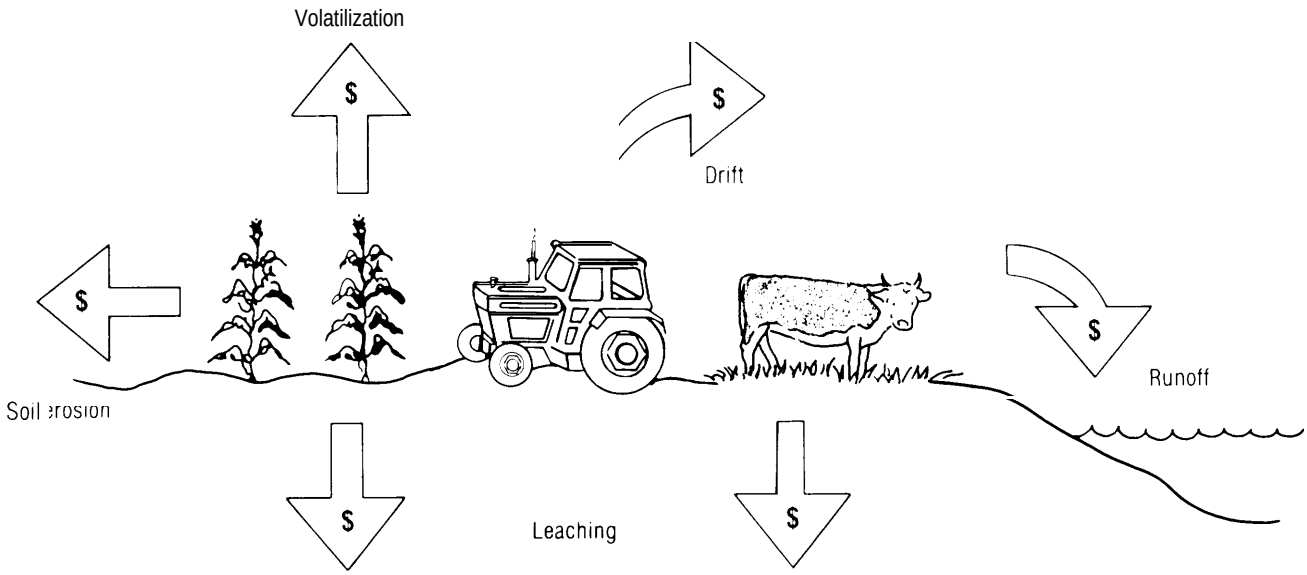
Authorizing legislation may mean little if not followed with appropriations, however, equally important is the coremitment of the administrators to the program (125,1 19). Guidance afforded an agency by top management can be crucial in developing appropriate responses to environmental and technical issues. Thus, the appointment of high-level management possessing the experience and technical background appropriate to the agency mission is likely to be of great importance, particularly with respect to formulation of agency initiatives in response to sensitive agricultural and environmental issues.

The offices of Secretary and Undersecretaries of Agriculture, Administrator of EPA, Director of the U.S. Geological Survey (USGS), etc., are presidentially appointed. Thus, congressional confirmation hearings offer an early opportunity to assess the capabilities and views of these potential candidates. These hearings also provide a forum for raising issues and discerning the depth of a nominee's knowledge of and concern for responding to critical environmental issues. Potential exists during this appointment process to reinforce congressional and public concerns with the appointee.

Focusing on Reduction of "Waste" in Agricultural Systems

Policy approaches that focus on waste reduction seem to offer significant potential for reducing groundwater contamination potential associated with current agricultural production practices. Losses of applied agrichemicals, excess energy use, etc. may all contribute to increased input costs for practitioners as well as create the opportunity for environmental contamination through a variety of pathways (figure 6-l). These wastes may be biodegraded into

Figure 6-l—Losses of Agrichemicals to the Environment are Financial Losses to the Farmer



Agrichemicals may be lost from an agricultural production system through a variety of mechanisms. These represent lost farmer investments as well as potential costs to society.
SOURCE: Office of Technology Assessment, 1990

other compounds, taken up by non-target organisms, or lost to various pathways where they may become pollutants in the hydrologic cycle. Actions to reduce such waste could have beneficial effects on environmental quality generally and groundwater quality specifically.

Thus, one promising approach to reducing the potential for agrichemical contamination of groundwater (as well as other media) is based on the concept of waste reduction. Waste reduction for agriculture may be defined as ''reducing the generation, emission, or discharge of agricultural pollutants or wastes through modification of agricultural production systems and practices' (34). Most farms could benefit from enhanced resource conservation activities and improved use of the physical and biological aspects of the agroecosystem (34,33,1 12).

Waste reduction approaches to agriculture also may have beneficial impacts on other issues of public concern, such as energy-use efficiency in agriculture. New approaches to cultivation (e.g., conservation tillage) have been linked to increased energy efficiency in terms of direct energy inputs. Energy efficiency in U.S. agriculture increased 55 percent between 1974 and 1985, largely through reduced tillage practices, increased control and timeliness of agrichemical and irrigation water applications, and other energy-conservation measures (148). However, use of energy-intensive agrichemicals increased 15 percent between 1974-85. Energy components in fertilizer and pesticide production are nearly 60 and 13 percent respectively (148). Clearly, improving agrichemical application efficiency with a goal of waste reduction also could have beneficial effects on overall energy conservation.

Waste reduction as a policy initiative to address groundwater contamination would require identification of the types of waste to be addressed (e.g., pesticides, nutrients) and the magnitude of reduction. Potential targets for waste reduction in agriculture might include: agrichemicals and livestock wastes, soil erosion, and greenhouse gas emissions (33). While such a policy tool is not specific to particular farming systems, it maybe biased towards heavy-input production systems. Organic production systems (cf: 163) could be viewed by some as the ultimate pesticide waste-reduction approach, however, such systems may rival conventional systems in other types of waste production (e.g., nitrate from livestock wastes). Potential for practices designed to reduce certain inputs could result in greater difficulties with conservation of other resources (e.g., herbicide reduction requiring additional cultivation may lead to increased soil erosion problems).

Federal activities in development of agricultural technologies are significant. Inclusion of waste reduction as a goal of ongoing agricultural research and extension programs, thus, could have a broad effect. A possible approach could include: setting priorities (e.g., identify "most wasteful" systems), assessment of a feasible level of waste reduction, identification of data gaps and the research needed to fill gaps, identification of appropriate extension and support programs, and development of a timetable and system for monitoring success of program,

Human resources and technical expertise was available to help practitioners implement soil conservation measures as outlined in the 1985 Food Security Act. However, dearth of such expertise related to ''agrichemical conservation measures' inhibits adoption of production practices using reduced chemical inputs (33). The scientific understanding of the effects of agrichemicals in food and drinking water is limited in comparison to the understanding of soil erosion processes and potential solutions. Thus, enhancement of organizational structure and technical expertise necessary for implementing new conservation policies related to groundwater protection is unlikely to occur rapidly (33). Analysis of the current capacity, then, is crucial to the development of rational timetables for achievement of water-quality conservation goals.

Design and extension of waste-reduction practices appropriate to cropping patterns or regions highly vulnerable to groundwater contamination could have significant impact on reducing the potential for agrichemical contamination of groundwater. However, development of strategies designed for waste reduction will depend on availability of information on agrichemical use patterns correlated with cropping region and cropping pattern.

POLICY ISSUE: Establishing an Organizing Prin - ciple for Goal-Setting

Option: Congress could establish an Agricultural Waste Reduction Initiative to serve as an organizing principle for identifying goals for U.S. agriculture and the environment.

Congress could direct agencies with agriculturally related responsibilities (USDA, EPA, etc.) to develop strategies aimed at achieving reduction of waste over the long term. Initial steps might include identification of the technical and informational needs to make decisions related to goal development and timetables for emission reduction and prioritization of these needs.

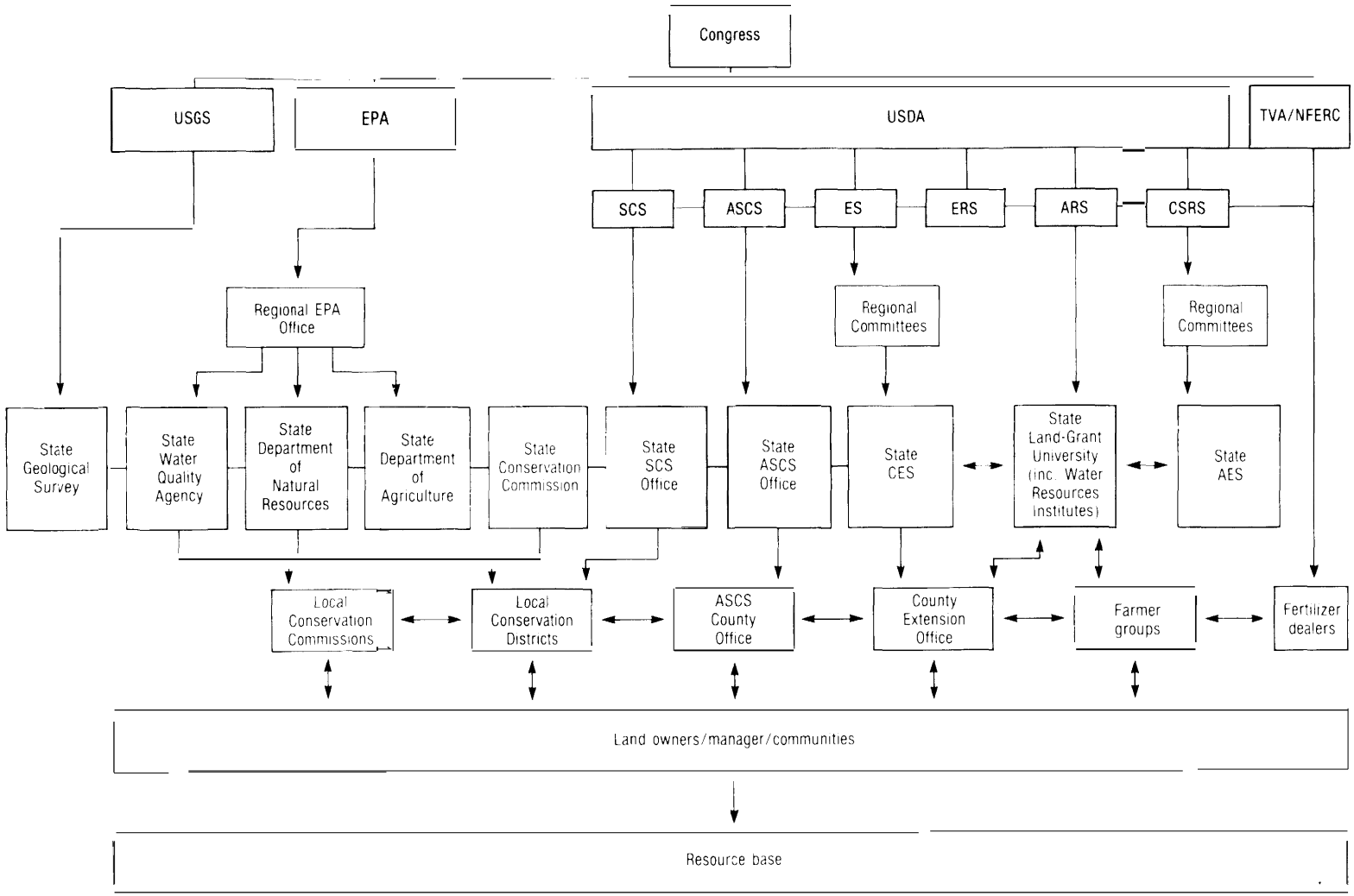
Waste reduction policy development will depend on: 1) accurate, current information on agrichemical use and identification of waste-generating production systems, 2) technically sound information on environmental fate of wastes in different settings, 3) development of technically and economically feasible alternatives for high "waste-generating" production systems, and 4) research and technical-assistance systems adequate to support such changes (33). This type of information could be used in combination with identification of regions highly vulnerable to groundwater contamination, and with information on relative risks of exposure to humans and the environment, to develop **a strategy to** protect groundwater.

Critical questions **that** must be answered are: how can conditions be created **that** would foster grower adoption of waste reduction production practices? and what forms of incentives and technical assistance structure and expertise are needed to support such **a** change? Analysis is needed of the organizational structures and technical knowledge necessary to support practitioners in implementation of new program titles that may become part of Federal legislative actions.

CHARACTERIZING THE CONFUSION: THE PATCHWORK OF AGENCY INVOLVEMENT IN PREVENTION OF AGRICHEMICAL CONTAMINATION OF GROUNDWATER

Setting goals, redirecting programs, or coordinating Federal efforts **to** reduce agrichemical contamination of groundwater is complicated by the number and variety of organizations involved in agriculture and water quality (figure 6-2). The Association of State and Interstate Water Pollution Control Administrators in 1985 identified "354 State and local programs, and 32 programs in 17 Federal agencies, which manage nonpoint-source activities and affect water quality' (8). These numbers have undoubtedly risen since then.

Figure 6-2—Primary Organizations Involved in Policymaking and Program Implementation Related to Agrichemical Contamination of Groundwater



Myriad organizations develop and implement policy related to agrichemicals and groundwater—to agriculture and the environment. The subsequent multiplicity of actors, actions, viewpoints, and approaches make it difficult to generalize on current or potential roles, evaluating extent of success, or defining lines of coordination and cooperation.

SOURCE: Adapted from the National Association of Conservation Districts, "Proposed Strategy for Protecting Surface and Groundwater from Agricultural Activities," June 1989.

Organizations Involved in Agrichemical Contamination of Groundwater

Identification of potential policy implementers, or even development of a catalog of current groundwater protection activities, is hindered by the breadth and diversity of public organizations operant in agriculture and groundwater contamination, nonpoint-source pollution, water quality, or other related environmental issues. In addition, some basic organizational characteristics hinder an integrated approach to protection of groundwater from agrichemical contamination.

- Organizations at all levels of government—Congress, Federal, State, local, and in some cases regional or international-are or have potential to become involved in protection of groundwater from agrichemical contamination. Within each of these levels, the types of organizations with potential roles to play include the more traditional agriculture, environment, and public health organizations, as well as newer interagency task forces, councils, and boards that have been developed specifically to address the issues.
- Organizations differ in the types of activities they use to effect change, including education and voluntary programs, incentives designed to lure decisionmakers into modifying farm-management systems, and regulations prohibiting certain types of activities. Organizations typically have been designed (or have evolved) to favor one type of influencing activity over another.
- Organizations also have tended to focus along lines more restrictive than what is needed to encompass the entirety of issues involved. For example, agricultural programs may focus on individual commodities; agricultural conservation and environmental protection programs have tended to single out individual pollution media; and health impact investigations may single out cancer or reproductive hazards from other potential health impacts.

This multiplicity of actors, actions, viewpoints, and approaches makes it difficult to generalize on current or potential roles, evaluate extent of success, or define lines of coordination and cooperation.[1]

The Role of Congress

Nearly 50 bills addressing groundwater topics, many including agricultural issues, were introduced in the 100th Congress (197), and roughly 20 were introduced during the first half of the 101st Congress. In addition to the diversity of approaches suggested in these bills, and an apparent lack of consensus on the most appropriate response, the sheer number of bills reflects a fundamental change in Congress. Bills introduced into the 100th Congress were promulgated by or referred to at least 14 full committees (197) and involved almost twice as many subcommittees (20).

Clearly, the agriculture/environment debate has lifted agricultural policymaking beyond the House and Senate Agriculture Committees, where it traditionally was focused (17). Agriculture no longer has the widespread constituency it once had, and now has to entertain concerns expressed by non-agricultural interests (21). However, agricultural interests have maintained a strong traditional congressional lobby: at least 180 organizations representing agricultural interests are registered with the U.S. Senate lobby (18).

At the same time, the number of Committees and Subcommittees with some jurisdiction over environmental issues has grown rapidly. For example, the number of committees and subcommittees using the words ‘‘environment’ or ‘‘resources’ in their titles grew from 0 in 1965 to 25 in 1990. This explains, to some extent, the number of committees requesting referral of agricultural bills containing environmental protection provisions, which includes much recently proposed agricultural legislation. Historically neither the House nor Senate agriculture committees have fully participated in developing water quality legislation, which generally has been developed by the environment and public works committees (36).

With environmental jurisdiction scattered throughout Congress, no legislative constituency exists for integrating agriculture and environmental policy, nor for integrating environmental policy overall. However, because the boundaries of many agricultural and environmental issues do not match political boundaries-just as boundaries of aquifers do not honor county lines-bargaining becomes essential

I More detailed discussions of Federal agency legislation and roles in protection of groundwater from agrichemical contamination can be found in Nipp (1 19), Zinn and Tieman (197), FCCSET (56), and OMB (190).

Box 6-A —Federal Agencies With a Role in Protection, Remediation, and Mitigation of Groundwater Contamination From Agrichemicals[1]

Executive Offices of the President
CEQ Council on Environmental Quality
OMB Office of Management and Budget
OPD Office of Policy Development
OSTP Office of Science and Technology Policy

U.S. Department of Agriculture
APHIS Animal and Plant Health Inspection Service
ARS Agricultural Research Service
ASCS Agricultural Stabilization and Conservation Service
CSRS Cooperative State Research Service
ERS Economic Research Service
ES Extension Service
FmHA Farmers Home Administration
FS Forest Service
NAL National Agricultural Library
NASS National Agricultural Statistics Service
SCS Soil Conservation Service

U.S. Environmental Protection Agency
ORD Office of Research and Development
OECM Office of Enforcement and Compliance Monitoring
OPPE Office of Policy, Planning, and Evaluation
OPTS Office of Pesticides and Toxic Substances
OSWER Office of Solid Waste and Emergency Response
OW Office of Water (including the Office of Ground Water Protection)

U.S. Department of the Interior
BIA Bureau of Indian Affairs
BLM Bureau of Land Management
BOR Bureau of Reclamation
FWS Fish and Wildlife Service
NPS National Park Service
USGS U.S. Geological Survey

Tennessee Vane-y Authority
NFERC National Fertilizer& Environmental Research Center

Department of Defense
ACOE U.S. Army Corps of Engineers

[1]OTA commissioned a survey of Federal Departments and agencies to identify relevant agencies and programs, their roles in agriculture and water quality issues, and the extent of their involvement over the decade 1980-1990. The agencies listed above do not include other agencies contacted, which may have a more minor or yet undefined role in groundwater protection, such as the Food and Drug Administration. In addition, other agencies, such as the National Oceanic and Atmospheric Administration were contacted and do have programs that relate to agrichemical use and groundwater contamination, but information on resources or perceived roles was not compiled for OTA. Each agency was asked to interpret aspects of ongoing programs, budgets, and personnel that support groundwater protection and remediation. The voluminous information collected is summarized in L.A. Dye, ''The Federal Role in Reducing Agrichemical Contamination of Groundwater, OTA commissioned paper, 1990.

to discovery of an efficient integrated solution (149). The institution responsible for such an integrated approach, Congress, has taken a fragmented approach. Instead of using the Committee room as an arena for debating national environmental policy, it has continued to expand and pass separate air, water, and solid-waste pollution legislation, impeding more integrative approaches (132). Groundwater may become just one more medium to add to this list.

Federal Roles and Activities

At the Federal level, at least 30 Departments or agencies have some influence over agriculture and groundwater issues (box 6-A); discussion of each of these organizations and their efforts is beyond the scope of this assessment. However, the main Federal organizations affecting agricultural contamination of groundwater are the Environmental Protection Agency (EPA), various programs within the U.S. Department of Agriculture (USDA), the U.S. Geological Survey (USGS), and the Tennessee Valley Authority (TVA), which houses the National Fertilizer & Environmental Research Center (NFERC). A brief summary of their activities follows.

The Tennessee Valley Authority has responsibility for electrical power generation and other development efforts for the seven-state Tennessee River Drainage Basin, including Tennessee, Virginia, North Carolina, Georgia, Alabama, Mississippi, and Kentucky. It also has broad *environmental protec*tion and natural resource management responsibilities for this area. The 201 TVA counties established the cooperative "Land and Water 201" program in 1984 to: 1) reduce soil erosion, 2) improve water quality, 3) increase farm income, and 4) serve as a national model and demonstration for multiagency

cooperative soil and water conservation programs (151).

The National Fertilizer Development Center was created with the Tennessee Valley Authority Act in 1933, and is considered the lead national organization in fertilizer research and education. As part of a recent TVA restructuring, the Center was renamed the National Fertilizer & Environmental Research Center, and redefined its mission to "be a leading national source of nutrient-related information for public and private use' and to direct its research to high-priority environmental issues (109,1 10).

The U.S. Geological Survey (USGS) conducts groundwater quantity and quality assessment, monitors aquifers at a number of sites across the nation, investigates temporal and spatial trends, and provides this information to Federal, State, and local agencies in support of their groundwater protection programs (box 6-B). It also maintains a large scientific program to study movement and fate of chemicals in the environment. More directly relevant, USGS is examining the impact of agricultural chemical use on groundwater quality in several U.S. regions in the pilot phase of its National Water Quality Assessment Program (78).

Although the Environmental Protection Agency (EPA) conducts a number of activities that affect agriculture (box 6-C), its primary relevant regulatory authority is over agricultural pesticides through the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The EPA regulates use of pesticides and, through its designated State lead agencies, is responsible for ensuring that users of restricted pesticides are trained in proper use. The first regulatory action

Box 6-B—Major USGS Activities Related to Agrichemical Contamination of Groundwater

The U.S. Geological Survey is engaged in a broad array of information collection, information management, and research projects pertinent to groundwater management and protection.

