United States Department of Agriculture

Water Quality

A Report of Progress

Background

The U.S. Department of Agriculture (USDA) announced its Water Quality Program in 1989, and established environmental quality as a priority in the Department.

The program is based on three principles:

- The Nation's water resources must be protected from contamination by fertilizers and pesticides without jeopardizing the economic vitality of U.S. agriculture;

- Water quality programs must accommodate the immediate need to halt contamination and the future need to alter farm production practices

- Ultimately, farmers must be responsible for changing production practices to avoid contaminating water resources

Goal

Farmers and ranchers will have the knowledge, technical means, and financial assistance to respond independently and voluntarily in addressing farm-related environmental concerns and related State water quality requirements.

Objectives and related activities:

Three objectives were established to assist in reaching the goal. For each of these, a series of results-oriented activities were identified. While there is some obvious overlap, the activities are most closely related to the objectives in the following ways(s).

Objective:

To determine the relationships between agricultural activities and water quality

Activities:

- Develop methods for sampling, measuring, and evaluating groundwater contamination

- Conduct research to provide the basis for improved management of chemicals used in agriculture

- Improve agrichemical management and agricultural production systems

- Evaluate the economic, social, and technical impacts of new and improved management practices and systems

Objective:

To develop effective agrichemical management and agricultural production systems that enhance or protect water quality

Activities:

- Build national and State data bases on agrichemical use and related farm practices

- Provide digitized geographic information systems for State and Federal evaluation of alternative policies and program strategies

- Improve agrichemical management and agricultural production systems

- Evaluate the economic, social, and technical impacts of new and improved management practices and systems

Objective:

To induce the farmer adoption of enhancement or protection strategies at significant levels in problem areas.

Activities:

- Expand USDA staff capacity to deliver educational and technical assistance to producers for effective agrichemical and waste product management and environmental stewardship

- Demonstrate and deliver technologies and management systems for voluntary farmer, rancher, and forester adoption and implementation

- Provide financial assistance to agricultural producers to accelerate the installation of measures designed to improve water quality

- Meet State water quality requirements through education and technical assistance

- Inform the public of program activities and achievements

Specific plans included the establishment of:
•5 Management Systems Evaluation Area (MSEA) projects
•16 Demonstration Projects
•230 Hydrologic Unit Area projects

The MSEA projects were designated for the Corn Belt—the region of most intensive use of agricultural chemicals in a humid region. The Demonstration Projects and Hydrologic Unit Area projects were to be distributed nationwide, addressing the most serious agricultural nonpoint source pollution (ag-nps) problems in each state.
This plan would have provided enough projects to address (at least) the four major ag-nps problems in each State, and would have made a significant impact on farm operations in the project areas. (Only 74 Hydrologic Unit Area projects were funded.)