Coordination and Dissemination of Federal Information on Groundwater. The USGS releases a comprehensive report on water resources annually: the National Water Summary. This report includes comprehensive documentation on water resource quantity and quality for each State, and includes case studies of nonpoint-source contamination. It also summarizes studies on managing and coordinating Federal and State water protection efforts. USGS also maintains a computerized National Water Storage and Retrieval System (WATSTORE) and a computer-based National Water Data Exchange (NAWDEX).

National Water Quality Assessment Program. Since 1986 the NAWQA program has conducted assessments of national and regional status of groundwater resources and monitors trends in factors that can affect groundwater quality, Agrichemical nonpoint-source contamination problems are under study in seven pilot projects (197).

Regional Aquifer Systems Analysis Program. The RASA program was established in 1978 to gather data on the quantity of water resources available in the nation's aquifers. RASA's objectives for each aquifer system study are to determine the availability and chemical quality of stored water and discharge-recharge characteristics, and to develop computer simulation models that may assist in understanding the groundwater flow regime and changes brought about by human activities (98). Twenty-eight aquifer systems have been identified for study, fourteen of which have been completed.

Federal-State Cooperative Program. USGS supports local efforts to collect data on ground and surface waters through cost-sharing arrangements with State and local governments. For example, USGS has provided support for mapping State aquifers, for monitoring pesticide contamination problems, and has assisted in developing wellhead protection programs.

State Water Resources Research Institutes. Under this program the USGS provides grants to 54 State and Territory Water Resources Institutes for research, information dissemination, and for training students in water resources fields. Approximately 35 percent of the Institutes' work is related to groundwater protection. Reauthorization of the Institutes has been hindered by their incorporation in broad and controversial groundwater protection bills.

Mid-continent Initiative. The USGS also is working in cooperation with the USDA's Midwest Initiative on a "Mid-Continent Initiative, " a 5- to 10-year research program characterizing the environmental fate of the widely-used agricultural herbicide atrazine. The area understudy, roughly bounded by the Upper Missouri and Ohio River Basins, was chosen largely because of the coincidence of hydrologic boundaries with a region of intensive agrichemical-use cropland (134).

Box 6-C—Major EPA Programs Affecting Agriculture

FIFRA Pesticide Programs

. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) gives EPA responsibilities for registering new pesticides and for reviewing and re-registering existing pesticides to ensure that, when used according to label directions, they will not present unreasonable risks to human health or the environment.

National **Survey of** Pesticides **in Drinking Water Wells**

• **The** National Survey is underway to determine the presence and concentration of 127 commonly used agricultural chemicals in 1,350 statistically selected wells. EPA expects to issue a draft report on the survey in late 1991.

Safe Drinking Water Act Programs

- The Safe Drinking Water Act (SDWA) requires EPA to publish maximum contaminant levels (MCLs) for any contaminants, including pesticides, which may have adverse health effects in public water systems (those serving over 25 persons or with 15 connections). Standards established by EPA under the SDWA are also being used as guidelines to assess contamination of groundwater in private wells. The EPA also sets nonregulatory health advisory levels on contaminants for which MCLs have not been established.
- The SDWA also established a Wellhead Protection Program (WHP) to protect wells and wellfields that contribute drinking water to public supply systems. Each State must prepare and submit to EPA a Wellhead Protection Program delineating the recharge areas around public water, identifying potential sources of groundwater contamination within these areas, and addressing identified potential sources to protect the public water supply. Although funds have been appropriated for the WHP Program, the EPA Administrator testified to the Senate that only 30 States have submitted proposed programs for review and approval by EPA (10).

1987 Water Quality Act Nonpoint Programs

. Section 319 of the Act requires States and Territories to file assessment reports with EPA identifying navigable waters where water quality standards cannot be attained or maintained without reducing nonpoint-source pollution. States must also file management programs with EPA identifying steps which will be taken to reduce nonpoint pollution in those waters identified in the State assessment reports. The Act authorizes up to $400 million total in Federal funding for implementing the programs. To date, 43 States and Territories have submitted nonpoint-source pollution assessments to EPA, and 36 have submitted final management programs.

1987 Water Quality Act Clean Lakes Program

- Section 314-of the Act requires States to submit assessment reports on the status and trends of lake water quality, including the nature and extent of pollution loading from point and nonpoint-sources. Also, methods to control pollution and to protect/restore the quality of lakes impaired or threatened by pollution must be described.
- Financial assistance is given to States to prepare assessment reports and to implement watershed improvements, as well as to conduct in-lake restoration activities. Several USDA small watershed projects have been coordinated with Clean Lakes projects.

1987 **Water Quality Act National Estuary Program**

• Section 320 of the Act provides for identification of nationally significant estuaries threatened by pollution, preparation of conservation and management plans, and Federal grants to prepare the plans. Planning is underway for 12 major estuaries.

'Near Coastal Waters Strategy

. Through its Near Coastal Waters Strategy, EPA is integrating its water quality programs to target priority programs and prevent pollution in near coastal waters. This includes the implementation of nonpoint-source management programs in coastal counties and will, in several cases, encompass accelerated implementation of agricultural conservation programs.

Regional Water Quality Programs

• **The** EPA and other Federal agencies are cooperating on several regional programs to reduce nonpoint source pollution, including the Chesapeake Bay Program, the Colorado River Salinity Control Program, the Great Lakes Program, the Gulf of Mexico Program, and the Land and Water 201 Program in the Tennessee Valley Region.

SOURCES: After USDA/ERS, "Agricultural Resources: Cropland, Water, and Conservation Situation and Outlook Report," AR-16, September 1989; and R. Barles, personal communication. Office of Ground Water Protection, Environmental Protection Agency, Mar. 9, 1990.

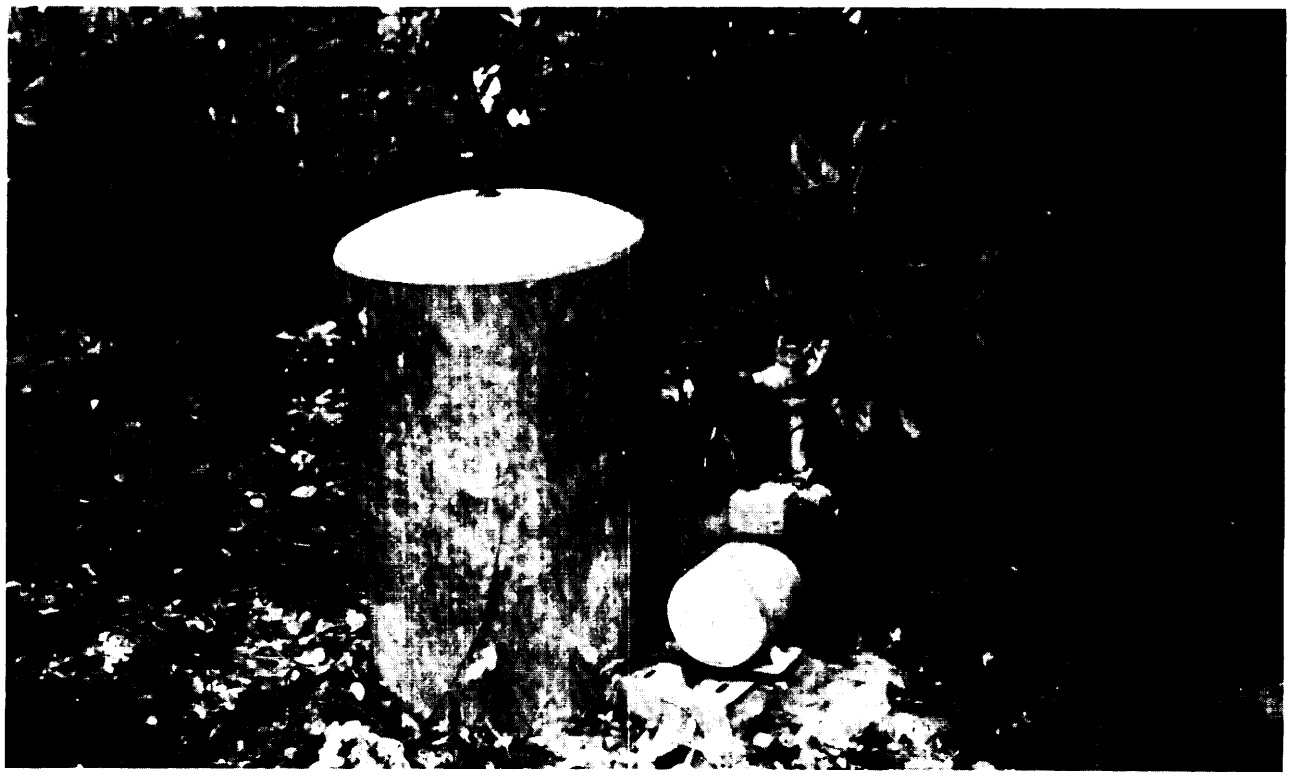


Photo credit: State of Florida *Department of Environmental Regulation*

Between 12 and 14 million private wells in the United States provide drinking water, most in rural areas. Private wells currently are not required to be tested nor to comply with Safe Drinking Water Act standards.

taken against a pesticide registration due to groundwater contamination in the continental United States was EPA's ban of DBCP (1,2-dibromo-3-chloropropane) in 1979. Since that time, EPA has canceled other pesticides due to groundwater concerns, established an Office of Groundwater Protection in the Office of Water, and added requests for data on leaching for reregistration of a number of pesticides (31).

The EPA has devised a "Groundwater Protection Strategy" (180) in response to its diverse groundwater protection responsibilities, with four main objectives:

- to support State program development and institution building;
- to assess potential problems from unaddressed sources;
- to issue guidelines for consistent agency decisions affecting groundwater; and
- to strengthen EPA's organization for groundwater management and cooperation with other Federal and State programs.

Following from that strategy, in which States retain primary responsibilities and authorities to protect groundwater, EPA developed a comprehensive plan to improve and coordinate Federal, State, and local efforts to protect groundwater from agrichemical contamination (186). The key component of this plan is development of pesticide/groundwater management plans by the States in accordance with section 319 of the Clean Water Act. EPA also is the primary sponsor of an interagency group, entitled Water Quality 2000, that is preparing to address reauthorization of the Clean Water Act in 1992.

The USDA has repeatedly expressed a growing commitment to enhancing its water quality protection and improvement efforts, of which groundwater protection is stated a major component. Numerous reports listing water quality as a top priority (cf: 51) and agency work plans have been released (cf: 175,167,168,166). These culminated in the development of the Water Quality Program Plan to Support the President's Water Quality Initiative" (165) (see box 6-D detailing plan).

Box 6-D—Major Components of the USDA Water Quality Program Plan

USDA completed its Water Quality Program Plan to Support the President Water Quality Initiative in July 1989. Its objectives are to: "1) determine the precise nature of the relationship between agricultural activities and groundwater quality; and 2) develop and induce the adoption of technically and economically effective agrichemical management and agricultural production strategies that protect the beneficial uses. . ." of groundwater.

Education and Technical Assistance—Adoption of agrichemical use, waste management, and production practices that may reduce or prevent contamination will be accelerated where existing of potential contamination of ground or surface water from agricultural nonpoint sources has been identified as a public concern. Adoption will be encouraged through enhanced education, technical and some financial assistance, and demonstration projects. Specific projects include:

. expanding USDA and CES staff capacity to deliver educational and technical assistance to producers for effective agrichemical and waste product management and environmental stewardship,
• demonstrating and delivering technologies and management systems for voluntary farmer, rancher, and forester adoption and implementation,
• meeting State water quality requirements through education and technical assistance, and
. informing the public of program activities and achievements.

Research and Development---Research programs will be aimed at developing knowledge about the fate and transport processes of agrichemicals, and at analysis of socio-economic effects of current and new agricultural management methods to allow measure of the relative cost-effectiveness of alternative practices and systems. Research programs will be designed to:

. develop methods for sampling, measuring, and evaluating groundwater contamination,
• conduct fundamental research to provide the basis for improved management of chemicals **used in agriculture,**
• improve agrichemical management and agricultural production systems, and
. evaluate economic, social, and technical impacts of new and improved management practices and systems.

Database Development and Evaluation-Data will be collected nationally on agrichemical use, related farm practices, and links with the physical environment. Further, centralized systems for linking data and statistical information on agricultural productivity, land use, agrichemical use, physical attributes of the land and surrounding watersheds, climate, and water quality are envisioned. Specific goals are to:

. build National and State databases on agrichemical use and related farm practices, and
. provide digitized geographic information systems for State and Federal evaluation of alternative policies and program strategies.

Interagency Coordination-The Water Quality Program Plan ''involves the capabilities and activities of more USDA Agencies, working in closer concert with a wider variety of Federal and State Agencies than any previously established Departmental function" (165). USDA water quality programs are coordinated through a new Working Group on Water Quality established in late 1989 as a unit of the Secretary's Policy and Coordination Council, and chaired by the Deputy Assistant Secretary for Science and Education. The Working Group is charged with: 1) coordinating all USDA policies and programs relating to water quality activities; 2) developing and recommending strategies for carrying out these activities; and 3) providing advice and guidance on water quality issues to the policy council (176).

SOURCE: Unless otherwise noted, information is adapted from U.S. Department of Agriculture and Cooperating State Agencies, "Water Quality Program Plan to Support the President's Water Quality Initiative" (Washington DC: U.S. Department of Agriculture, July 1989).

The USDA, through the Soil Conservation Service (SCS), Economic Research Service (ERS), Agriculture Research Service (ARS), Cooperative States Research Service (CSRS), Extension Service (ES), and Forest Service (FS) primarily conducts research, publishes information, and offers advice to farmers on pesticide and fertilizer use, land management, and agronomic or silvicultural practices (box 6-E). No lead agency has been identified; rather a Working Group on Water Quality has been established to coordinate the activities of eight principal USDA agencies and their cooperating State institutions.

The Resources Conservation Act of 1977 requires SCS to develop national plans and programs for soil

Box 6-E—Major USDA Conservation and Water Quality Programs

1985 Food Security Act Provisions

- Conservation Reserve Program (CRP) provides annual rental payments to land owners and operators who voluntarily retire highly erodible and other environmentally critical lands from production for 10 years. It also provides technical assistance and cost-sharing payments up to 50 percent of the cost of establishing a soil-conserving cover on retired land. Rental payments to any person may not exceed $50,000 per year. County enrollment is limited to no more than 25 percent of cropland, unless USDA grants a special waiver. To date, approximately 30 million acres of cropland have been enrolled.
- Conservation Compliance requires that farmers who produce agricultural commodities on highly erodible cropland have approved conservation plans by Jan. 1, 1990, and finish implementing them by Jan. 1, 1995, or lose eligibility for USDA program benefits.
- Sodbuster provision requires that farmers who convert highly erodible land to agricultural commodity production do so under an approved conservation system, or forfeit eligibility for USDA program benefits.
- Swampbuster provision bars farmers who convert wetlands to agricultural commodity production from eligibility for USDA program benefits, unless USDA determines that conversion would have only a minimal effect on wetland hydrology and biology.

Continuing Assistance Programs

- Agricultural Conservation Program (ACP) provides financial assistance to farmers for implementing approved soil and water conservation and pollution abatement practices. Cost-sharing payments to a given farmer may not exceed $3,500 per year on l-year agreements, and may not average over $3,500 per year on multi-year agreements. Except for Water Quality Special Projects, conservation priorities are set by States and counties based on local soil and water quality problems. Program initiated in 1936.
- Conservation Technical Assistance (CTA) provides technical assistance by the Soil Conservation Service (SCS) through Conservation Districts to farmers for planning and implementing soil and water conservation and water quality improvement practices. Program initiated in 1936.
- Great Plains Conservation Program (GPCP) provides technical and financial assistance in Great Plains States to farmers and ranchers who implement total conservation treatment of their entire operation. Cost-sharing assistance is limited to $35,000 per farmer contract. program initiated in 1957.
- Small Watershed Program provides Federal technical and financial help to local organizations for flood prevention, watershed protection, and water management, Program initiated in 1954.
- Resource Conservation and Development Program assists multicounty areas in enhancing conservation, water quality, wildlife habitat and recreation, and rural development. Program initiated in 1962.
- Emergency Conservation Program provides financial assistance to farmers in rehabilitating cropland damaged by natural disasters. Program initiated in 1978.
- Rural Clean Water program is an experimental program implemented in 21 selected projects. It provides cost-sharing and technical assistance to farmers voluntarily implementing best management practices to improve water quality. Cost-sharing limited to $50,000 per farm. Program initiated in 1980; ends in 1995.
- Model Implementation Program provides Federal cost-sharing and technical assistance to encourage practitioner adoption of Best Management Practices that may beneficially affect water quality.
- Extension Service provides information and recommendations on soil and water quality practices to land owners and operators, in cooperation with SCS and Conservation Districts.
- Farmers Home Administration provides loans to farmers and associations of farmers for soil and water conservation, pollution abatement, and building or improving water systems that serve several farms. It may acquire 50-year conservation easements to help farmers reduce loan payments.
- Forestry Incentives Program provides cost-sharing up to 65 percent for tree planting and timber stand improvement for private forest lands of 1,000 acres or less,
- Water Bank program provides annual payments for preserving wetlands in important migratory waterfowl nesting, breeding, or feeding areas. Program initiated in 1970.

Research Programs

- Agricultural Research Service conducts research on new and alternative crops and agricultural technology to reduce agriculture's adverse impacts on soil and water.
- Cooperative State Research Service coordinates conservation and water quality research conducted by State Agricultural Experiment Stations and land-grant universities. This agency allocates and administers funds appropriated for special and competitive grants for water quality research,
- Economic Research Service estimates economic impacts of existing and alternative policies, programs, and technology for preserving and improving soil and water quality. With National Agricultural Statistics Service, collects data on farm chemical use, agricultural practices, and costs and returns.
- Forest Service conducts research on environmental and economic impacts of alternative forest management policies, programs, and practices.

SOURCE: U.S. Department of Agriculture, Economic Research Service, ''Agricultural Resources: Cropland, Water, and Conservation Situation and Outlook Report '' AR-16, September 1989.

and water conservation. The resulting report lists the Department's priorities for soil and water resource protection for the next decade. The most recent plan was completed in 1989, and included a significant redirection from the last plan completed in 1982. In the plan for the 1990s, water quality protection moved from sixth to second national priority.

State and Local Level

State and local governments play perhaps the most active role in groundwater protection (box 6-F), A variety of State departments and agencies administer or cooperate in research, monitoring, and technical assistance programs that provide information to producers on environmentally appropriate farming practices. State agencies also may provide financial or technical assistance to producers to assist them in modification of farming practices (see ch. 5, app. 5-l), and may regulate farming practices or agrichemical use beyond those regulations promulgated by EPA.

At the State and local levels, pesticides are regulated by State Lead Agencies (SLAs) that have been granted FIFRA primacy by EPA. States may ban chemicals from use in certain areas, or may

Box 6-F—Selected State Programs Affecting Agriculture and Groundwater Quality

States increasingly are enacting innovative and sometimes stringent environmental laws. These are "having an indirect impact on Federal policy as States put pressure on the Federal Government to take similar action or as industry goes to Congress in search of uniform Federal laws to replace the patchwork of conflicting State requirements' (93).

Ground Water Quality Protection Programs: Twenty-two States have developed comprehensive programs to protect or improve groundwater quality. Most include one or more common program elements: 1) classification, assessment, and mapping of groundwater sources; 2) groundwater quality standards, 3) groundwater quality monitoring; 4) control of farming practices; 5) control of land uses; 6) economic incentives; and 7) education programs (12). Specific examples include:

- Iowa's Ground Water Protection Fund and Ground Water Protection Strategy, which uses pesticide registration fees and fertilizer taxes to finance sustainable agriculture research and demonstration activities;
- Massachusetts Wellhead Protection Program, which established land use control and restricts pesticide use in critical recharge areas around wells; and
- Wisconsin's Risk Assessment Program, which is based on numerical ground water standards.

***Best** Management Practices: Thirty-six* States provide financial or regulatory incentives for installing and maintaining best management practices (BMPs) to promote soil conservation and protect surface water quality (175).

- Financial incentives include: cost-sharing programs (26 States); income or property tax credits or deductions (7 States), no-or low-interest loans (5 States); and purchasing conservation easements or development rights in agricultural lands (3 States).
- Seventeen States require either approved plans or permits for activities that could cause soil erosion or pollution discharges into waterways, or compliance with established permissible soil loss limits. Ten States give farmers cost-sharing assistance specifically to help them meet the requirements.

Innovative State Financing Mechanisms: States will face competing demands for funding of groundwater, drinking water, and surface water programs in the coming decade, potentially requiring many to develop alternative funding mechanisms. Some States already have created innovative financing mechanisms, including: 1) user and impact development fees; 2) dedicated tax revenue; 3) state revolving loan funds; and 4) special water quality districts and utilities (74).

- Iowa's 1987 Groundwater Protection Act established a Groundwater Protection Fund capitalized by user and producer fees on pesticides, fertilizers, and other products contributing to nonpoint-source pollution.
- Minnesota established an environmental trust fund to be capitalized with one-half of the proceeds from the State lottery. The fund is expected to reach $100-$200 million by the end of 1993.
- Washington State uses an $0.08 per pack increase in the sales tax on cigarettes to finance water pollution control programs. Half of the funds are designated for wastewater treatment; 20 percent for ground water protection; and 10 percent each for nonpoint-source pollution, lake management, and discretionary purposes.

modify the label or use restrictions required by EPA. For example, in the early 1980s the insecticide aldicarb was found in a number of wells in Wisconsin and in shallow groundwater under an experimental plot in Florida (82). As a result, these States enacted significant rate, timing, and spatial use restrictions designed to minimize groundwater contamination (see table 6-2).

Most SLAs are State Departments of Agriculture, but other agencies or even universities may serve as SLAs. Programs to protect public drinking-water supplies, regulated under the Safe Drinking Water Act, commonly are implemented by State health departments. The differing State authorities have caused coordination problems in addressing agrichemical contamination incidents. For example, at least three different agencies in each State became involved in recent groundwater contamination events in Florida, California, and Wisconsin. Several States have established State interagency task forces or coordinating committees to ensure communication among agencies with pesticide and drinking water responsibilities (31). These groups also commonly work with sub-State agencies such as county health departments, regional water quality control boards, or regional planning organizations (cf: 23,74).

A number of States have issued laws and regulations regarding agrichemical contamination of groundwater (cf: 12,75). The States have taken diverse approaches, ranging from taxation of agrichemical purchases to fund special monitoring and extension programs in Iowa, to designation of Special Protection Areas based on proven or potential contamination by agrichemicals in Nebraska (5). As noted earlier, Connecticut has established strict liability for contamination (12).

Several States also now require that field studies be conducted in their States, in addition to those required by the EPA for national product registration, in an attempt to account for differing local hydrogeologic vulnerabilities. For example, groundwater studies are required in California and Florida, costing up to $500,000 each (31). Should other States choose to require local field studies, the cost may inhibit development and registration (or reregistration) of even those pesticides unlikely to cause groundwater contamination. However, EPA currently is unable to supply States with the technical guidance necessary to extrapolate field and laboratory results to different areas of the country (31).

Table 6-2-Sample Restrictions on Aldicarb Use in Wisconsin and Florida

	Wisconisin	Florida
Rate	Maximum 2 lbs. active ingredient per acre	Maximum 5 lbs. active ingredient per acre
Timing	Maximum 1 application per 2 years	Maximum 1 application per year
	4 to 6 weeks after planting	Between January 1 and April 30 for citrus growers (major users)
Spatial	Moratorium areas defined as 1 mile radii around wells with 10 ppb aldicarb or greater	Minimum of 300 meters lateral distance from a drinking-water well
Other	May be applied only by a State-certified pesticide application specialist	Warnings must be posted on the property and on wells near area of use
	Label must contain warning of potential for ground water contamination	Use will be suspended in an area if concentration of more than 10 ppb are found in drinking water

SOURCE: S.2. Cohen, "Pesticides and Nitrates in Ground Water: An Introductory Overview, ''contractor report prepared forthe Office of Technology Assessment (Springfield, VA: National Technical Information Service, August 1989).

EPA's proposed strategy for agricultural chemicals in groundwater includes a prevention strategy and a response strategy, and relies heavily on a decentralized, State implementation approach (181). The prevention strategy relies on the development of State regulatory management plans using a number of regulatory options (see table 6-3) intended to balance pesticide-use risks and benefits depending on the site-specific nature of use, value, and vulnerability of the local groundwater resources. If management plans are not developed by States for areas of suspected vulnerability to certain chemicals, use of those chemicals may be canceled in those States by the EPA. This program may burden some States, particularly those with no analogous preexisting program (100, 198).

EPA plans to issue five criteria./guidance documents to implement the strategy, but funding and staffing required to produce these documents is uncertain (31). The documents include:

- minimum criteria for State groundwater monitoring programs;
- minimum criteria for State response plans, addressing water supply, monitoring, and registration issues;
- criteria EPA will use to review State management plans for adequacy;

Table 6-3—Regulatory Options Available to States Under the EPA Strategy

- . Moratorium Areas
- . Wellhead Protection Areas
- . Well Set Backs (Buffer Zones)
- . Future Well Requirements: Location, Depth, Construction
- . Change in Rate of Application
- • Change in Timing of Application
- . Change in Method of Application
- • Advance Notice of Application
- . Integrated Pest Management
- • Best Management Practices
- . Additional Monitoring
- • Additional Training and Certification

SOURCE: U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, "Agricultural Chemicals in Ground Water: Proposed Pesticides Strategy," December 1987.

- • criteria EPA will use to evaluate effectiveness of State management plans; and
- • a hydrogeologic document entitled ''Techniques for Assessing the Natural Sensitivity of Aquifers to Pesticide Contamination. "

The latter document is scheduled for publication in late 1990 (80).

Trends Affecting Organizational Activities

Controversies and confusion remain over apportionment of roles between Federal and State Governments, and type of approach to use for prevention of agrichemical contamination of groundwater. New trends in both these areas are further blurring the issues. Historically, agricultural programs have been largely a Federal role and water-related and environmental programs have been a State role. Similarly, agricultural programs have tended to rely on encouraging voluntary actions by farmers, and environmental programs have used regulatory options.

Changes in Historical Roles

After the American Revolution, the States were accorded sovereign interests in navigable waters and, thus, responsibility for managing and allocating their water supply. This has been modified to some extent through Federal legislation such as the Clean Water Act (CWA) (28) and the Safe Drinking Water Act (SDWA) (141). For example, "navigable waters' are redefined as the ''waters of the United States' under the CWA, discarding the classical view of waters that may be used for navigation (196). These statutes provide the Federal government with substantial responsibility for setting standards, and for developing and delegating federally defined water quality protection program management to States (149).

Environmental protection also was primarily a State concern until the 1960s, but became increasingly a Federal concern during the 1970s and 1980s (most notably with the creation of the Environmental Protection Agency and the Council on Environmental Quality). During the latter two decades, a partnership of sorts has evolved among the different levels of government, with each taking on different responsibilities (149). Despite this evolving partnership, the Federal role continues to dominate environmental protection programs. National-level legislation and Federal agency programs set the national agenda, basic regulatory framework, and determine many of the operating mechanisms (132).

Within this framework, States generally are required to develop and, with EPA approval, implement environmental protection programs. However, fiscal responsibility for environmental protection programs has been shifting to the States. EPA grants to State and local governments have declined over the past 10 years in real terms, and area declining or constant percentage of EPA's budget. Thus, States are funding a growing percentage of their program expenditures (149, 11 1).

Despite confusion over who should do what, and who should pay for what, the States have been at the forefront of actions to prevent agrichemical contamination of groundwater. Most States now have a legal framework that includes some means to address agrichemical contamination of groundwater, but few have developed preventative programs; in most cases, a patchwork of laws exists rather than a comprehensive groundwater management program (12).

Two basic categories of regulations (beyond regulations on the chemicals themselves) can be used to prevent agrichemical contamination of groundwater: 1) land-use controls that regulate the location of certain types of development; and 2) land-management regulations that restrict the types of 1and-uses practiced, even though they may place no restriction on the location or type of development (24). Land-use controls, such as zoning, are traditionally the province of the States. Land-management regulations, which are more likely to be adopted to prevent groundwater contamination by agrichemicals, are being explored in States' new

groundwater protection strategies, but depend heavily on information provided by Federal agencies. "With the EPA giving the states the primary responsibility for groundwater policy, and requiring the development of State groundwater strategies, States have begun to realize the deficit of information-both institutional and physical-that they are now facing" (12).

Historically, agriculture rested in Federal hands, based on the premise that access to agricultural information and technologies should be freely available to a largely agricultural populace. However, with the rise of environmental concerns about agriculture, decline in the farming population, and declining Federal role in agricultural research and technology development (cf: 162), decisionmaking about U.S. agriculture is becoming increasingly complex.

Diversity of Approaches

The two Federal agencies with authority to control agricultural nonpoint pollution are the USDA and EPA, each with different missions and approaches. The USDA's goal is agricultural production and it has a voluntary, bottom-up approach; the EPA's goal is pollution abatement, and it has a regulatory, top-down approach (36) (figure 6-3; 177). To date, the Office of Management and Budget has favored development of voluntary programs to reduce agrichemical contamination, based largely on economic considerations (124). Voluntary programs are seen as a form of 'cost-sharing,' whereby costs of protecting the environment are shared by the general public, rather than placed exclusively on producers who are effectively 'price-takers' unable to pass along increased costs of production. A third approach to address environmental problems in agriculture was developed in the 1985 Food Security Act: cross-compliance denies farmers government benefits unless they follow approved conservation practices.

Voluntary-Voluntary approaches involve pollution controls implemented by farmers of their own free will. Voluntary programs involve no external coercion, primarily relying on: 1) research and development of farming methods to reduce or prevent pollution; 2) farmer education to increase awareness about contamimination pathways and pollution-reducing practices; and 3) demonstration and technical assistance to show farmers how to implement new practices and to convince them of their benefits (97,37,101). Farmers incur no legal penalty if they do not adopt proposed practices, but unfamiliar practices may be associated with some level of economic risk.

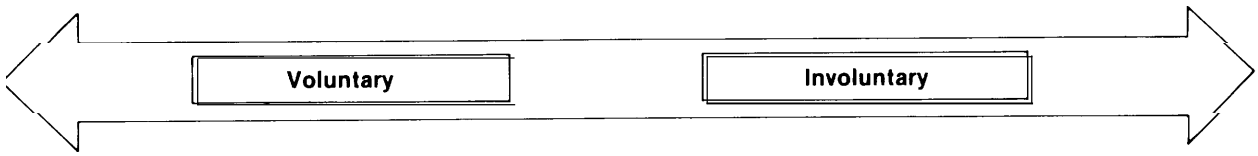
Of the three approaches, voluntary programs allow the farmer greatest flexibility in choosing crops, field sites, and farming practices. Examples of voluntary approaches include information dissemination and field demonstrations of practices by CES and SCS and in federally funded programs such as the Model Implementation Program and Rural Clean Water Program (97,146).

The main advantages to voluntary approaches are their political acceptability and flexibility. Farmers and their representatives have long opposed regulation in agriculture, which explains in part why voluntary pollution control programs have prevailed as part of agricultural policy (107). Voluntary program flexibility also allows for easier adjustment to changes in technical knowledge (180).

Voluntary programs' main disadvantages, however, are low participation rates and ineffectiveness due to inadequate or non-uniform implementation (97,47). Participants may reduce pollution originating from their own lands significantly, but nonparticipants continue to pollute, especially in the absence of adequate incentives to change. Furthermore, cost-share incentives for implementing practices are subject to local approval and interpretation as to what is politically, technically, and economically feasible (180). As a result, such practice-based voluntary programs are ineffective in areas with inadequate public support (83).

One hundred percent participation in voluntary programs, however, still may not achieve sufficient pollution reduction to attain desired water quality goals or standards. Only minor reductions in sediment and nutrient losses have been achieved through most voluntary programs, for example, even in areas with intensive information and demonstration campaigns (182,154,47,129). Compared to regulatory approaches, voluntary programs also have high costs in personnel, time, and finding (143). As a result, researchers, public interest groups, and some farmers have begun to criticize voluntary pollution control programs in agriculture because 50 years of voluntary soil conservation programs have not achieved societal goals for reducing erosion (47).

Figure 6-3-Range of Approaches to Agricultural Programs



Educational
Public presentations
School programs
Household chemical cleanup days
Waste 011 collection programs
Free water analysts programs
Aquifer hotlines
Publicity tactics
-Bumper stickers
Mascots
Poster contests
Billboards
-Aquifer area roadsigns

Operational
Contamination hotlines
Agricultural practices
Soil conservation
-Limit chemical application
Engineering practices
industrial practices
Contingency programs
-Hazardous material spill teams
Water system interconnection
Construct Ion practices

Economic
Water use taxes
Phased capital improvements
Purchase of development rights
Land purchase
Watersheds
-Sensitive areas
Public land retention
Eminent domain
Conservation/scenic easements
Property tax Incentives
Tax abatements
-Water conservation
-Water saving device installation
Letters of record to landowners

Regulatory
Special management districts
Zoning regulations
-Special zoning & overlay districts
● Floodplain
● Conservation
● Well field
Permits and waivers
Transfer of development rights
-Performance standards
Cluster zoning
Reduced density zoning
Subdivision and plannted unit Development ordinances
-Building and landscape codes
● Double plumbing
● Grading & soil restoration
● Water & sewer hookup
Well development standards
Aquifer penetration restrictions
States and federal designations (Critical areas or sole source)
Watershed rules & regulations

Many approaches exist to address agricultural nonpoint pollution. In general, USDA tends to use a voluntary, bottom-up approach and EPA follows a regulatory, top-down approach.

SOURCE: U.S. Department of Agriculture, Soil Conservation Service, "Principles of Groundwater for Resource Management Systems: Field-Level Training Manual," SCS South National Technical Center, Fort Worth, TX, August 1987.

Cross-compliance-Cross-compliance approaches involve pollution controls implemented by farmers (e.g., use of specific Best Management Practices—BMPs--or plans based on specific BMP combinations) in order to be eligible for certain program benefits. Cross-compliance programs are composed of: 1) specified pollution-reducing management practices; 2) a government-based program that provides benefits only to those using specified practices; and 3) verification and enforcement mechanisms to ensure eligibility of program beneficiaries.

The first cross-compliance programs to control agricultural nonpoint pollution from soil erosion were contained in the 1985 Food Security Act (FSA), representing the only Federal-level step taken so far toward making agricultural pollution control approaches more restrictive. The FSA requires farmers to implement approved conservation plans for highly erodible lands as a condition for receiving Federal farm program benefits. Cross-compliance approaches still rely on voluntary adop tion of pollution-reducing practices; they limit farmers' options only if the farmer chooses to participate in the government programs. Moreover, only certain commodities are covered by government programs, so only producers of these commodities are potential cross-compliance participants.

Cross-compliance programs, like the voluntary programs, tend to be more politically acceptable than regulatory programs. However, the main disadvantage to cross-compliance programs is that their implementation depends on base program participation, not on the severity of pollution problems (l). Base-program dependence also means that cross-

compliance incentives mirror base-program incentives, which may not be great enough to induce participation in the first place. For example, were payments reduced to bring down farm program costs, the penalty for non-compliance with conservation provisions also would decrease (38). Cross-compliance incentives could also disappear altogether if the base program is discontinued. Cross-compliance programs have other disadvantages, also associated with voluntary programs, in that they depend on local public and administrative support and local interpretation of USDA pollution control regulations (123).

Cross-compliance programs also are subject to regulatory modification by the department or agency administering the base program, influencing the types of pollution controls that are implemented. In the FSA's conservation compliance program, for example, USDA regulations were changed to allow farmers to implement ''Alternative Conservation Plans" (ACPs) on their highly erodible lands and remain eligible for farm program benefits.

Regulatory and local administrative changes thus affect the extent and uniformity of pollution control achieved through cross-compliance programs, and the extent of such changes is likely to reflect the intensity of commodity crop production in local areas. The greater the intensity of commodity crop production in an area, the more pressure is placed on administrators and congressional members to permit continuance of highly polluting practices as ''technically, politically and economically feasible. " Administrative ''malleability also has implications for groundwater pollution control, because groundwater contamination is likely to be worse in hydrogeologically vulnerable areas with high agrichemical-use intensity. Local administrators may be responsive to pressures from agricultural interests to weaken pollution control requirements unless countered by high levels of interest expressed by nonfarm populations. Cross-compliance programs alone are thus unlikely to achieve significant reductions in agrichemical contamination of groundwater in these areas.

Regulatory—Regulatory approaches involve pollution controls implemented by farmers in response to laws or rulings that impose penalties for noncompliance. Regulatory approaches require: 1) clear specification of what must be done or not done; 2) clearly defined penalties; and 3) verification and enforcement mechanisms. Examples of extant regulatory approaches are complete or partial pesticide bans, prohibitions on fall application of fertilizers, and requirements to triple-rinse pesticide containers prior to disposal. Regulatory approaches give farmers the least flexibility by requiring them to act in specified ways to avoid penalties.

Regulations have the advantage of allowing farmers and agricultural firms to know what is expected of them and to achieve economies of scale based on these expectations. However, uniform national regulations applicable to a wide range of hydrogeologic conditions would place excessively strict controls on areas where groundwater contamination may not occur or insufficient controls on areas where contamination potential is severe. An alternative would be to implement regulations only in vulnerable ''target' areas. However, such "target' area regulation may increase the cost of crop production in these areas thus placing these farmers at an economic disadvantage. Highly restrictive regulations in the most severely affected areas have the potential to cause people in these areas to go out of business, which makes strong support of such regulatory approaches unlikely. The challenge for regulatory programs is to specify farming practice requirements that are stringent enough to reduce pollution but that do not prohibit management strategies that will maintain farm economic viability.

A key disadvantage to the regulatory approach in agriculture has been opposition from farmers and their representatives, and this may have unintended adverse impacts (e.g., farmers may refuse to provide information voluntarily on agrichemical use and management to research and extension staff (91)). Regulation is rarely a popular policy, especially in the case of agriculture. In the last 20 years, however, farmers may have moderated their opposition to regulation, particularly in relation to agrichemicals (130). In some studies, farmers made distinctions among combinations of regulatory practices and did not universally reject regulation (175,70,81). Reduced farmer opposition, combined with recent public concern about health effects of nitrate and pesticide pollution, may result in more serious consideration of regulatory measures in integrated pollution control approaches to reduce groundwater contamination.

Other key disadvantages to regulation are the cost and feasibility of enforcement. If regulations are not designed realistically, if enforcement monitoring is unlikely, or if penalties are small, farmers may simply disobey the law (139). Regulatory enforcement is difficult in agriculture with potentially polluting activities ranging over wide areas, and enforcement is not a significant or well-accepted function for most State and local agricultural agencies. Thus, the lack of institutional mechanisms to enforce regulations in agriculture is another reason why regulatory approaches to pollution reduction have been difficult to advance. However, the potential for regulatory penalties may be a significant inducement for farmers to voluntarily adopt contamination-reduction practices.

Another disadvantage is that regulatory approaches tend to be medium- or resource-specific, lending themselves easily to prohibition of specific practices that adversely affect a single resource. Regulatory approaches to address multiple resource concerns are more difficult to design, because integration of numerous practices, each designed to protect a specific resource, into an appropriate management system for a particular site is difficult. Documented implementation plans and follow-up audits could serve as regulatory enforcement mechanisms for ''mandatory systems' in hydrogeologically vulnerable areas, but these would be costly in terms of personnel and time.

Integrated Approaches To Reducing Agrichemical Contamination of Groundwater-Past response to voluntary nonpoint-source pollution control programs indicates that "doing more of what has been done in the past' will not adequately address soil erosion and surface-water quality problems (47). It is unlikely that practitioners will widely adopt new practices, with attendant new risks, without significant incentives or penalties for noncompliance. Thus, solely voluntary programs are likely to have even greater shortcomings in addressing groundwater contamination, which is invisible and more difficult to measure than erosion and surface-water pollution. Considering the advantages and disadvantages of voluntary, cross-compliance, and regulatory approaches, it seems likely that an effective approach would combine elements of all three strategies.

An integrated groundwater pollution reduction program for agriculture could emphasize voluntary and cross-compliance approaches on the national level to improve agrichemical management, reduce point-source contamination, and spur adoption of technologies that replace agrichemicals or reduce waste associated with their use. In hydrogeologically vulnerable "target" areas, however, agricultural impacts on groundwater may need to be regulated to a greater extent along with intensified voluntary efforts and defined, nonmodifiable standards for allowable practices in cross-compliance programs. The challenge will be to devise appropriate mixes of the three approaches in these areas.

For example, following the model established in Nebraska, "Natural Resource Districts" or "Agro-ecological Regions' might be identified based on agricultural and hydrogeologic characteristics. A tiered program could be established for each region based on actual risk **to** water consumers and the environment (1 19). In areas where contamination is low or unlikely, education and voluntary programs might be emphasized. Districts with higher actual or potential contamination risk might require farmers to participate in certain programs (e.g., showing receipt of attendance at a nutrient management program prior to purchasing nitrogen fertilizers). In areas showing severe contamination, use of particular chemicals or farming practices might be banned entirely. With such a program, Federal, State, regional, and local roles would have to be closely coordinated.

Potential Solutions to Common Problems

A wide range of organizations have influence over policy, programs, and farming practices that may have potential to reduce agrichemical contamination of groundwater, and a broad range of policy instruments exists that can be haphazardly implemented, or integrated into a comprehensive package. However, development of a comprehensive approach **will** require:

- congressional leadership,
- clarification of roles,
- coordination/integration of programs and approaches,
- dealing with the legacies of agency histories,
- evaluating adequacy of authority, and
- evaluating resource (staff, funding, information) adequacy.

Taking the Helm: Options for Congress

Identification of national goals, and determination of the national agenda, for agricultural and environmental issues is the province of the Congress. The special properties of agrichemical contamination of groundwater, its relationship to integrating agricultural and environmental policy, and the need to coordinate Federal and State efforts, have until recently been neglected under the pressure of providing immediate public safety (12). Foresight—the "systematic process of bringing lateral and long-range implications into policy decisions" (71)--has not been formally brought to bear in consideration of agrichemical contamination of groundwater.

On the other hand, the House of Representatives has developed rules that require it to incorporate foresight into its processes: 1) multiple referral of important bills to several interested committees ensures that multiple viewpoints are incorporated into legislative debate; 2) requirements that each committee ''shall on a continuing basis undertake futures research and forecasting" on matters within its jurisdiction (160); and 3) requirements that inflationary impact and long-term budget estimates accompany each bill (71). Still, multiple referral of bills has served to impede passage of key legislation, eventually allowing the budget process to force passage of 'least-controversy" bills (e.g., "FIFRA-Lite';[2] cf: **4),** and committee staff largely are too enmeshed in day-to-day committee work to undertake much futures research. Congressional research offices can serve to focus debate on issues, but cannot serve as forums for resolution of controversy over national goals.

Integration of agricultural and environmental policy requires the Congress to give full consideration to the effects of policies on the objectives of other sectors. Successful integration also presupposes an administrative structure designed to anticipate conflicts, determine acceptable trade-offs, and foster selection and implementation of a coherent set of instruments that will achieve joint objectives (127,128). The agricultural-environmental agenda has grown substantially in the last two decades; concern over groundwater quality is just the latest manifestation of that agenda.

POLICY ISSUE: Lack of a Central Forum for Congressional Consideration of Agriculture and Environmental Issues

The U.S. Congress does not have a filtering or integrating mechanism to ensure that all components of agricultural legislation consider potential for unintended impacts on agricultural productivity, agrichemical use, groundwater quality, the rural environment, or other areas in which there is a public interest. Similarly, no centralized forum exists to ensure that environmental legislation does not conflict with legitimate public interests in agriculture. A congressional-level organizational unit might provide such a forum, ensuring that open debate, integration or determination of priorities, and foresight are incorporated into decisionmaking on agriculture and the environment.

Option: Establish New Congressional Committee

Congress could establish a Joint Committee on Agriculture and the Environment (or a Natural Resources and Environment Committee with a broader mandate) with specific jurisdiction to bring goals for agriculture and the environment, beginning with agrichemical contamination of groundwater, into open debate, to review the Federal role in U.S. agriculture, and to review all extant and proposed legislation for possible implications for the environment.

Alternate Option: Establish Alternate Congressional Forum

Congress could establish a temporary Selector Ad Hoc Committee on Agriculture and the Environment, or a National Agricultural Policy Study.

Either body would be formed of congressional Members and staff representing interested committees, whose express mandate is to provide to the Congress analysis of: 1) relevant trends, 2) changing goals for agriculture and the environment, and 3) potential conflicts in extant and proposed legislation. Such a committee, or a facsimile thereof, would need at least the following attributes: 1) not historically tied to any particular constituency, 2) not tied exclusively to a narrow subdivision of environmental or agricultural policy, and 3) not hindered by jurisdictional narrowness from considering the full

[2]"FIFRA-Lite" is a term coined to refer to the 1988 amendments to the Federal Insecticide, Fungicide, and Rodenticide Act which deleted reference to the controversial issues of reimbursement liability, and groundwater contamination (cf: 4).

realm of relevant questions. As such this entity might begin to promote congressional consideration of the range of national goals and Federal roles in agriculture and the environment,

Establishment of a Joint Committee allows coordinated consideration of issues by both chambers of Congress, and may be necessary for an issue covered by widespread jurisdiction in both chambers. Although establishment of a Joint Committee may be more cost-effective than creation of committees or policy study groups in each chamber, consideration of integration of agricultural and environmental legislation may require only a temporary congressional forum.

Either chamber may create a temporary Select Committee to conduct continuing comprehensive reviews or to resolve issues fragmented jurisdictionally among several standing committees. For example, a Select Committee To Investigate the Use of Chemicals, Pesticides, and Insecticides in and with Respect to Food Products was created in 1950 because the House Committee on Agriculture "was occupied with other matters and because that standing committee did not have jurisdiction over public health questions' (188). The Select Committee issued its final report in 1953, and was disbanded.

Select committees are expected to be of temporary duration, with clearly defined subject matter and method of inquiry, and shall deliver products (e.g., reports, bills) to standing committees with jurisdiction over parts of the issues as well to to the House. However, a House Committee on Rules report (1 88) on establishment of Select Committees lists concerns with proliferation of congressional committees, including increasing congressional costs and space problems, imposing additional committee burdens on Members, and potential interference with the standing committee system. Therefore, the Subcommittee established guidelines for establishment of new committees, including:

- . the proposed select committee must deal with *a* significant and major issue;
- . the present committee system does not address the issue effectively, for reason of fragmentation of jurisdiction over subject matter, or because of lack of staff resources for investigation, or to permit a broad perspective not available through any one standing committee.

Developing a comprehensive approach to agriculture and the environment clearly fits within these guidelines.

The House of Representatives also has the option of creating an Ad Hoc Committee expressly to consider one or a certain group of bill(s) (188,132). The first such committee was the Ad Hoc Committee on the Outer Continental Shelf, established in the U.S. House of Representatives in 1975, including representatives from major House committees with a role in energy development and environmental management of the outer continental shelf. This Ad Hoc Committee was created to "prevent major jurisdictional problems involving six or more standing committees' and was considered a **success** (188).

A National Ocean Policy Study was created in the Senate in the early 1970s, with the purpose of providing a forum for ocean-related matters that have multiple committee jurisdiction. Although not technically a subcommittee, and not a recipient of legislative referrals, the Policy Study was composed of Senators with an interest in the development of a comprehensive oceans policy, and developed numerous pieces of legislation for consideration by relevant Senate committees. It also aggregated an interdisciplinary group of congressional staff who could devote full time and effort to consideration of the complete range of ocean issues. Were a National Agricultural Policy Study established, it could be accompanied by a non-congressional National Agricultural Policy Review Commission established to assist in analysis and presentation of viewpoints on goals.

Clarification of Public Roles

The relative roles of the Federal agencies, and State and local governments, have not yet been detailed. Clearly all levels of government will have to work with the private sector and individuals to reduce agrichemical contamination of groundwater. To date, agencies at all levels of government have been attempting to undertake virtually all types of activities.

As States undertake initiatives to address water quality and agriculture, it will be necessary to sort out Federal, State, and local roles more clearly. This will be a difficult task. For example, arguments for regulatory uniformity, consistency of standards, and balanced treatment of farmers among different

Box 6-G—Rationales for Federal v. State/Local Jurisdiction Over Issues

Justification for Federal level program	Justification for State/local program
National problem or interstate/inter-local problem	Regional/local problem
Need for detailed scientific/technical information	Need for detailed information on local circumstances
Substantial externalities, information requirements, or economies of scale	All benefits and costs are within the jurisdiction
Need for uniform treatment of individuals, polluters, or municipalities	Flexibility and ability to provide more innovative solutions
Need to resist pressures to attract or keep industry by reducing environmental standards	Relatively homogeneous taste (goal) of local population
Need for minimum standard of health or ecological protection	Problem pervasive enough to be of major concern to the community
To reduce duplication and ease industry compliance for industries that engage in much interstate commerce	Need for rapid implementation
To reduce absolute burdens on municipalities	Need for more assured funding (e.g., earmarked tax v. general revenue)
To compensate losses aggregated in time or space by decisions made prior to the pollution control law	

However, "it is not clear which levels of government are more likely to represent the desires of future generations, particularly in a mobile society. "

AFTER: F.G. Sussman, "Environmental Federalism: Allocating Responsibilities for Environmental Protection" Staff Working Paper (Washington DC: Congressional Budget Office, September 1988).

regions provide a rationale for a strong Federal role. However, diversity of hydrogeology, farmer characteristics, and farming practices suggests a need to tailor approaches to local conditions (1 11) (see box 6-G).

Most likely, a tiered approach, involving actions at all levels of government, maybe most appropriate. For example, the Executive Director of the Association of State and Interstate Water Pollution Control Administrators suggested that States should have primary responsibility for managing groundwater quality and quantity, and identifies the Federal role as:

- providing technical assistance, research and development, and information dissemination to the States;
- assisting States in the review and definition of geologic and climatic conditions controlling groundwater quality and quantity, but having no responsibility in groundwater quantity management;
- involving States in Federal activities and providing adequate financial support for State programs addressing interstate groundwater quality; and
- developing useful mechanisms for States to translate research results, risk analysis, and guidelines into meaningful groundwater standards (73).

A consensus on the appropriate allocation of roles among Federal, State, and local organizations will be necessary to ensure that a coordinated, nonduplicative, and comprehensive system is developed to achieve the multiple public objectives of agriculture and environmental quality.

Even with substantial Federal involvement in program development, it seems likely that a majority of actions will be implemented by the States, given the site-specificity of groundwater vulnerability and the diversity of agricultural practices. Congress needs to ensure that a framework exists so that Federal directives actually can be implemented.

POLICY ISSUE: Lack of Clear Federal Agency Leadership

Confusion exists over leadership within and among Federal agencies with responsibilities for agriculture and environment. In the absence of top agency leadership, some lower level officials may be reluctant to develop or implement groundwater protection policy (1 19).

The question of leadership roles among the agencies similarly can produce difficulties in re-

spending to policy initiatives. An often-raised issue in numerous groundwater quality hearings of the 100th Congress was which of the Federal agencies should be designated as the "lead agency" in groundwater protection. Given specialized expertise among a number of the agencies (e.g., USGS-data collection and coordination; EPA—standards and regulatory structure; USDA--crop and farm management, education and technical assistance, research; TVA—nutrient management) designation of a single lead agency probably is undesirable.

Executive agency reorganization could aggregate relevant authorities and responsibilities in a single agency, such as the oft-proposed Department of Natural Resources. This would allow clear identification of authority and accountability. However, it probably would not be appropriate for one organization to hold both regulatory and assistance responsibilities. Further, even if such an organization did not include regulatory authority currently held by EPA, large-scale reorganization involves serious disruption of programs and does not necessarily result in improved coordination. It may be more appropriate to assign specific domains of groundwater protection responsibilities to each of the agencies that complement the assignment of specific goals (1 19) including a mechanism to ensure interagency coordination.

Option: Identify Lead Role Responsibilities For Multiple Agencies

Congress could specifically identify lead agencies for subsets of the issue. Based on historical specialization in certain areas related to agriculture, to environmental protection, and to hydrogeology, agencies could be assigned specific lead roles to coordinate data collection, data management, information dissemination, and research program development.

Congressional identification of agencies or programs that could lead efforts in certain sub-areas of the issues probably is unnecessary. The OMB and the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) efforts serve to identify natural roles for the agencies to take, and identification of lead agency status is at least partially defined via the Memoranda of Understanding already established among the agencies. However, congressional recognition of the established roles, and explicit oversight of completion of activities within those areas, might encourage coordinated action.

Alternate Option: Require Development of an Interagency Plan by Federal Agencies

Congress could require that USDA, EPA, USGS, and TVA/NFERC develop an Interagency Proposal for Groundwater Protection in Agriculture detailing needs, roles, means for communication and coordination, etc Congress may wish to request that the relevant agencies put together an interagency proposal, and perhaps an interagency budget, to develop and implement comprehensive groundwater protection programs.

The agencies are already somewhat experienced in developing groundwater protection budgets for OMB. The agencies also already have developed documents that could serve as the foundation for an integrated interagency plan. However, given the current extent of confusion over definition of roles and approaches, and bureaucratic slowness in adopting new approaches or programs, this is unlikely to provide a timely analysis, nor a comprehensive view.

Moreover, an integrated interagency plan and budget proposal would require review and approval by each of the congressional authorization and appropriations subcommittees related to the agencies. Thus, the resulting budget and plan would have to be modular, so that each agency's component could be reviewed and approved by the appropriate congressional subcommittee, or Congress would have to develop the capacity for intercommittee authorization, appropriation, and oversight.

Legislative Authority and Flexibility

USDA has broad organic authorities to address all issues related to American agriculture; its authorizing legislation, commonly called the Farm Bill, is reconsidered by the Congress every 5 years. Consequently, programs to protect groundwater from agricultural chemicals have developed within offices that have broader historical mandates and functions. Other offices have programs specifically directed towards protecting groundwater quality.

Like USDA, USGS has broad organic authorities to pursue its primary missions. According to an OMB Circular A-67 (1964), USGS is charged with responsibility for interagency and intergovernmental ground- and surface-water data coordination, and

with encouraging consistency in data collection and storage. In addition, the Water Resources Research Act authorizes USGS to provide finding to States, although such funding has been declining (197). However, additional authorizing legislation could serve to give agencies specific direction and priorities within their broader range of activities, and to legitimize specific activities (1 19).

POLICY ISSUE: National Fertilizer & Environmental Research Center Activities Dependent on TVA Oversight and Appropriations

TVA authority is based upon the 1933 Tennessee Valley Authority Act. The National Fertilizer & Environmental Research Center (NFERC) was created to assist with modernization of agriculture in the River Basin, but has since established itself as a national ''center of excellence' in fertilizer research and development (76). However, funding continues to be allocated to the NFERC under appropriations for the regional authority and, thus, can be strongly affected by decisions made with regard to the organization as a whole.

Option: Make NFERC an Independent National Center of Excellence

Congress could separate NFERC authorization and appropriations from the Tennessee Valley Authority, and redefine it as an agricultural research center of excellence, perhaps as part of the land-grant system, or as a stand-alone center based on the model of the National Center for Atmospheric Research (NCAR) or the National Institutes of Health. An independent NFERC could be created that would have explicit authority to undertake, sponsor, or direct national research, development, extension, information dissemination, and education efforts related to agricultural nutrient management and development. The center could continue to focus on commercial fertilizers and livestock waste management, or could be expanded to include additional agricultural nutrient-related issues, such as basic agroecosystem research.

Incorporation in the land-grant system might allow NFERC to define protocols for experiments to be replicated by other land-grant research centers on differing hydrogeologic sites. However, if NFERC becomes part of the land-grant university system, its funds would be allocated under the Hatch Act, and the avenue for special allocations may be narrow.

If the new organization were modeled on NCAR, a joint Federal-university consortium organization, it might focus more strongly on basic research and on computer simulation modeling of environmental fate of chemicals and modeling of the nitrogen cycle, for example. Similarly, funding could be allocated from USDA, EPA, the National Science Foundation, and other Federal research agencies. As a National Center, it may be joined in the future by other such "centers of excellence" focusing on other agricultural issues, and comprise one part of a coordinated group of research centers such as the National Institutes of Health,

As an independent center of excellence, funding and personnel decisions could be made related to nationally -identified needs. Separation of NFERC from TVA probably would require increased appropriations to NFERC to cover costs of support services currently obtained from TVA, in addition to those required to expand programs or develop new efforts. Separation of NFERC also could entail a reduction in appropriations to TVA. However, in light of TVA's experience and expertise with various forms of power-generating utilities, it might profitably reorient its environmental programs towards those more directly relevant to power generation, such as management of hazardous waste, or reduction in greenhouse gas emissions.

POLICY ISSUE: Lack of Comprehensive EPA Authority

EPA is unique among the four primary agencies in that all of its programs are specifically mandated by law. It does not have the broad organic authority available to the other agencies, and hence has less flexibility to develop programs. Existing legislative mandates set the tone for the agency's agenda and program development. Thus, perhaps the piecemeal approach contained in the mandates themselves work against a comprehensive or integrated response to environmental problems (152). Because legislation tends to focus on specific media, EPA and its programs are organized to address these specific media, rather than to track pollutants as they move among media. In addition, by their nature, regulatory programs require specific authorizing language, and little clear authority exists for EPA to regulate privately -owned drinking-water wells (119).

Option: Provide a Systems Approach in Organic Legislation For Environmental Protection

Congress could establish clear means to coordinate regulatory programs relating to protection of water quality throughout the entire hydrologic cycle, and clear authority to undertake a preventative approach, in an organic act for a Department of Environmental Protection. Several legislative proposals have been put forth in an effort to elevate EPA to Department level. Proponents argue that the associated increase in flexibility and ability to operate proactively defend elevation to Cabinet-level status (152). It has been suggested that EPA's level in the bureaucratic hierarchy works against its ability to coordinate effectively with other key agencies despite a clear cause for EPA concern in the interests and activities of these agencies. Supporters of proposals to elevate EPA to Department level also argue that equal footing with other departments is needed to promote widespread integration of environmental policy in other programs (152).

It has been suggested that EPA's lack of Cabinet standing indicates a lack of understanding regarding U.S. environmental problems: environmental protection could be viewed as a temporary governmental responsibility and not a long-term effort to protect the public interest meriting a change in bureaucratic structure (152). However, elevation to Cabinet level alone may not ensure that EPA activities would be enhanced: funding must be assured and potentially increased, and the organic legislation will need to provide EPA the authority and flexibility to deal with agriculture and water quality issues in a comprehensive, coordinated, systems fashion.

Formal congressional recognition of the continuous nature of the hydrologic cycle, and thus of the myriad pathways of water contaminants, in an organic act for EPA, might assist that agency to develop coordinated water quality protection programs. A clear mandate to undertake preventative programs, in addition to its regulatory responsibilities, could assist EPA to reorient its activities from a contaminant- or media-specific focus towards more comprehensive water quality protection.

POLICY ISSUE: Fragmented Legislative Authority for Water Quality Protection

At present, water quality concerns are addressed in a number of separate pieces of distinct and often uncorrelated legislation. Failure to integrate the provisions of these distinct laws into a coordinated set of statutes may lead to problems and conflicts in their implementation. For example, since anhydrous ammonia fertilizer can volatilize into the atmosphere, be washed into surface waters, or percolate into groundwater, use of this fertilizer could be covered not only by the diverse groundwater protection provisions already enacted, but also by laws to protect surface waters, reduce air pollution, and protect the global climate. The time may be approaching when a farmer who applies fertilizer on a field may have to comply with the provisions of more than a dozen separate pieces of legislation (1 19). The demands of each of these separate Acts could require different and sometimes contradictory behaviors.

Option: Evaluate Water Quality Laws for Coordinated, Comprehensive Approach

Congress could create a "blue-ribbon" panel of lawyers, administrators, and scientists to evaluate current water-quality laws, to identify areas of conflict and overlap, and to suggest legislation that would integrate extant laws into a rational and consistent structure. Each law could be **modified in reauthorization accordingly, or an omnibus water** quality **bill** could be developed that encompasses earlier legislation. Evaluation of current legislation and authority could be undertaken concurrently with development of organic legislation for a Department of Environmental Protection, or could be conducted independently. Reauthorization of water quality laws based on the evaluation could assist in development of a comprehensive, coordinated approach to water quality protection, but would not provide an ongoing framework to ensure maintenance of such an approach as new water-related issues emerge.

Development of omnibus water quality legislation would allow for continued comprehensive consideration of water quality issues, however, this would require the integration of laws developed and supported by separate committees within Congress. Each committee responds to somewhat different constituencies, each likely has a different set of priorities, and sometimes fierce competition exists between committees for jurisdiction. A comprehensive, integrated and rational set of groundwater laws may be difficult to create under these circumstances.

legacies of Organizational History

Each Federal agency has a unique history and set of resources for protecting groundwater. USGS has a history of 'pure science and research, ' and limits its activities to providing data and coordinating data collection for other agencies. TVA/NFERC and USDA combine data collection and monitoring with basic and applied research, technology transfer, and technical assistance. EPA engages to some extent in the preceding activities, but also has regulatory and enforcement responsibilities. Each agency has some combination of ''top-down' and "bottom-up' approaches with the well-known ensuing conflict between addressing local or regional needs and establishing programs based on visible national priorities.

Jurisdictional issues among agencies also may hinder effective programs. For example, EPA has appropriations and authority to conduct pesticide applicator training programs, but lacks the rural infrastructure and communications network necessary to deliver the program. Consequently EPA contracts with the USDA Extension Service for delivery through its extension network. However, funding has declined, and neither EPA nor USDA may be committed to make investments in a program where their respective responsibilities and authorities appear vague.

USDA and TVA have greater experience in outreach and technical support, but both are wary of direct involvement in enforcement programs. Conversely, EPA has demonstrated a repeated interest in participating in education, outreach, and demonstration programs, and has some degree of experience in each of these areas. Further, EPA has critical information on pesticide management and handling that may not currently be extended through USDA's channels. EPA lacks the outreach communications infrastructure and personnel present within USDA.

Differences in administrative structure, approach to environmental protection, and general wariness by both agencies has hindered cooperative ventures. Little research has been conducted on the efficacy of various institutional structures or approaches to protecting groundwater quality (192), so few conclusions can be formed.

POLICY ISSUE: Program Implementation Based on Political Boundaries Rather Than Hydrogeological Regions

The arrangement of decentralized (regional or field) offices of each of these organizations tend to be based on political boundaries that rarely correspond with natural resource boundaries (e.g., groundwater basin, watershed). One early attempt to subdivide the nation into meaningful water regions (figure 6-4) shows little correlation between State or county boundaries and water-resource boundaries. This complicates agency coordination efforts: groundwater protection programs must link local, State, regional, and Federal activities into a coherent, coordinated action to be effective. Each of the major agencies will have to develop national programs that can be administered through hydrogeologically meaningful regions, potentially necessitating reorganization of field activities. However, efforts may more easily be based on water-resource boundaries, as illustrated by the SCS studies of groundwater contamination within 37 "high risk" hydrologic regions identified based on hydrogeological factors.

Option: Implementing Programs Based on Natural Resource Systems

Congress could require that the relevant information collection, research, and outreach programs conducted by each of the major agencies (e.g., USDA, EPA, USGS) be directed to hydrogeologically defined "ecoregions." Most implementation organizations have jurisdictions determined by political boundaries. This will hinder establishing programs based on' ecoregions, and may require development of new organizational coordination mechanisms, or restructuring of some organizations. Thus, this may require that SCS, ES, and EPA outreach services be combined into one massive service; that outreach personnel be located within the same facilities to aid coordination; or it may require cross-training of SCS, ES, and EPA outreach personnel.

Coordination of Interagency Activities

Given the many water quality protection programs underway, it is not surprising that widespread concern exists regarding the extent of potential duplication of effort and the level of cooperation and coordination among Federal agencies. Some duplication may be desirable, as a way to ''check the system, " but wasteful duplication of basic functions and responsibilities should be avoided. Despite the increase in agency coordination that has already occurred (106), many believe that Federal programs should be better coordinated, especially to provide

Figure 6-4-Comparison of Water Resource Boundaries and State Boundaries

The lack of correlation between State or county boundaries and water-resource boundaries may complicate the development of comprehensive water quality protection schemes.

SOURCE: U.S. Water Resources Council, *The Nation's Water Resources, 1975-2000,* vols. *1-3, In*: **Nipp, 1989.**

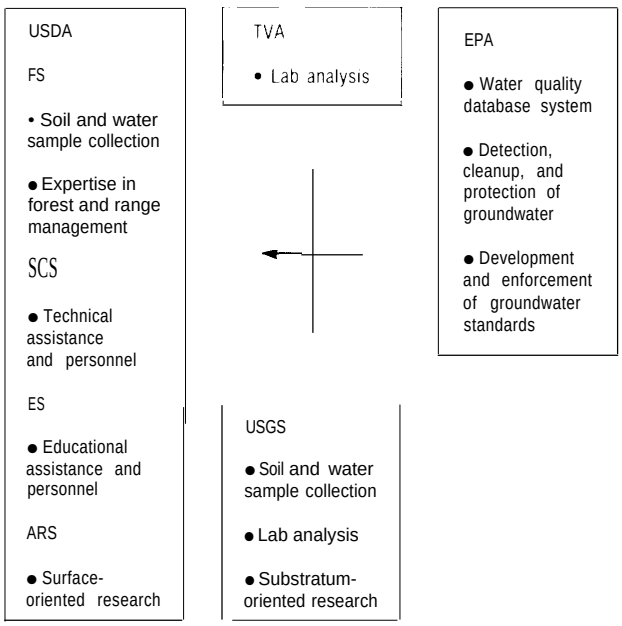
consistent advice and assistance to States and individuals (cf: 119,46,197).

The Office of Management and Budget (OMB) initiated the Interagency Task Force on Groundwater in 1987 to catalog Federal agency activities to protect groundwater quality and to develop a coordinated interagency groundwater protection strategy. These efforts culminated in the President's Water Quality Initiative for fiscal year 1990. The OMB and Congress have cited needs for more detailed and cooperative planning efforts to facilitate coordination within and among Federal agencies, resulting in new coordinating mechanisms (56, 119). Subsequently, the Subcommittee on Groundwater of the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) was made responsible for:

> . . . coordinating Federal nonregulatory groundwater efforts related to research, resource assessment, information management and dissemination, technology demonstration, technical assistance, training, and education, The membership of the subcommittee includes the Departments of Agriculture, Commerce, Defense, Energy, and Interior; the Council on Environmental Quality; the Environmental Protection Agency; the National Aeronautics and Space Administration; the National Science Foundation; the Nuclear Regulatory Commission; and the Office of Management and Budget (56).

The Subcommittee also has responsibility for facilitating implementation of existing Memoranda of Understanding and other cooperative agreements that exist among agencies (see figure 6-5). It seems that, as water quality program staff interact, there is a growing effort to plan and develop new programs

Figure 6-5-Network of Primary Federal Interagency MOUs on Water Quality



The primary Federal agencies, and a number of other Federal, State, and local organizations, have signed Interagency Memoranda of Understanding (MOU) allocating responsibilities for various components of groundwater research, monitoring, data management, and program activities.

SOURCE: Office of Technology Assessment, 1990

jointly, such as the independently planned but cooperatively merged USGS Mid-Continent and USDA Midwest Initiatives to study effects of herbicide use on groundwater.

Option: Prepare and Maintain Management Matrices of Agency Roles and Responsibilities

Congress could require that the OMB/FCCSET Subcommittee on Groundwater prepare such matrices showing clearly the activities undertaken by each relevant Federal agency or office to protect groundwater from agrichemical contamination; and provide an accompanying report detailing agency roles and responsibilities. One tool that may allow ready identification of roles and activities is the management matrix (1 19,120). Such a matrix can show agencies and offices on one axis and issues, components of the hydrologic cycle, research topics, or similar categories on the other axis. Responsibilities of each agency or office can be listed in the resulting form. This procedure should show readily where duplication is occurring, or where important topics are not addressed.

Submatrices may be similarly constructed, such as a research matrix. For example, the USGS-sponsored Technical Integration Group--composed of technical program managers from USDA, USGS, EPA, and TVA/NFERC-has developed a research matrix showing components of the hydrologic continuum on one axis and the physical processes affecting movement through the continuum on the other axis (table 6-4). The resulting research matrix can be used to identify which scientific disciplines are pertinent to each hydrogeologic component, and assists in identification of lines of coordination and communication.

POLICY ISSUE: Coordinating Federal and State Actions

Based on the 1984 Groundwater Protection Strategy, EPA has provided the States with roughly $40 million in grants since 1985 to support development and implementation of Ground Water Protection Programs (184). These programs are intended to provide a State with a cohesive, resource-oriented perspective to underpin the many federally directed (e.g., Resource Conservation and Recovery Act; Federal Insecticide, Fungicide, and Rodenticide Act; Superfund) and State-initiated programs that address specific sources of groundwater contamination. A State Ground Water Protection Program provides consistent policies, approaches, and information within each State on groundwater vulnerability assessments, resource use and value classifications, State groundwater standards, and protection priorities. Centralizing these functions in one program helps achieve consistency in groundwater protection and cost-effectiveness in avoiding unnecessary duplication among different State agencies and programs.

In 1988, EPA proposed a strategy to specifically address the concern for pesticides in groundwater (183). The key component of this source-specific strategy is the development of pesticide/groundwater management plans by a State as the basis for continued EPA registration for State use of pesticides posing groundwater concerns. The Agency's pesticide strategy builds on the 1984 strategy by requiring the State's lead agency for pesticide regulation (usually the State Agricultural Agency) to develop its pesticide/groundwater management plan in cooperation with the State's lead agency for groundwater protection (usually the State Water Quality Agency or Public Health Agency). In this

Table 6-4—Sample Program Management Matr x[a] of Research Responsibilities

	Department of Agriculture							Geological Survey				Other Federal agencies	State and local institutions			Special interest group
	CSRS				ES											
	ARS	SAES	ERS	FS	SCS	CES	Other	WRD	GD	NMD	EPA		Natural resources	Agriculture/ Water research	Other	
Fundamental process research:																
Water and solute transport	X	X						X	X		X			X		
Transformation processes	X	X						X	X		X			X		
Sorption processes	X	X						X	X		X			X		
Biological processes	X	X						X			X			X		
Evaluation of farming systems:																
Farming systems managment	X	X														
Technology evaluation	X	X	X					X								
Effects on soils	X	X														
Socioeconomic consequences		X	X												X	
Development of systems:																
Management systems	X	X	X												X	
Chemical application	X	X									X					
Diagnostic tools	X	X						X								
Spatial data:																
Compile, integrate, transfer	X	X						X	X					X	X	
Evaluate	X	X							X							
Develop decision aids:																
Evaluate and develop models	X	X						X			X			X	X	
Target decision aids	X	X														
Economic decision aids		X	X												X	
Technology transfer:																
Transfer to E&TA agencies	X	X						X	X		X					
Service functions:																
Laboratory and sampling	X	X						X	X		X			X		
Standards and glossary	X	X						X			X					
Impacts on ecosystems:																
Surface water	X	X						X	X		X			X		
Terrestrial	X	X						X	X		X			X		

S—A
S—C Ext
S—C
S—
Ext
S—F
D—G
MD—N M
S—St
S— Se
W D—Wa

es

M M ed ud W M *grichem ca*
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reamer, protection objectives and approaches for pesticides will more likely be consistent with other groundwater protection efforts, and can build on the work underway within the States on groundwater resource mapping and monitoring (10).

EPA also has responsibility for overseeing State NonPoint-Source Programs as established by Section 319 of the Clean Water Act. The Act requires the States to develop assessments of their nonpoint-source pollution problems and Management Programs to address these problems. In EPA's guidance to the States, the Agency requested that States include information on any known or suspected groundwater problems caused by nonpoint-sources and that such information be consistent with each State's Ground Water Protection Program (181). EPA's Regional Offices also were requested to encourage the States to incorporate the groundwater policies, approaches, and information of their Ground Water Protection Programs in their NPS Management Plan submissions to the Agency.

Congress has appropriated $40 million to EPA for implementation of the Section 319 NPS Program in 1990, the first monies appropriated for implementation of the section. The Agency is providing grants to States for demonstration and implementation of best management practices (BMPs) for nonpoint-source control; some of these projects are aimed at groundwater protection (10). However, section 319 gives neither EPA nor the States additional enforcement authority, such that compliance is voluntary (57).

Coordination of a State's NPS Program with the State's Ground Water Program is intended to help assure consistency in a State's approach to groundwater protection across a wide variety of point and nonpoint sources of contamination. Concomitantly, such an approach allows the NPS Program to integrate groundwater protection priorities of the State's Ground Water Program with those for surface water, to develop an overall priority plan for addressing nonpoint sources within the State. EPA has underway a study to profile the degree of coordination between these two programs that has been achieved by the States.

Recent policy papers from EPA's Ground Water Task Force call for assuring consistent and coordinated groundwater policies and efforts across all groundwater programs within or supported by EPA and among other Federal agencies (185). The Task Force also stated that the key means for achieving such consistency and coordination is to ensure the implementation of Comprehensive State Ground Water programs (186). Many of EPA's source-specific regulatory programs affecting agriculture already have been coordinated with States' Ground Water Protection Programs, or plans for their coordination are underway.

Given that many of the BMPs developed and demonstrated under the NPS Programs and the USDA Initiative likely will be proposed as components of, or alternatives to, regulatory programs, it is important that these programs and efforts are each coordinated with the States' Ground Water Protection Programs. EPA and USDA currently are working to link States' NPS Programs to the selection of research and demonstration projects that USDA will fund under the President's Water Quality Initiative (see box 6-D).

Option: Multiple Referral of State Agrichemical and Groundwater Plans

Congress could have each State plan evaluated by each relevant agency (USDA/ES, USDA/ERS, EPA, USGS, etc.) or, alternatively, could establish a joint, interagency group to review State plans. Because of the site-specific nature of groundwater contamination by agrichemicals and the concomitant site-specificity of farming practices likely to reduce contamination, and because of the lead role the States have taken in response to agrichemical contamination of groundwater, coordinated development and approval of State Groundwater Protection Plans and Pesticide Management Plans may provide one avenue for coordination of Federal/State activities. However, having as many as 100 plans reviewed sequentially or iteratively by up to 10 agencies likely would stall the planning process.

An alternative method of coordinating Federal and State activities would be to have the State plans reviewed by an Interagency Review Board comprised of representatives from the major Federal agencies to ensure that plans consider all information available from the agencies, and to assist in coordination of Federal and State activities within each State. Regular reappraisals of plans and activities could allow readjustment of Federal and State activities to achieve increasing coordination as programs are implemented.

Option: Develop a Coordinated Farmland Resources Management Program

Congress could establish a program based on the Coastal Resource Management Act model to achieve coordinated use and protection of farmland resources and reduction of adverse environmental impacts associated with agricultural production. The Coastal Zone Management Act (CZMA) of 1972 (Public Law 92-583) (30) established coastal zones as areas of special significance to States and the Federal government, and authorized establishment of State Coastal Management Programs (CMP) (box 6-H). The CMP model encourages voluntary State participation, promotes centralization of State planning, establishes a clear line of State-Federal communication and assistance, and focuses on specific land areas and associated resources and multiple pollution sources.

The CZMA could serve as a model for development of an Agricultural Resource Management Act promoting development of State Agricultural Resource Management programs (ARMP). As coastal and nearshore resources clearly have been deemed of special significance ecologically and economically, farmland has been determined to be of national importance (cf: 54,22,131). And off-site impacts of agricultural activities are of growing concern just as the offsite-impacts of land-based activities became of concern in coastal areas and nearshore waters. Just as under a CMP, certain areas may need to be protected from agricultural development (e.g., wetlands, riverine fringes, and other agriculturally related highly vulnerable areas), but agricultural use of the area also may need to be allowed in balance with environmental protection goals.

An ARMP could be designed to protect farmland resources and manage potential adverse environmental impacts (e.g., groundwater contamination). Voluntary participation by States could be encouraged through a Federal grant-in-aid approach, as in

Box 6-H-Coastal Resources Management Program

The Coastal Zone Management Act of 1972 (CZMA) established coastal zones as areas of special economic and ecologic significance to the States and Federal government. The CZMA set Federal guidelines, however, it lacked regulatory powers and thus its success depended on voluntary participation. This Act established precedence for a Federal grant-in-aid program to encourage the protection and management of coastal resources while fully recognizing State primacy over the identified resource.[1] The 1976 amendments to the Act clearly articulated". . .a national interest in the effective management, beneficial use, protection, and development of the coastal zone" (Section 302 (a)).

The Act further recognized that the competition over resource use generated by population growth and economic expansion commonly resulted in the biological and physical degradation of the coastal environment and, thus, the Act was crafted as a mechanism to mitigate/ameliorate such adverse impacts (27).

Consequently, each of 32 coastal States, 3 territories, and 2 commonwealths developed Coastal Management Programs (CMP) that:

1. identify boundaries and evaluate coastal resources requiring management or protection;
2. examine policies with respect to their ability to accomplish this task, or develop new policies that will addresss the identified needs;
3. determine specific uses and geographic areas to be managed based on resource capability and suitability analyses and socio-economic and public interest considerations;
4. consider the national interest in planning and siting of facilities that meet more than local requirements; and
5. include sufficient legal authority and organizational arrangements for program implementation and to ensure compliance (55).

In addition to State coastal management programs, a national program for CZM is administered by the Office of Ocean and Coastal Resource Management (OCRM) (previously the Office of Coastal fine Management) under the Department of Commerce. The mission of this office is to encourage comprehensive and unified consideration of land and water uses that are sensitive to maintaining the integrity of the coastal ecosystems (27).

[1]"'[t]he key to more effective protection and use of the land and water resources of the coastal zone is to encourage States to exercise their full authority over the land and waters in the coastal zone, and, that this should include unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance'(Section 302 (h))" (27).

the CZMA, with grants for planning and plan development, program implementation, and related education activities. However, if protection of groundwater resources is deemed of significant importance, a stronger, regulatory approach might be used. The planning phase of State ARMP development could include components such as:

- identification of areas of particular concern (e.g., aquifer recharge zones, areas deemed to be highly vulnerable to groundwater contamination) to be eligible for the program;
- development of program goals and steps for implementation (e.g., Indiana's "T by 2000" program);
- analysis of existing policies and programs for potential conflicts with program goals, and development of new policies to support program goals; and
- demonstration of sufficient State authority and organizational structure to implement the program.

A national program for agricultural lands could be established within USDA to provide funds for planning and plan implementation by States as well as monies for acquiring lands that are clearly identified as integral to maintaining the viability of groundwater resources (e.g., aquifer recharge zones). The office could provide a central location for review and approval of State programs and ensure comprehensive, integrated State approaches in program development.

An analog to the land acquisition approach was found within certain legislative proposals seeking to make aquifer-recharge zones eligible under the Conservation Reserve Program (CRP). Lands eligible on a groundwater protection basis would be removed from agricultural production for a specified contract period. Given the nature of aquifer protection, and the site-specific nature of agrichemical movement through the soils and underlying sediments and rocks, a long-term approach such as outright State purchase of land or land-development rights, may be in the best interests of groundwater resource protection. State purchases of land-development rights need not be held in perpetuity, and would allow other land uses that are determined benign in terms of groundwater contamination potential.

If an Agricultural Resources Management Act were enacted, it might be necessary to invest additional resources to expand certain agencies in order to support the Act's implementation. Previously, SCS maintained an office responsible for providing technical assistance to States and local governments regarding farmland protection.[3] The SCS computer-assisted Land Evaluation and Site Assessment system (LESA) developed in 1981 has been adopted by several States to facilitate their farmland preservation programs. The SCS effort, however, was discontinued in 1984 concurrent with a USDA decision that farmland conversion was greatly exaggerated (22).

State and local governments have developed data collection and analysis, monitoring, incentive, and zoning programs to implement farmland-preservation programs. Five states (Hawaii, Utah, Illinois, Delaware, and Virginia) have developed LESA systems since 1982 and a national survey identified 36 operational LESA systems in 19 States; the number has increased since the completion of the survey. Geographic Information Systems (GIS) are the newest trend in land-use planning. Although these systems are not used widely yet, they allow multiple variables (e.g.,hydrology, topography, soils, land cover, land tenure, and other variables) related to farmland to be displayed and analyzed together (22). These capabilities would be invaluable in implementing ARMPs that would require identification of vulnerable areas and development of indirect and direct approaches to encourage program participation. Thus, ARMP programs may best be established in States where a farmland protection program already exists.

Numerous approaches have been taken by the States for selective protection of farmland. Information gathering and analysis methods are equally diverse. Among the tools used by State and local governments to monitor change and develop farmland protection programs are: farmland mapping inventories, satellite tracking of landuse changes,

[3]The Farmland Protection Policy Act (Public Law 97-98) (FPPA) enacted in 1981 (regulations completed in 1984) identified farmland as an important national resource and required Federal agencies to consider adverse impacts of policies on farmland preservation (13 1). This Act was in part a response to a concern that metropolitan expansion was converting prime farmland to nonagricultural uses (131). However, the FPPA has not been highly effective in decreasing farmland conversion except where State farmland-protection programs exist. The Act itself does not require that a project be changed based on its potential impact on farmland conversion only that such impacts be examined and alternatives considered (22).

computer-assisted decision-making programs (e.g., GIS), and land capability analyses (22).

Tax and financial incentives, land-use controls, regulation, and acquisition or transfer of land or partial interest in land currently are the major State and local approaches used to protect farmland. All States but Nevada use at least two of these approaches; tending to progress from the indirect (e.g., tax incentives; right-to-fare laws) to the more direct approaches that require a strong public constituency. Direct approaches may include purchase or transfer of development rights, agricultural districting programs, property tax credits, agricultural-land tax relief programs, comprehensive land-use programs with farmland preservation as major goal; and statewide zoning programs. Agricultural zoning ordinances have been on the rise in 25 States. For example, Oregon's statewide land-use planning program (begun in 1975) requires local governments to identify prime agricultural land, usually by SCS Class I-IV farmland, and apply exclusive farm-use zoning, meaning restrictions on home construction or land partitioning unless it is shown to increase productivity (1 15).

Agricultural districting programs are voluntary programs designed to preserve a certain amount of farmland. These programs involve organization of a farmland district as a legally recognized entity, whereby the farmers agree not to develop the land for a specific time period. The government offers benefits to the district such as protection from annexation or nuisance suits. Thirteen States have enacted districting programs and New York alone now protects nearly 8 million acres in this manner. The approach is popular largely because it affords long-term protection at low costs (22).

Expertise housed in ARS, ES, and SCS would be integral in the implementation of ARMP. These management programs would likely rely heavily on the development of whole-farm agrichemical best management plans. ES and SCS already have experience in current application of Best Management Practices and Resource Management Systems respectively, designed to address protection or conservation of specific resources (e.g., soil, surface water). Appropriate whole-farm agrichemical management plans would need to be developed on a site-specific basis, however, and this may translate into high costs in terms of additional personnel and time. Further, the issue of groundwater protection is relatively new and increased research efforts may need to be directed towards development of practices designed to protect and conserve groundwater resources.

POLICY ISSUE: Development of Combined Technical/Policy Expertise

Interagency and Federal/State/local program coordination or integration probably will require unique talents and capabilities. Farmers and producers deal with one domain of priorities and problems. Scientists communicate in their dialects of jargon in a somewhat separate domain of priorities. Administrators function in yet another realm. Policymakers struggle to broker public sentiment into public law. Rare and few are the individuals that are fluent in the dialects of each of these communities and fewer are those that can travel freely among them.

A new "hybrid class" is needed of integrators (e.g., scientist-farmers, scientist-administrators, and scientist-policymakers) trained to communicate and facilitate communication up and down the management continuum, as well as laterally among agencies (1 19). The integrator needs a technical understanding of the issues under consideration, a grasp of policy implications of the issues, the capability of transcending the mindset of particular disciplines or administrations, and the capacity to speak the languages of the different specialties that are party to the decision (66).

Development of policy-educated scientists, and science-educated policymakers can be facilitated by sharing personnel from professional associations with Federal agencies or the Congress. The American Association for the Advancement of Science has perhaps the largest such program, detailing approximately 40 individuals to congressional and Federal offices each year. However, such sharing occurs much less commonly in the case of professional associations related more specifically to agriculture and the environment. For example, for the last several years the American Society of Agronomy provides a Congressional Fellow detailed to the Congress, commonly working with the House Committee on Agriculture. The Fellow provides a means of direct communication between the Society and congressional deliberations of agricultural issues. Such associations could be expanded to include Congressional Fellows detailed from other professional societies such as the American Geological

Institute to congressional committees or to Federal agencies.

Option: Encourage Interagency St@ Details

Congress could facilitate sharing of staff among Federal agencies. One means to facilitate communication among agencies and offices is for them to "borrow" each others' staff. To some extent this already is occurring. For example, the USDA has stationed Soil Conservation Service employees at each of EPA's regional office, and a USDA employee is detailed to EPA headquarters to assist with interdepartmental coordination (106). Some agencies also have detailed staff to congressional offices and to OMB. However, the total number of staff thus ''shared' is small and positions may not be continuously filled. Formal mechanisms and reward systems could be established to ensure continuity in interagency ''cross-fertilization. '

Another mechanism might be to encourage the development of "Technical Integration Groups" related to agrichemical contamination of groundwater; or to broader agriculture and environment issues. One Technical Integration Group (TIG) has been promulgated by the USGS and is now formally recognized by EPA and TVA; USDA is involved in the TIG although it has not formally recognized it as a coordinating mechanism.

The TIG actually is composed of three levels of groups: Strategy Teams, the Technical Integration Group proper, and the Headquarters Group, each comprising representatives from the participating agencies, State organizations, and academic organizations. The four Strategy Teams, composed of researchers from a variety of fields, regularly convene to identify and determine research needs, protocols, etc. The Technical Integration Group is an interdisciplinary team of technical program managers who ensure coordination of activities, many suggested by the Strategy Teams, and have authority to allocate resources to the programs. The Headquarters Team, still in formation, is expected to authorize research plans developed by the Technical Integration Group (133).

The primary activity of the current TIG has been to coordinate the Midwest (USDA)/Midcontinent (USGS) Initiative. This research program is a prototype cooperative research program on herbicide leaching in agricultural systems, focusing on the 11 States forming the 'Corn Belt. " The methodologies for research and research coordination are expected to be transferable to other regions and other cross-agency research issues (133). Establishment of other such interagency working groups probably would improve interagency coordination and interdisciplinary, systems-approaches to research, program implementation, and policymaking.

Congress could facilitate development of technical-policy expertise by supporting development of training and education programs for "hybrid-studies, aimed at increasing interdisciplinary understanding in Federal agency personnel. However, development of such expertise will take considerable time and money, and may do little to ensure improved communication among Federal agencies or Federal, State and local levels of government.

Coordination of Intra-Agency Activities

Complexity of programs and approaches and multiplicity of actors occurs within as well as among Federal agencies. The major Federal agencies have developed mechanisms to identify and coordinate programs relevant to water quality. The USDA has the largest number of organizational units related to agriculture and environment issues. However, coordinating systems may not include all relevant offices within the agency, and coordination systems developed commonly are not easily amenable to congressional oversight. Centralizing coordinating responsibilities in single offices or committees might improve responsiveness to congressional requests and directives.

Option: Centralizing USDA Accountability for Coordination

Congress could require USDA to establish a central person, office, or coordinating committee that will be held accountable for coordination of USDA activities related to agriculture and the environment. Improving inter-office coordination within the USDA might increase its flexibility in response to emerging issues. A USDA Working Group on Water Quality has been established within the Secretary's Policy and Coordination Council to oversee implementation of the Water Quality Program Plan and to improve intra-agency and interagency coordination relevant to agrichemical contamination of groundwater. This could be formalized and expanded to comprise a coordinating committee to address environmental issues at large, reporting directly to the Deputy Secretary. Water

quality programs could be one set of issues coordinated by this committee. Alternately, a formal position could be created in the Office of the Secretary with express responsibility for coordinating all agency environmental protection efforts.

Means for Congress and the Federal agencies to rapidly and accurately identify activities within certain agencies are necessary for effective coordination and oversight of programs to protect groundwater from agrichemical contamination. Thus, agencies need to develop 'vertical' information systems that provide information flow from field agents to agency administrators (119). For example, a national program leader in Washington DC may need to know what kind of nitrogen management programs are underway in Lancaster County, Pennsylvania. In such a case, the administrator can call the relevant field agent for response, but what if the request is for a concise summary of all nitrogen-related program activities underway in 100 counties in the northeast? As efforts are targeted towards areas of high hydrogeologic vulnerability, such requests become more likely,

At present, USDA has computerized systems listing extension service activities (the Program Document Data Base) and federally funded agricultural research programs (the Current Research Information System). However, these systems were not designed to readily provide answers to questions now being asked by policymakers and program managers. Both have received criticism in recent reports (cf: 158,121) calling for standardized classification systems and reporting formats.

For example, the Current Research Information System (CRIS), maintained by the CSRS, catalogs ongoing research conducted by the Agricultural Research Service and the land-grant universities. The CRIS system tends to categorize research programs on the basis of commodity, following the historical concern of the agricultural community with production of an abundant and inexpensive food supply. The system has been expanded to monitor some broadly defined natural resource and environmental issues, but is not yet capable of categorizing projects on the basis of their contribution to groundwater quality protection or similar issues. The CRIS system provides a ''fwst cut' at isolating potentially relevant projects, but the resultant list must be manually searched and evaluated for extent of research program relevance to the issue of concern.

Option: Improving Program Tracking System

Congress could require that USDA expand the CRIS system, specifically to categorize ongoing research on the basis of current issues of public and congressional concern and, perhaps, also to include activities other than research promulgated or sponsored by the USDA. Alternately, Congress might request that similar tracking systems be fully developed for data collection, education, and technical assistance following the same type of reporting structure required by the CRIS system.

A system is needed that can track the diverse programs underway in dispersed offices so that they can be integrated with national programs. Further, the program information needs to be stored in such a way that desired information is easily searched and retrieved. However, a tracking system should not create paperwork such that the resulting burden is greater than the information benefits that result.

In order to accomplish this, some standardized classification system, and a list of the relevant issues of concern, must be generated. The list of issues could focus solely on those relevant to agrichemical contamination of groundwater, or could be expanded to include other issues of broad public concern such as other environmental issues, rural development, and trade issues. Congress could develop the list of issues, or might require USDA to develop the list as a first report on the CRIS modification.

A classification system of current research or programs would essentially constitute an agreed-upon set of rules for defining the different type of groundwater research and programs that are underway. For example, the criteria might determine whether work is relevant to groundwater protection or not, and under this, whether it is primarily: 1) collection of data and samples, 2) analysis of research and data collection, 3) management of people involved in the above, or 4) development of policy or regulations resulting from the preceding activities (120). The research categories identified by the Technical Integration Group could serve as a starting point for developing a list of categories of groundwater protection work (133). Congress could require that an interagency body such as the

FCCSET Subcommittee on Groundwater or the Technical Integration Group develop a classification system that would be relevant across all agencies.

The list of issues of concern, and the classification system probably will have to be reconsidered on a regular basis. Programs and research, particularly basic research can be relevant to a broad array of popular issues. In addition, the issues themselves change over time. Therefore, Congress might require regular reporting on potential new issues to add, or 'old' issues that might be dropped from the list. Providing for public discussion of the issue list might allow for foresight on additional issues of public concern. USDA activities related to those issues could be identified, prior to their development into public ' 'crises. ' With the use of agreed-upon classification systems, it would be possible for Congress to ask USDA or other agencies how much is spent on groundwater data collection, research, education, and technical assistance, and to receive numbers that are likely to be more defensible than those provided now.

Congress also could require that the agencies jointly support an evaluation of current program tracking databases and their relative utility. Based on this evaluation, an optimal ''Program Tracking System" might be designed, using one standard classification system. If the system were designed specifically for groundwater protection from agrichemical contamination, the system might be coordinated through the National Agricultural Library. However, if Congress decides the system should track the larger array of environmental and social issues related to agriculture, it may be more appropriate for FCCSET, OMB, or some other neutral agency to manage the system.

Adequacy of Resources

Groundwater protection will be an ongoing process. It will require the development of a number of products and investigation of numerous practices, and these efforts will have to be sustained over a number of years (1 19), In an era of diminishing Federal fiscal resources, difficult decisions need to be made about the public's commitment to protecting groundwater from contamination compared to other social concerns. No set of groundwater protection programs will succeed with sporadic, haphazard, and inadequate funding. For example, meeting USDA's stated commitment to water quality improvement will require a consistently high level of effort for a number of years. This commitment probably will require funding of agency groundwater programs over competing priorities and providing adequate staff resources (197).

Provision of this funding and staffing already is under question. For example, the Extension Committee on Organization and Policy reported that 'the conventional problems of personnel limitations and the need for staff training" hinder the Extension Service's ability to extend groundwater education programs to practitioners (52). These 'conventional problems '' include inadequate funding, inadequate numbers of personnel, and inadequate resources to train and prepare extant personnel.

Furthermore, Extension Service and Soil Conservation agents operating at the county level have multiple responsibilities; it is difficult for them to allocate the time and resources to attend groundwater training programs, particularly if the issue is not a high priority for the residents of their particular county. The majority of the funds available to these field agents comes from county and State governments, whose priorities thus take precedence. If the Federal Government wants a large role in directing the priorities of these systems, it probably will have to share a larger part of the funding burden.

These problems extend beyond education and extension. Water quality research in general, and groundwater protection research in particular, is long term and expensive. For example, one report estimates that study of the movement of agricultural chemicals through the soil profile into the groundwater usually requires drilling wells for sampling, each of which may cost several thousand dollars. Processing and analyzing one water sample for agricultural contaminants, following EPA protocols, costs several hundred dollars. Each site will require a number of samples to follow fluctuation and movement of the chemicals over time. If one sample is taken from a well every 2 weeks in the course of a year, analyzing these samples will cost $7,000 to $8,000. Conservatively, if only 10 sampling sites are chosen, then $70,000 to $80,000 a year would be spent on sampling costs, $20,000 to $30,000 in drilling costs, and further funds would be required to cover labor and other costs (40).

Option: Substantially Increasing Funding for Programs Directly Relevant to Agrichemical **Contamination** *of Groundwater*

Congress could increase funding for extant Federal research, education, and extension programs, and grants to States for such programs, based on direct relevance to reducing agrichemical contamination of groundwater. Many of the groundwater research and education programs developed under the President's Water Quality Initiative have ''matching funds" requirements, where State or local governments must match the Federal allocation to receive funds.

Despite the lead role States have taken, financial resources are sufficiently scarce that States seem willing to comply with Federal guidelines in order to secure new dollars. Moreover, State readiness to respond to Federal dollars seems widespread. For example, in fiscal year 1989, after discounting congressionally earmarked projects, CSRS received about $1.8 million in new funds for groundwater research to be carried out across the nation. Nearly 240 research proposals were submitted, of which only about 20 could be funded. State researchers and educators have developed proposals, but finding from the Federal government probably is necessary to conduct these programs, and to leverage the coordination of the diverse State programs into an integrated national program (193).

Expansion of research, education, and extension programs to incorporate the whole suite of agriculture and environmental issues may be costly. For example, the National Research Council recently released a report that called for a $500 million increase in funding for agricultural research, in part to address public concerns about the effects of agricultural production on the environment (1 13). Water quality is explicitly identified, and research areas are specified:

- developing cost-effective agricultural and silvicultural systems that minimize or, preferably, eliminate surface and groundwater pollution from both point and nonpoint-sources;
- devising land management practices that reduce or eliminate the transport of pollutants through surface and subsurface flows and assessing the quantitative effects of such practices;
- developing methods for increasing water yields and availability while minimizing water quality degradation;
- using irrigation waters more efficiently;
- designing innovative systems for restoring water quality and preventing contamination from nonpoint-sources;
- developing cost-effective remediation systems; and
- understanding the economic and social effects of possible abatement, remediation, and agricultural production strategies (1 13).

Research on groundwater protection, as well as other environmental and natural resources issues, could fit into this new funding framework should it become available. However, increasing funding substantially beyond that already provided by the President's Water Quality Initiative is likely to pose difficulties in a time of fiscal austerity. Therefore, evaluating and reorienting existing programs, and existing appropriations, may be more appropriate than massive new infusions of funds.

REDIRECTING FEDERAL AGRICULTURAL PROGRAMS

Introduction

Agricultural policy represents a complex "web" of programs governing commodity production, risk management, resource conservation, and agricultural research and education. Federal agricultural programs provide farmers with a variety of benefits including commodity program price supports, income supports, and supply controls; crop insurance subsidies and disaster payments; storage payments; market enhancement subsidies; credit subsidies; and conservation land rental and cost-share payments.

Farm policies affect cropping practices and related agrichemical use primarily by conferring different relative benefits on commodities. Income and price supports, for example, reduce economic risks associated with growing seven major commodities, which encourages farmers to grow these crops preferentially over other crops which are not "protected" by farm programs (e.g., some small grains and perennial legumes useful in crop rotations).

Farm policies are criticized for creating certain commodity surpluses and huge Federal outlays of entitlement payments to farmers who are growing a limited range of crops. In fiscal years 1987 and 1988, for example, subsidies to farmers totaled $25.5 billion and $20.3 billion, respectively (174). Critics charge that such subsidies inflate the Federal deficit, distort production incentives, increase farmer de-

pendence on Federal payments, and make U.S. agriculture generally less competitive (7,77).

Differences in cost of agricultural production in many regions also has been altered by subsidization of agricultural inputs, such as irrigation water, as well as through protection from liability for environmental damages (14). Federal programs affect farmers' implementation of conservation practices to reduce soil erosion and improve water quality, but programs tend to make production a higher priority than resource conservation (34). On one hand, some program provisions encourage conservation through cross-compliance requirements, voluntary cost-share incentives, and technical assistance programs encouraging conservation. On the other hand, commodity and risk-reduction programs can conflict with conservation provisions by imposing short-term planning horizons for production decisions and discouraging long-term planning for resource conservation. Thus, in addition to restricting cropping options, commodity and risk reduction programs may provide disincentives to implementing conservation practices.

Furthermore, Federal programs are blamed for subsidizing unnecessarily high levels of aggregate agrichemical use by supporting agrichemical-intensive commodities, encouraging production of crops in areas that may not be suitable for their growth, encouraging production practices that require higher agrichemical inputs, and delaying development of reduced-chemical or nonchemical alternatives. Certain program crops, such as corn and cotton for example, use higher amounts of nitrogen fertilizers or pesticides than non-program crops (169). Incentives to increase program crop acreage to the extent possible under farm programs discourages farmers from rotating crops or integrating non-program crops into rotation systems (60).

Alternatives to current Federal farm programs are being debated, ranging from modifications that maintain the general framework of price and income supports (e.g., expanding current cross-compliance requirements on soil erosion control to include nutrient and pesticide management plans) to more drastic approaches involving elimination of Federal farm payments based on production output (i.e., "decoupling"). Proponents favoring the maintenance of support programs recognize the associated problems and trade-offs but prefer the stability these programs afford; they fear that "decoupling' would cause severe disruptions in production patterns and expose producers to commodity markets that may not be self-correcting and that are highly distorted by the concentration that has occurred among commodity buyers.

Proponents of decoupling, on the other hand, believe that elimination of price and income supports would allow farmers to be more responsive to market signals and encourage them to grow a more diversified range of crops rather than being encouraged to specialize in program commodity crops. A third alternative would be to follow up "decoupling' with a "recoupling" of Federal payments to adoption of approved conservation practices. The Federal government under this approach would then be paying farmers to steward the nation's agricultural resources, rather than intervening in commodity markets. *Any* changes in farm programs are likely to affect farmer choice of crop, production practice, and agrichemical management strategy, all of which may affect the potential for agrichemical contamination of groundwater.

Major Programs Affecting Farmers' Decisions

Groundwater protection from agrichemical contamination is a cross-cutting issue and will be influenced by all three types of agricultural programs-production, risk reduction, and conservation. Some of these programs may directly cause intensified agrichemical use, or they may conflict with other programs indirectly leading to increased use. Policy options addressing conflicts within and among all three types of programs may help remove barriers to improved agrichemical management or reduced agrichemical use.

Production Programs

Agricultural production programs are comprised of separate commodity programs outlined in the commodity titles of Federal farm bills authorized every five years. Commodity programs guide national production of at least 13 different commodities, with 7 commodities commanding the greatest portion of farm program benefits: wheat, feed grains (corn, sorghum, oats, and barley), cotton, and rice. Assistance is also provided to producers of sugar, wool, mohair, honey, peanuts, tobacco, peas, dairy products, and soybeans (15). The Secretary of Agriculture has the authority to add to the list of

program commodities if deemed necessary to achieve legislative goals.

Commodity production programs are intended to help farmers, processors, and distributors obtain prices that result in an orderly, adequate, and steady supply of agricultural products for the nation's consumers (3). Commodity programs vary in price support levels, producer requirements, and producer participation rates, and any program changes tend to generate different benefits, price ratios, and input substitution possibilities for farmers (14). Commodity programs also influence the amount and locations of cropland planted to various program crops (49). Thus, commodity programs strongly affect farmers' decisions related to crop choice, agrichemical use, and farming practices and resulting potential for agrichemical contamination of groundwater.

Commodity programs partially buffer farmers from market price fluctuations through three main types of programs: 1) price support; 2) direct payment; and 3) supply management (155). The first two of these programs account for approximately 80 percent of Federal farm program outlays (156). Certain features of each type of program have been criticized as encouraging the production of agrichemical-intensive crops or discouraging crop rotation. Policy options that address these features thus assume that the general framework of price and income supports will be maintained as agricultural policy.

Price Support Programs—Price supports guarantee that farmers will be able to sell their commodities at a price, or loan rate, set by Congress. Price supports are provided through ''nonrecourse loans' from the USDA Commodity Credit Corporation (CCC) in which the farmer uses his crop as collateral. If the commodity's market price is lower than the loan rate when the loan matures (usually after 9 to 12 months), the farmer can forfeit the crop to the CCC instead of repaying the loan in cash (15). Thus, nonrecourse loan rates provide a price floor for commodities when market prices drop.

Direct-Payment Income Support Programs— Income supports are provided to farmers through direct payments, called ' 'deficiency payments," when commodity market prices fall below ''target price' levels set by Congress. Deficiency payments make up the difference between a commodity target price and its market price or government nonrecourse loan rate, whichever is higher. To frost qualify for deficiency payments for a specific program crop, a farmer must have planted that crop on a portion of the farm for the last 5 consecutive years. This is the farmer's "crop acreage base" for that commodity, which is thereafter calculated using a 5-year rolling average of the number of acres planted to that crop (171). A farmer's total deficiency payment depends on which program crops are grown, the number of acres eligible, and average "program payment yields" per acre established by USDA/ASCS. Annual deficiency payments per farmer are limited legislatively to $50,000, but certain exceptions allow some persons to receive considerably more (155,16).

Supply Control Programs—To receive price or income supports for any commodity, farmers must agree to reduce their acreage in that commodity by a percentage set by USDA as part of an acreage reduction program (ARP). Also known as "set-sides,' ARP requirements in recent years have ranged from 5 to 30 percent of base acreage (170). USDA rules stipulate that acreage set-asides be planted to soil conserving crops. Thus, acreage eligible for deficiency payments for a specific commodity in any given year is that crop's base acreage minus the required ARP, or the crop's "permitted acreage. "

Commodity programs are included among the ''institutional factors' that are likely to influence farmers' decisions related to resource protection (109), Choices made with regard to commodity program may have environmental effects sufficient to overwhelm efforts made through traditional conservation programs (38). Production program constraints may be especially felt by participating farmers in hydrogeologically vulnerable areas who could reduce groundwater contamination through changes in cropping practices. Commodity program issues and options relating to cropping patterns and associated agrichemical use are discussed here.

POLICY ISSUE: Current Federal Farm Programs Restrict Cropping Flexibility and Discourage Crop Rotation

Federal farm programs provide price and income supports for only a few crops and thus limit participating farmers' crop choices and planting flexibility. Even among the program crops, Federal price and income supports are greater for crops using higher levels of agrichemical inputs (e.g., corn,

cotton, and wheat) than for crops that are less agrichemical-intensive (e.g., oats and barley). Federal programs also discourage farmers from diversifying because deficiency payments are based on the number of program crop acres averaged over the past 5 years. For example, farmers currently wishing to receive Federal benefits for more than one program crop can establish multiple bases, but these farmers' deficiency payments will drop due to: 1) lower ''acreage base' for currently enrolled crop in the following years; and 2) 5-year period required for ''new' crop bases to be established before any payments can be obtained.

Consider the farmer currently growing continuous corn and who wishes to start a 3-year crop rotation by planting a third of the current crop base in corn, a third in soybeans, and a third in oats. This farmer faces the strong disincentives of a reduction of corn base acreage eligible for deficiency payments reaching 66 percent in the fifth year of the rotation. Further, no payments are received for oats for 5 years, and no payments for soybeans (although soybean price supports would be available). Even if this farmer wanted to plant total acreage to soybeans for only 1 year and then return to continuous corn production, a 20 percent reduction in base acreage would be incurred for each of the following 5 years (114). Farm programs thus encourage farmers to plant the maximum number of base acres possible to their current program crops in order to maintain acreage base and deficiency payments.

Some crop flexibility is currently provided through the 0/92 and 50/92 provisions for feed grains, wheat, and cotton in the 1985 FSA and subsequent amendments (126). The 50/92 program allows farmers to receive almost all (92 percent) of their deficiency payments for that commodity in return for planting only 50 percent of permitted acreage. However, Congress limited the crops that could be grown on the remaining permitted acreage and did not allow for alfalfa or clover, which are soil-building legumes useful in rotations.[4] Alternatively, the 0/92 program allows farmers to receive 92 percent of their deficiency payments without planting any permitted acres to the commodity crop, as long as their entire permitted acreage is planted to conservation uses. Although conservation uses include establishing vegetative cover by growing sod or legume crops, farmers cannot harvest these crops as hay or pasture forage. This harvesting prohibition may discourage farmers from utilizing the 0/92 option because it eliminates the possibility of sale or on-farm use of conservation crops.

Limited increases in cropping flexibility have also been provided in recent years through USDA rules related to conservation compliance and disaster assistance. For certain commodities, for example, some farmers have been allowed 'base exchanges to meet conservation compliance requirements, where base acres planted to low-vegetative-cover crops are replaced by acres planted to crops having more vegetative cover to reduce soil erosion (170). The Disaster Assistance Act of 1988 also provided for base exchanges and base protection for oats, soybeans, and sunflowers in 1988 and 1989 (43). Furthermore, USDA in 1989 allowed up to 20 percent of a farm's permitted acreage to be planted to non-program crops without a payment reduction, although this rule may not be extended after 1990.

Increased cropping flexibility can be beneficial to farmers faced with new environmental requirements or drought conditions. Greater cropping flexibility could also be extended as a result of the need to protect groundwater resources from agrichemical contamination. However, national changes in farm programs permitting increased cropping flexibility across the board would not benefit all farmers equally. Local soil, climatic, and topographic conditions constrain some farmers' cropping options more than others. Kansas dryland farmers, for example, have few options to grow anything but wheat (67)-if other farmers begin to grow it, the resulting increase in wheat supply would depress the market for established farmers who have specialized in that crop. Farmers in the Southeast, on the other hand, would probably enjoy greater benefits from cropping flexibility, because weather conditions in this region make it possible to grow a wider range of crops. Changes in farm program flexibility will thus benefit some farmers more than others and some changes may have adverse indirect impacts on certain farmers (67). Regions with limited crop choices may require special policy attention and additional analysis to identify potential impacts of program changes.

[4]The Food Security Improvements Act of 1986 allowed triticale, rye, flaxseed, sweet sorghum, guar, sesame, safflower, sunflower, and castor beans among other crops which do not have ''established markets."

The following options could increase cropping flexibility in Federal commodity programs. These options could be authorized as provisions affecting commodity production nationally, or they could provide the basis for special rulings specific for geographic areas designated as vulnerable to groundwater contamination.

Option: Increase Cropping Flexibility in Targeted Areas

Congress could authorize USDA to designate special groundwater-protection area adjust ments for base acreage formulas that would allow farmers in these areas to use crop rotations and less agrichemical-intensive crops as one strategy to reduce groundwater contamination. Program participants in hydrogeologically vulnerable areas may be ''locked' into growing agrichemical-intensive crops, especially if they depend on price and income supports to increase potential net returns and reduce risk. For example, constraints may be particularly severe for producers growing continuous corn in sandy areas, such as the central Platte River valley in Nebraska, where extensive groundwater resources are contaminated by nitrate and herbicides (145). Constraints resulting from base acreage requirements of existing farm programs could limit the effectiveness of voluntary or semi-regulatory programs to reduce contamination in hydrogeologically vulnerable areas, especially where significant contamination reductions are needed for groundwater to meet drinkingwater standards. This option would allow commodity program participants, particularly those in hydrogeologically vulnerable areas, to implement crop rotation systems designed to reduce agrichemical use and thus potential for agrichemical contamination.

Option: Increase National Cropping Flexibility

Congress could increase cropping flexibility under commodity programs on a nationwide basis. Under this approach Congress could:

End crop-specific bases altogether and reinstate ''whole-farm bases. " A whole-farm base program would be similar to the "Normal Crop Acreage" (NCA) program used between 1978-81 (45). One approach would be for the USDA to assign one base to each farm according to its cropping history and allow any combination of the major commodities to be grown. The farmer would then receive price and income supports based on the commodities grown that year. Although this approach would increase flexibility, it would not necessarily ensure groundwater protection or less agrichemical use in hydrogeologically sensitive areas, especially if price and income supports for agrichemical-intensive row crops continue to be higher than for less agrichemical-intensive commodities. Also, alfalfa and other nitrogen-fixing crops are not commodity program crops, and their acreage still would not be included in support programs.

Another approach would be to assign whole-farm bases nationally but designate more specific cropping combinations for whole-farm bases in hydrogeologically vulneralble areas. Thus, farmers in these areas could only receive price and income supports for commodities grown in environmentally beneficial rotations suited to local groundwater vulnerability conditions.

Protect the base of any farmer **wishing to grow non-program crops on crop acreage base.** Base protection could bean ongoing feature of commodity programs or Congress could allow all farmers a one-time base exchange, e.g., 10 acres of corn base with 10 acres of base in another crop. This would allow farmers to keep their commodity program base acreage while being able to plant legume and small grain crops in crop rotations, giving them the option of using beneficial rotations if they so desire. A disadvantage to increasing cropping flexibility in current farm programs is that it would not ensure that farmers choose cropping patterns that are environmentally beneficial. If flexibility is increased through any of the above options, groundwater protection benefits are likely only if cropping flexibility is coupled with incentives to adopt environmentally-beneficial cropping patterns and removal of incentives to intensify agrichemical use.

Congress could authorize a new, national rotation-based "commodity program. " Congress could create another farm bill title based on crop rotations and environmental stewardship and covering a variety of program and non-program crops. Like other commodity programs, this program would have voluntary enrollment but could provide higher relative incentives for farmers to grow soil-building or conservation crops. Participation would require all participants to comply with crop rotation standards. The advantage to this approach would be that cropping flexibility changes would be

directed toward supporting environmentally beneficial crop rotations.

One disadvantage to such a program would occur if numerous farmers chose to institute ''forage legumes" (e.g., alfalfa, clover) in crop rotation systems. If enough farmers should enter such a rotation, the livestock feed market-currently the largest market for those commodities-might not be capable of absorbing the suddenly-increased stock, especially without a substantial reduction in commodity price. Thus, under the options listed above, legumes could be instituted as program crops with all the attendant incentives for production and increases in farm commodity program payments, or a concomitant program to expand the market for legume-crop products (e.g., pelletized alfalfa might serve as a replacement for road salts) might be instituted.

POLICY ISSUE: Current Farm Programs Encourage Intensification and Production of Agrichemical-Intensive Crops

Among the seven major commodities supported by farm programs, the more agrichemical-intensive commodities, such as corn and wheat, have higher target prices than other commodities such as oats and barley. The differences in returns afforded by current target prices is reflected in the different participation rates for the commodity programs. In 1988, for example, corn commodity programs enjoyed about 90 percent participation of all corn producers while oats programs had only 30 percent participation. Current target price differentials therefore encourage farmers to plant more acres in corn and wheat (103). Increased acreage planted to crops that use relatively higher amounts of fertilizers and pesticides, particularly in continuously-cropped fields, contribute to greater potential for agrichemical contamination of groundwater in hydrogeologically sensitive areas.

Options: Increase Incentives for Growing Less Agrichemical-Intensive Crops

Congress could align target prices among program commodities. Reduced price and income supports for erosive, agrichemical-intensive row crops such as corn would reduce incentives to grow these crops in hydrogeologically sensitive areas. Higher price and income supports for small grains are likely to increase acres planted to these crops and would encourage their use in environmentally beneficial crop rotations.

Congress could conditionally authorize haying and pasturing of conservation crops in some areas. Authorization of such harvest probably should be dependent on an analysis of the impacts of commodity programs on agrichemical use in hydrogeologically vulnerable areas. This analysis should include an examination of the potential impacts of allowing harvesting of conservation crops, such as clover and legumes, planted on ARP set-asides. Harvesting is typically prohibited for fear that it will have adverse impacts on hay producers. However, harvest might be permitted on hydrogeologically vulnerable areas as an incentive to include such crops in rotations. Conversely, repeated harvesting of these crops can severely reduce the amount of nitrogen returned to the soil, such that annual harvests may have to be limited in number or volume.

Congress could require inclusion of nitrogen-fixing crops in 50/92 and 0/92 programs. Such an approach could encourage producers to adopt crop rotation given the potential for increasing soil fertility through incorporating legumes in crop rotation. Thus, alternating planting of the legume and commodity crop could provide additional benefits in terms of reduced fertilizer and pesticide use.

Options: Remove Incentives for Intensification on Non-Set-Aside Acres

Farmers who participate in commodity programs typically set aside their least productive or most marginal acres, and they may keep these same acres out of production year after year (32). Since deficiency payments are calculated in part on base acreage and partly on historical yield of those acres, incentives are strong to boost production on the acres planted to the program crop. This commonly entails high agrichemical inputs, planting high-yielding varieties, and planting in close formation. Thus, overall production of specific commodities has increased in some cases, despite set-aside provisions implemented to reduce crop supplies (153,174).

Congress could redefine set-asides or acreage limitations to a multi-year (3-to 5-year) program. Such an approach could encourage planting of perennial crops that provide greater benefits in terms of soil-building and soil erosion control. This could

encourage some producers to adopt crop rotation in order to derive additional benefits from enhanced soil characteristics. Further, the more marginal agricultural lands would remain out of production for a longer period of time. Evidence indicates that crop production on marginal lands generally requires greater agrichemical inputs, thus, some benefits may also be generated by associated use-reduction. However, set-asides are designed for production control and thus this option would entail making long-term decisions relative to commodity production levels.

Congress could address production control through reducing the intensity of agrichemical use rather than land diversion. The incentives for maximizing production on cultivated acreage remain significant, frequently encouraging overapplication of agrichemicals. Establishment of a maximum "bushel per acre" for commodity program payments may have potential for reducing overall chemical use. Such a calculation could be made based on general production in a given region, similar to the methods used for calculation of deficiency payments. With such a limit established, there might be little incentive to overfertilize or apply ''insurance' pesticides. Alternatively, the maximum yield level could be set based on a realistic yield goa1[5] on afield-by-field basis and thus take into account the site-specific aspects of agricultural production. Program flexibility, perhaps in the form of regular reevaluations, must be incorporated to allow revision of identified maximum levels as technological advances allow yield increases without adverse environmental impacts.

POLICY ISSUE: Current Farm Programs May Be Subsidizing Practices That Contribute to Agrichemical Contamination of Groundwater

Some Federal commodity programs tend to support agrichemical-intensive practices, virtually resulting in subsidies for agrichemical contamination of groundwater. Another significant development in the agricultural sector is the passage of conservation compliance provisions in the 1985 Food Security Act (Public Law 99-198) (62). Conservation plans for highly erodible lands (HEL) are projected to rely on conservation tillage, residue management, and cropping practices.

Options :Expand Cross-Compliance to lnclude Groundwater Protection

Congress could expand cross-compliance requirements to include groundwater protection by requiring nutrient and pesticide management plans for eligibility. Congress could prevent subsidization of groundwater contamination by expanding cross-compliance requirements for participation in commodity programs to include documentation that agrichemicals are being used properly and judiciously. However, this would require substantial time, staff, and funding for the SCS alone or in combination with other UDSA agencies (e.g., ES, ARS, CSRS, ASCS, ERS) to develop new plans and integrate the new plans with extant conservation plans developed for current cross-compliance programs.

Congress could target base and payment protection for farmers adopting environmentally beneficial rotations. Congress could allow farmers to receive full deficiency payments when they plant up to one-third of their permitted acreage to nitrogen-fixing or conservation crops. One disadvantage to this option is that it rewards farmers who have not already implemented crop rotations and penalizes farmers whose current crop acreage bases are lower due to established crop rotations. Program benefits could be adjusted to compensate farmers who have established crop rotations or conservation cropping practices through cropping history documentation.

Congress could require environmentally beneficial rotations and management plans in hydrogeologically vulnerable areas. Congress could authorize base protection for any farmer wishing to grow non-program crops on crop acreage base (189), but not protect the deficiency payment outlay for these farmers, *unless they start* a transition to approved, environmentally beneficial rotations.

Congress could prohibit any Federal farm program benefits for commodities grown under continuous cropping practices. Significant reductions in insecticide and herbicide use can be achieved by going from continuous corn, for example, to growing corn in rotation with soybeans. A prohibition on continuous cropping is unlikely to affect large numbers of farmers: continuous cropping is not a prevalent practice among producers of major field crops, except for some crops in certain

[5]Realistic yields are determined b, averaging production from a given field over a 5-year period (see ch. 4).

regions (39). However, producers of certain crops (e.g., rice) might need special programs (e.g., a program akin to the 0/92 program or wetlands protection payments similar to the Conservation Reserve Program). Prior to authorizing this prohibition Congress could request a study to assess potential impacts of a nationwide ban on continuous cropping as a farming practice.

Conservation Programs

Federal farm programs contain agricultural con**servation components that could** also be used as tools to address the need for groundwater protection from agrichemical contamination. Besides conservation cross-compliance provisions, two voluntary agricultural conservation programs could be pertinent to groundwater protection: 1) conservation cost-share and technical assistance provided on an ongoing basis through SCS and ASCS; and 2) the 10-year Conservation Reserve Program (CRP) of the 1985 FSA. However, each of these programs would need to be modified to reorient traditional objectives to serve better as groundwater protection policy tools.

Conservation cost-share programs, for example, traditionally have focused more on facilitating implementation of structural changes (e.g., terracing) rather than on modifying land-uses or farming practices that would be needed to protect groundwater. Furthermore, the rationale for long-term land retirement programs would have to be expanded from the current primary focus on retiring erosive marginal lands to include hydrogeologically vulnerable areas or aquifer recharge zones.

A groundwater protection approach based on modifying conservation programs to include groundwater concerns, however, may not achieve significant groundwater quality impacts, for two reasons. First, allocating soil conservation funding to more severely affected ‘‘target’ areas has been difficult and largely unsuccessful (154,68). Similar difficulties are likely to be encountered in allocating groundwater protection assistance to hydrogeologically sensitive areas. Second, even intensified education and cost-share programs have not resulted in significant reductions in soil erosion or water quality degradation (47). The overall poor record of voluntary conservation programs in reducing soil erosion rates is considered largely due to the fact that government programs and economic pressures impose conservation disincentives that are greater than conservation program incentives.

Conservation disincentives are built into farm programs that have historically served production rather than resource protection objectives. As a result, land conservation programs have been used more as a production control tool to reduce commodity surpluses than as a means to modify land use or to meet national goals to reduce soil erosion and protect water quality.

Thus, groundwater protection efforts conducted solely within an expanded conservation program are not likely to reduce groundwater contamination any better than conservation programs have reduced soil erosion. Rather, effective groundwater quality protection may not be achieved unless other features of agricultural and economic policies are adjusted to ‘‘create a climate in which natural resources are wisely used because people are both willing and able to use them wisely’ (142). In the absence of broader changes in government programs, however, conservation programs could be expanded to include groundwater protection assistance.

Conservation Cost-Share and Technical Assistance Programs-Conservation cost-share programs traditionally have focused more on facilitating implementation of structural changes (e.g., terracing) than on modifying land-uses or farming practices. Cost-sharing programs also have tended to have a narrow focus (e.g., erosion reduction, tree planting). Furthermore, budget reduction imperatives have tended to reduce assistance levels provided under Federal cost-share programs, and many States have implemented State and local cost-share programs to maintain assistance levels.

State and local policies and programs greatly influence conservation cost-share and technical assistance programs, and will be highly instrumental in protecting groundwater from agrichemical contamination (see ch. 5, app. 5-l). Federal funding and direction of SCS and ASCS activities, however, affect these agencies’ capacities to staff, train, and coordinate programs to serve as significant groundwater protection mechanisms.

Option: Review Federal Cost-Sharing Programs for Impacts on Agrichemical Management and Water-Quality Protection

Congress could require USDA to review extant cost-share programs to determine their impacts

on **agrichemical management and water-quality protection, and their potential as incentives to improve agrichemical management. Based on** such a review, Congress could earmark funds for extant conservation programs such as the Agricultural Conservation Program, or for expanded integrated conservation cost-sharing, such as the ASCS Integrated Crop Management Program. In addition, Congress could require a review of State cost-share programs and grant funding provided to States for cost-share programs. This review might identify opportunities for more cost-effective provision of cost-share programs, and could provide assistance to States to find alternative funding mechanisms.

Development of an expanded Federal cost-sharing program that integrates multiple environmental concerns (e.g., soil-erosion reduction, wetland and wildlife preservation, protection of water quality) might provide significant benefits without substantially increasing funding levels. A simultaneous program to expand State cost-sharing programs, via grants and assistance in identifying funding mechanisms, while potentially requiring increased expenditures in the short-run, might alleviate some budget concerns in the long term.

Long-Term Cropland Retirement Programs for Conservation-Federal cropland retirement programs serve as production controls as well as means to reduce soil erosion through long-term voluntary contracts with farmers to retire erosive cropland. Farmers in these programs convert cropland into grasslands, woodlots, or wildlife-forage plantings in return for government payments and cost-share assistance to establish permanent vegetative cover. Under any long-term cropland retirement program, the total amount and distribution of lands retired under such programs depend on a variety of factors:

- national program missions specified in legislative or administrative language;
- State- or county-level restrictions on amounts of land to be retired;
- amount of funding allocated to implement the program;
- degree of implementation by State and local administrators; and
- degree of program participation, which is influenced by attractiveness of cost-share and other program incentives to landowners.

The long-term cropland retirement program currently in effect is the 10-year Conservation Reserve Program (CRP) established by the 1985 Food Security Act. To participate in the CRP, farmers petition to put highly erodible croplands identified by the SCS into grasses, trees, or other vegetative cover for at least 10 years in return for annual rental payments. Farmers follow locally approved conservation plans to convert their CRP lands, which cannot be grazed, harvested, or used for other commercial purposes during the 10-year contract period (150).

POLICY ISSUE: Cropland Retirement Incentives May Be Too Low To Achieve Adequate Participation

Farmer incentives in land retirement programs for conservation purposes, however, must be attractive enough to provide similar or greater benefits compared to potential returns fkom cropland. Otherwise, farmers are less likely to enroll cropland acres. The 34 million acres enrolled in the Conservation Reserve Program between 1986-90, for example, fell short of the program's original policy goal to enroll 40 million acres. One of the factors involved in the enrollment shortfall was stronger farm prices relative to those of the early 1980s (94).

The impacts of long-term land retirement programs on agrichemical use depends on the types and amounts of cropland enrolled, and the choice of long-term vegetative cover. Agrichemical use on CRP lands is generally much lower than on croplands, although farmers might apply agrichemicals to establish permanent vegetative cover in the first year of the program. Aggregate agrichemical use is therefore expected to decrease with increased acreage enrolled in long-term land retirement programs (150).

Federal policies related to agricultural production and conservation also have impacts which vary by region. Agrichemical applications due to reduced planted crop acreage are more likely to decline in areas of heavier fertilizer and pesticide use (69). However, because the CRP was designed to reduce soil erosion, its criteria for enrollment did not include identification of lands most vulnerable to groundwater contamination or those receiving heavy agrichemical use.

Options: Expand the Conservation Reserve Program

Congress could expand the CRP to include hydrogeologically vulnerable areas. This approach has been examined to some extent in certain legislative proposals put forth in the 100th Congress (e.g., H.R.4137 and S.2045 proposed to establish 20 million acres of groundwater recharge eligible for CRP, however no action was taken). Inclusion of aquifer recharge areas or highly vulnerable areas in the CRP could generate significant benefits to preventing groundwater contamination from agricultural practices. However, the lack of understanding of subterranean water movement may hinder effective targeting of eligible areas.

Such an approach assumes the ability to identify highly vulnerable areas when such information and current targeting methods (e.g., DRASTIC) are still contested. Further, areas currently identified as highly vulnerable may represent high-cost farmland and thus payments for such conservation approaches may be prohibitive. An expansion of this program clearly will require additional funding given the current inability to reach target enrollment for CRP because of lack of funds. Furthermore, expanding acreage reduction may have adverse effects on commodity production, commodity prices and thus food prices as well.

Another consideration is whether or not the 10-year term contained in current CRP contracts would be sufficient to generate benefits to groundwater. Expansion of CRP based on a short-term contract period likely would result in a reduction of chemical input to groundwater for a similarly short term. This aspect is particularly important given the variability in rate of agrichemical movement through the soil profile and the potential for chemicals applied many years ago to continue moving. Thus, chemical contamination of groundwater may well continue during or beyond the contract period. Another consideration is the effects of plow-down and subsequent decomposition of conservation crops potentially creating a "nitrate pulse" through the soil profile, possibly reducing overall groundwater protection benefits.

Congress could extend the terms of CRP contracts in hydrogeologically vulnerable areas beyond the 10-year limit. This would be especially beneficial if accompanied by promotion of tree-planting with its associated nutrient-scavenging and carbon storage benefits. However, costs associated with tree-planting may be much higher than for sod or legumes and, thus, may pose a disincentive for practitioners. Still, the potential benefits in reduced agrichemical use with respect to protection of national (e.g., groundwater) or global (e.g., atmosphere) resources may argue for increasing payments for those acres planted to trees.

Risk Reduction Programs

Federal farm programs also provide some measure of economic security and risk-reduction through programs combined here under the category of "security" programs. These include farm credit programs, crop insurance, disaster assistance, and marketing programs.

Farm Credit Programs—Fanners obtain credit through two main charnels: the Farm Credit System (FCS), and the Farmers Home Administration (FmHA). Farm credit policies and practices may in some cases make it difficult for farmers to take actions to protect groundwater resources. Major farm credit programs are briefly described here, along with options to remove obstacles to enhanced groundwater protection.

The FCS is congressionally chartered to provide production credit and farm real-estate financing to farmers through a national network of cooperatively owned banks and local-lending associations **(26). A** Federal Farm Credit Board approves rules **and** regulations governing operations and oversight of FCS institutions and supervises the Farm Credit Administration (FCA), which regulates all FCS lenders (136). The FCS administers its programs through 12 Farm Credit Banks reorganized under the Agricultural Credit Act of 1987. Farm Credit Banks make real estate loans and long-term loans to Production Credit Associations (PCAs), which in turn make short- or intermediate-term loans to farmers. PCA loans usually have maturities coinciding with production or marketing periods.

The Farmers' Home Administration (FmHA) is a Federal farm credit institution authorized by the Consolidated Farm and Rural Development Act to provide credit to farmers who are unable to obtain credit from private lenders. FmHA has a number of farm loan programs which include:

- farm ownership loans, which finance farm purchases and improvements or additions to farms; these loans may also be used to finance non-farm enterprises and refinance debt;

- farm operating loans, which are short- to intermediate-term loans for machinery or equipment, annual operating expenses, refinancing of debts, or creditor payments;
- emergency disaster loans, which provide financial assistance to farmers sustaining substantial losses from a natural disaster; and
- soil and water loans, which finance land and water development, use, and conservation; these may be used for construction and maintenance of terraces, dikes, reservoirs, ponds, and waste disposal facilities for compliance with pollution control laws.

FmHA makes two types of loans: 1) insured direct loans, which are made and serviced by FmHA from a government revolving fund; and 2) guaranteed loans, which are made, financed, and serviced by a private or cooperative lender, but with FmHA guaranteeing the lender against a 90 percent loss on the loan if the borrower defaults (63). Because FmHA is agriculture's "lender of last resort, " it holds the largest number of high-risk loans. The 1985 Food Security Act made several significant changes in FmHA lending policy to reduce government costs from loan delinquencies, including the curtailment of FmHA insured direct loans in favor of guaranteed loans.

In 1988, 118,000 FmHA borrowers were delinquent and facing possible foreclosure. The Agricultural Credit Act of 1987 required FmHA to modify delinquent loans to the maximum extent possible in order to keep borrowers on their farms and avoid government losses (26). FmHA is required to restructure a severely delinquent loan if the cost to restructure is less than foreclosure action. Loan rescheduling can include reamortization, lower interest rates and deferral of payments, and debt reduction or ''write-down, ' which includes debt reduction through conservation easements. An easement is a 50-year contract between a landowner and an outside party to restrict the type and extent of development that may take place on the property, with the landowner retaining title. FmHA easements may be used for conservation, recreation, and wildlife purposes. However, FmHA has not used the conservation easement option to its potential. A portion of the farmers who still face foreclosure after all other loan servicing and debt restructuring options might be able to save their farms with an easement (42).

POLICY ISSUE: Some Farm Credit Mechanisms May Be Generally Under-Used and Could Provide Innovative Mechanisms To Protect Hydro - geologically Vulnerable Areas

Given the problems associated with attempting to protect groundwater solely through changes in commodity or conservation programs, other mechanisms may be more appropriate to protect severely affected areas. An alternative mechanism, for example, would be the use of farmland easements (195). Property easements involve a transfer of certain use rights of private property, yet allow owner retention of title to the land; easements may be based on conservation or other values. The earliest government-sponsored long-term conservation easements were established in the 1930s and 1940s to protect scenic views and wetlands, and have been a major component of certain private-sector conservation groups (e.g., Nature Conservancy, American Farmland Trust). The primary benefits of using conservation easements to restrict certain uses of farmland are: 1) easements are less transitory than zoning ordinances and other land-use controls, and 2) they have only a modest impact on government revenues (largely through tax credits).

Congress first enacted benefits for the gifts of "less than fee" interests in land in 1964 (195). Benefits derived from a longstanding precedent for using tax policy ''to further non-revenue national objectives' (87).[6] The Federal Government established rewards for land donations to qualified private-sector organizations capable of protecting the easement in perpetuity with a tax deduction worth the value of the property rights surrendered, and by conferring significant estate tax benefits on conservation easement donors and their heirs. However, tax reform diluted the incentive for easements: the appreciated value of a donated easement is no longer tax deductible.

Options: Authorize Alternative Mechanisms To Protect Groundwater Resources

Congress could authorize tax deductions for farmland easements for groundwater protection purposes. Section 170(h) of the tax code could be

[6]Tax policy is another potential avenue of influencing landowner, farmer, and agricultural investor decisions related to agrichemical use and agricultural management systems. For further information, see Ward, Benfield, and Kinsinger (195).

changed to complement the CRP. Such a reform could allow persons enrolling hydrogeologically vulnerable land in the CRP to obtain a charitable tax deduction provided they donate a permanent agrichemical-control easement on the affected property.

Current Federal government-sponsored farmland easements are conducted largely through restructuring FmHA loans. Section 1318 of the 1985 Food Security Act allowed FmHA borrowers to exchange conservation easements for partial debt forgiveness, but FmHA has yet to take any conservation easement for such purposes (195). A recent FmHA rule proposal would elevate conservation easements to a "primary loan service program" and FmHA would accept easements on wetlands, highly erodible lands, and certain "uplands" with "environmental significance." If a farmer could put hydrogeologically vulnerable land into an easement and be allowed to deduct the difference between the field's market value as cropland and its value under a less chemically intensive management regime, this might lend economic stability to rural communities as well as assist in surplus reduction.

Congress could expand acceptability criteria for conservation easements. Congress could implement more authority for conservation easements to satisfy farm debts, using soil, wetland, and groundwater vulnerability criteria for easement acceptability. State and private-sector programs also might be encouraged to purchase development rights or conservation easements. State and local governments already have established programs to purchase easements requiring the retention of farmland in agriculture. For example, the RIM (Minnesota) gives direct payments in exchange for either a 20-year or permanent development easement. Such programs also could be reoriented to include establishment of easements on hydrogeologically vulnerable lands. Partial easements might require the sealing of contaminated agricultural drainage wells, changes in tillage or irrigation practices, or reduced chemical use.

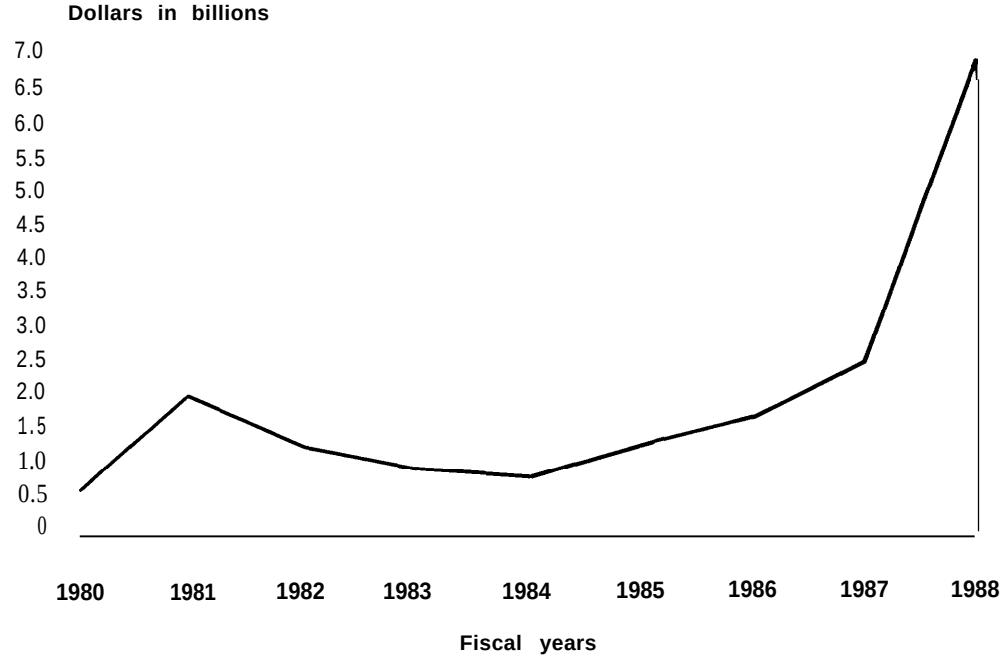
Congress could authorize grants to State and local governments for purchase of conservation easements. The Land and Water Conservation Fund (the primary mechanism for funding Federal acquisition of parks, forests, refuges, and recreation areas) also has a State grants component that provides funding for expansion and enhancement of State and local land preservation programs (137). This program, or an analog, could be used to provide grants to State and local governments for purchase of conservation easements.

Disaster Assistance—Disaster assistance provided to farmers by USDA takes the form of: 1) direct payments, 2) emergency loans, and 3) crop insurance. Although provisions vary among the programs, most provide cash to disaster victims in the event of natural disaster (see figure 6-6). The direct payment program has replaced the Disaster Assistance Payment Program that was phased out in the early 1980s; its most recent use was in response to the 1988 drought emergency (43). As of March 1989, certain aspects of the program covered 472 crops and livestock.

The emergency loan program is conducted through FmHA and provides loans at subsidized interest rates to producers sustaining a crop or livestock loss as a result of natural disaster. Loans are made in disaster areas specifically declared by the President, Secretary of Agriculture, or the FmHA Administrator. A minimum of 30 percent loss of the normal annual production must be sustained by the producer in order to be eligible for an emergency loan. The original intent was to subsidize growers' return to farming operations after a disaster, however, the program has been modified to extend loans for operation expansion. Physical loss loans are also available under this program to cover damage or destruction of property essential to farm operations. It is estimated that nearly 80 percent of emergency loans are for production loss and the remainder are for physical losses (157).

Under the crop insurance program, farmers can purchase subsidized crop insurance for most commodities through the Federal Crop Insurance Corporation (FCIC) (155). With the insurance, a farmer with crop loss is guaranteed payment for a certain amount of his production per acre, ranging from 50 to 75 percent coverage. Farmer participation in Federal crop insurance programs has been generally low, however, averaging at about 25 percent of all eligible acreage in 1987. Participation rates vary widely by crop, ranging from O to 60 percent, with participation typically lower with low-risk crops and in low-risk areas (155). Reasons for low participation include poor program marketing, high premium costs, self-insurance of farmers, and farmers' conviction that the Federal government will come to the rescue anyway in disaster situations (155). However,

Figure 6-6-Government Costs for Agriculture Disaster Assistance Programs



Significant Federal resources are directed towards disaster assistance to agricultureal producers. Low participation in crop insurance programs has been attributed to the availability of Federal disaster assistance programs that provide direct cash payments for agricultural losses.

SOURCE: U.S. Congress, General Accounting Office, *Disaster Assistance: Crop Insurance Can Provide Assistance More Effective/y Than Other Programs,* **Report to the Chairman, Committee on Agriuclture, U.S. House of Representatives, GAO-RCED-89-211, September 1989.**

farmers argue that coverage is too costly and inadequate and private insurance companies serving as marketing agents for the FmHA add that required paperwork is too complex (29).

The most recent crop insurance legislation, the Federal Crop Insurance Act of 1980, allows the FCIC to employ a variety of private insurance agencies and farm cooperatives in its attempts to publicize and sell crop insurance. This Act was intended to phase out and eventually replace the Disaster Payments Provisions established in the Agricultural Act of 1949, which provide government insurance against yield losses due to drought, flood, hail, wind, frost, fire, excessive rain, insect infestation, plant disease, and other ‘‘unavoidable causes’ (2).

POLICY ISSUE: Crop Insurance and Disaster Assistance Programs May Encourage Agrichemical-Intensive Practices in Hydrogeologically Vulnerable Areas

Prior to 1980, USDA disaster assistance was conducted primarily through cash payments totalling nearly $436 million annually between 1974 and 1980 (157). Consequently, the direct payment program was criticized for being costly and encouraging production of crops in unsuitable areas. Thus, Congress expanded the scope and availability of crop insurance in an effort to reduce the need for disaster assistance programs. However, provision of disaster assistance through direct payments and emergency loans continued through the 1980s. Experts and farmer groups attributed the low participation in crop insurance programs to the availability of Federal disaster assistance that provides direct cash payments to producers at no cost and thus send the message that crop insurance is unnecessary.

From 1980-88, USDA provided nearly $17.6 billion to support all three disaster assistance programs (direct assistance $6.9 billion; emergency loans $6.4 billion; and crop insurance $4.3 billion). Annual increases are noted under each program (157). Clearly, significant Federal resources are directed towards disaster assistance to agricultural producers and thus may offer a potential mechanism for affecting or modifying agricultural practices.

Option: Cross-Compliance in Risk-Reduction Programs

Congress could restrict crop insurance subsidies and disaster payments to those farmers who have approved nutrient and pesticide management plans. This approach would essentially create a cross-compliance situation, linking disaster payments with implementation of approved agrichemical management plans. Effectiveness of such an action would depend on producers believing that lack of compliance would in fact result in ineligibility for Federal assistance. Strong congressional sentiment that farmers should buy crop insurance to be eligible for other Federal programs may offer some potential for convincing producers that their behavior may in fact affect eligibility for Federal assistance (29). For example, legislation was passed in 1988 that required farmers to purchase crop insurance in order to be eligible for drought emergency assistance payments. The Chairman of the House Committee on Agriculture stated in response to the 1988 drought relief measure that: "Given the budget situation, the only thing riskier than betting on the weather is betting on the Federal Government to come to the rescue again. " However, it may appear that undue hardship or penalty is being placed on the part of producers, particularly since production or physical losses are incurred as the result of natural disaster and not personal mismanagement.

Option: Liability Insurance for Groundwater Contamination

Congress could provide liability insurance for groundwater contamination for farmers with approved nutrient and pesticide management plans. Liability for agrichemical contamination of groundwater has been established by several States (e.g., Connecticut, California). Liability insurance for agrichemical contamination of groundwater could be provided through various farm credit mechanisms (FCS, FmHA, FCIC) for producers in States where liability statutes are in place.

Marketing Orders—Marketing orders were originally authorized in the Agricultural Marketing Agreement Act of 1937 with the purpose of regulating the "handling" of agricultural commodities in interstate and foreign commerce to ensure that consumers receive "an adequate supply of a commodity at stable prices' (41). They are primarily used for fruit, nut, vegetable and milk production. The government sanctioned farmers in such regions to form cartels that set controls on the amount and quality of products that may be imported to these regions, thus enhancing local production of these commodities.

For example, although transportation technologies now enable marketing of Wisconsin dairy products in Southern Florida at competitive prices with local producers, marketing orders still restrict importation of products from outside the area (cf: 41). The two largest dairy farms in the United States are located near the Okeechobee (Taylor Creek-Nubbin Slough watershed) in Florida, a resource that is currently threatened by phosphorus inputs. These dairies cover nearly 14,000 acres with 9,000 head (0.642 cows per acre); the phosphorous output may lead to hyper-eutrophication of the lake and eliminate its usefulness as a source of drinking water, recreation, and wildlife habitat (96). Thus, it has been suggested that such marketing orders may in fact contribute to commodity production in unsuitable areas (41).

POLICY ISSUE: Obsolete Marketing Order Programs May Encourage Inappropriate Agricultural Production in Hydrogeologically Sensitive Areas

Obsolete marketing orders may encourage or protect agricultural production in regions where it otherwise might not be economically viable. Further, agricultural production of crops in regions not suited to them commonly requires greater external inputs, most commonly agrichemical, to create conditions conducive to production. In some of these areas, potential adverse impacts on surface- and groundwater resources then may be a significant concern.

Option: Review Marketing Orders

Congress could direct USDA to conduct a review of marketing order programs for possible contributions to groundwater quality degradation. Based on such a review, regions where extant marketing orders may pose a risk to the environment could be evaluated for alternatives to continuing the marketing order or development of alternatives to current production practices. Elimination of marketing orders that seem to promote production in unsuitable regions is one option. However, this approach offers no assurance that producers might not simply begin producing a commodity that may

generate equally adverse environmental impacts (e.g., exit dairy and enter sugar production). Alternately, the programs could be revised to include an environmental component, one requiring participating producers in sensitive areas to implement production practices designed to reduce potential for agrichemical contamination of surface- and groundwater.

Factors Hindering Effectiveness of Minor Changes in Farm Programs

Some farm program modifications, such as increasing cropping flexibility under commodity programs, can remove disincentives to the adoption of crop rotations and reduce the need for intensive agrichemcial use. Other farm program modifications, such as expansion of cross-compliance to include improved nutrient and pesticide management practices, would also provide incentives to encourage more efficient and judicious agrichemical use, However, fundamental conflicts inherent in farm programs and general agricultural policy work against the simultaneous achievement of production and resource protection objectives (21). These conflicts could impede significant progress in the development of public and private-sector capacities to protect resources in agriculture, and the resulting implementation of programs and cropping systems that integrate resource protection into agricultural production processes.

Since the 1930s, farm program modifications have represented the typical approach to resolving problems within and among agricultural production sectors, and this same approach **was** used in the 1985 Food Security Act in an attempt to integrate production and soil erosion control objectives. Farm programs face further modification with other environmental problems, including agrichemical contamination of groundwater and emerging ones such as atmospheric pollution by agrichemicals. One concern is that constant attempts at "fine tuning' result in an uncoordinated set of conflicting laws and regulations that in turn create more problems requiring yet more '' fine tuning (90). If agricultural policies are to address agricultural resource degradation issues effectively over the long term, a more fundamental approach to policy reform may be needed, evaluating and addressing the following conflicts:

- conservation and production titles of the Farm Bill tend to be developed separately;
- legislation on agriculture and the environment tends to be handled by separate committees; and
- congressional hearings provide the only formal mechanism to include the public in the development of agricultural policy.

Emerging environmental issues in agriculture will confront the same inherent conflicts.

U.S. agricultural policy has been first and foremost an agricultural *production policy,* shaped by the interests of commodity producers, which has made resource conservation a voluntary, and perhaps secondary, consideration for most farmers. Agricultural policy's production emphasis may have been appropriate in the past, because it was based on the assumption that the U.S. public expects and demands an inexpensive, consistent food supply. Recent Gallup polls suggest that this assumption of public desire for a ''cheap food supply" may no longer be correct, and the U.S. public may now be willing to support higher food prices to protect the national resource base and support less-polluting farming practices. If agricultural policy is to truly include resource protection and environmental stewardship as *publicly demanded* objectives for U.S. agricultural production, integration of environmental and production objectives must involve some mechanism for deciding how the costs of resource protection efforts will be shared among farmers, government, business, and consumers. The process by which agricultural legislation is developed will thus have to be opened to wide debate.

Educating for the Future

Considering the high level of public concern about agriculture's environmental impacts, ensuring that agricultural producers, researchers, and policymakers have sufficient knowledge of relationships between agriculture and the environment to anticipate adverse environmental impacts from practices, programs, or policies is likely to become increasingly important. Similarly, environmental scientists and policymakers will need to have increased knowledge of U.S. agriculture in order to integrate agriculture and the environment in research and policy. A firm basic education in agroecology probably would benefit both groups.

Increasing exposure to environmental sciences could help agricultural students and professionals to become more aware, knowledgeable, and skilled in addressing environmental problems. However, several constraints exist to the strengthening of environmental studies components in agriculture and natural resource school (ANR) curricula. United States educational policies give primary responsibility for education to the States, despite continued calls for increased Federal attention to education. The secondary role of the Federal Government in education makes it difficult to promote widespread curricular changes among the broad range of programs found at different institutions.

POLICY ISSUE: Integrating Agriculture and Environment in Education

Curricular change is difficult because the professional and college reward systems tend to emphasize research over teaching. Individual efforts to develop course and curriculum materials take considerable time and effort. However, scholarly efforts aimed at course and curriculum renewal seldom are rewarded, especially at the larger institutions (93,88). Many faculty, particularly those in the land-grant system, have the majority of their salary support for research, rather than teaching. Finally, little funding in general is available for college program modification activities; one exception is private grant tiding, such as the Kellogg Foundation grants for agricultural curriculum renewal at the University of Minnesota (105) and University of Wisconsin (89).

Another means of encouraging students and graduates to achieve specific environmental knowledge and skills is through certification programs established by professional societies, such as the American Registry of Certified Professionals in Agronomy, Crops, and Soils (ARCPACs). Some States (e.g., Indiana) have approved ARCPACs certification programs and standards to be used in certifying agricultural professionals (138).

Other methods of encouraging understanding of agriculture and the environment are provided through Federal programs to expose teachers and students to agricultural research or to Federal agency functions. For example the USDA Agricultural Research Service conducts the Teachers Research Fellowship, providing temporary employment for secondary school science teachers in agricultural research projects. The Research Apprenticeship program offers the same opportunities to high school students. Cooperative Education provides part-time work with ARS to high school through graduate program students during school vacations. More broadly, the Federal Junior Fellowship Program encourages high school students to work with a variety of Federal agencies. These and similar programs could be oriented toward giving future producers, educators, researchers, and policymakers a basis from which to consider the integration of agriculture and the environment.

Option: Review U.S. Education System for Ability To Provide Agricultural/Environmental Expertise

Congress could require the USDA Office of Higher Education, jointly with the Department of Education, to conduct an evaluation of the U.S. education system to determine its capacity to provide graduates who are adequately trained in agricultural and environmental sciences to address national needs in environmental research, pollution control, and technology development in agriculture. Such an evaluation, however, would be difficult to do for several reasons. First, the environmental sciences encompass a broad group of disciplines and professions, ranging from ecology to atmospheric sciences to wastewater treatment. No clear definitions exist for the environmental sciences in general, nor for agricultural **courses covering** environmental impacts specifically. Specific definitions and classification of training programs by objective and content would aid in assessment programs.

Second, organization, degree programs, and instructional requirements are determined within each institution and vary considerably from college to college. Currently, agricultural students in ANR colleges are educated primarily to address problems and concerns in agricultural science, production, and business. Although most land-grant colleges offer environmental studies courses as electives, few require agricultural science students to take these courses (105). Many agricultural science courses incorporate material on environmental impacts, but no standard criteria exist for the amounts and types of environmental information to be included in these courses.

Finally, the USDA Office of Higher Education at present does not have the resources to conduct such an evaluation, and the Department of Education

conducts few programs related to environmental education relative to other programs. Thus, Congress could request such an evaluation from a congressional research agency, or from a special commission established for that purpose.

THE BOTTOM LINE: QUESTIONS FOR CONGRESS

Given the: 1) level of public controversy (based on public interest in agricultural development and in environmental quality), 2) levels of uncertainty related to agrichemical contamination of groundwater (on the problem, the causes, and the potential solutions), and 3) existence of technologies (extant and emerging) that have strong potential to reduce agrichemical contamination of groundwater, the ultimate determinant of potential policy directions depends on the answer to one question: *how will Congress choose to deal with the uncertainty and, thus, define the problem?*

What action(s) Congress opts to take to protect the Nation's groundwater from agrichemical contamination may depend as much on how it chooses to approach the problem as on the state of science and technology. For example, groundwater contamination could be viewed simply as an additional target of environmental concern (along with surface water) and extant conservation programs could be modularly expanded to include groundwater protection provisions, or to increase the priority already given to such provisions.

Groundwater contamination also could be considered an outcome of farm programs that create disincentives for farmers to protect the environment. Strategies for dealing with the problem could then involve program modifications to reduce or remove disincentives and provide incentives for conservation. However, the basic program structure would be preserved. This approach is reflected in the 1985 Food Security Act provision related to soil erosion and wetland preservation.

A broader approach than either of these is to view groundwater contamination as one of many symptoms of the need to integrate environmental protection into agricultural policy as a whole. Rather than make piecemeal efforts to address soil erosion, surface-water quality, or groundwater quality, and rather than focus on a few culpable programs, Congress could review and modify the entire agricultural policy/program structure to balance **a goal** of environmental protection with that of agricultural production.

This view reflects potential for a changed Federal view of the relationship between agriculture and the environment. Historically, agricultural policies and programs have placed major emphasis on increasing production. However, in the future, protecting environmental and public health could be considered as important as that of enhancing agricultural production. Choosing this approach would require reconsideration of national goals for agriculture and for environment, clarification of the Federal role in agriculture, and review of the congressional separation of agriculture and environment in committee structure. The tone is set for increased legislative and executive attention to agriculture's impact on the environment.

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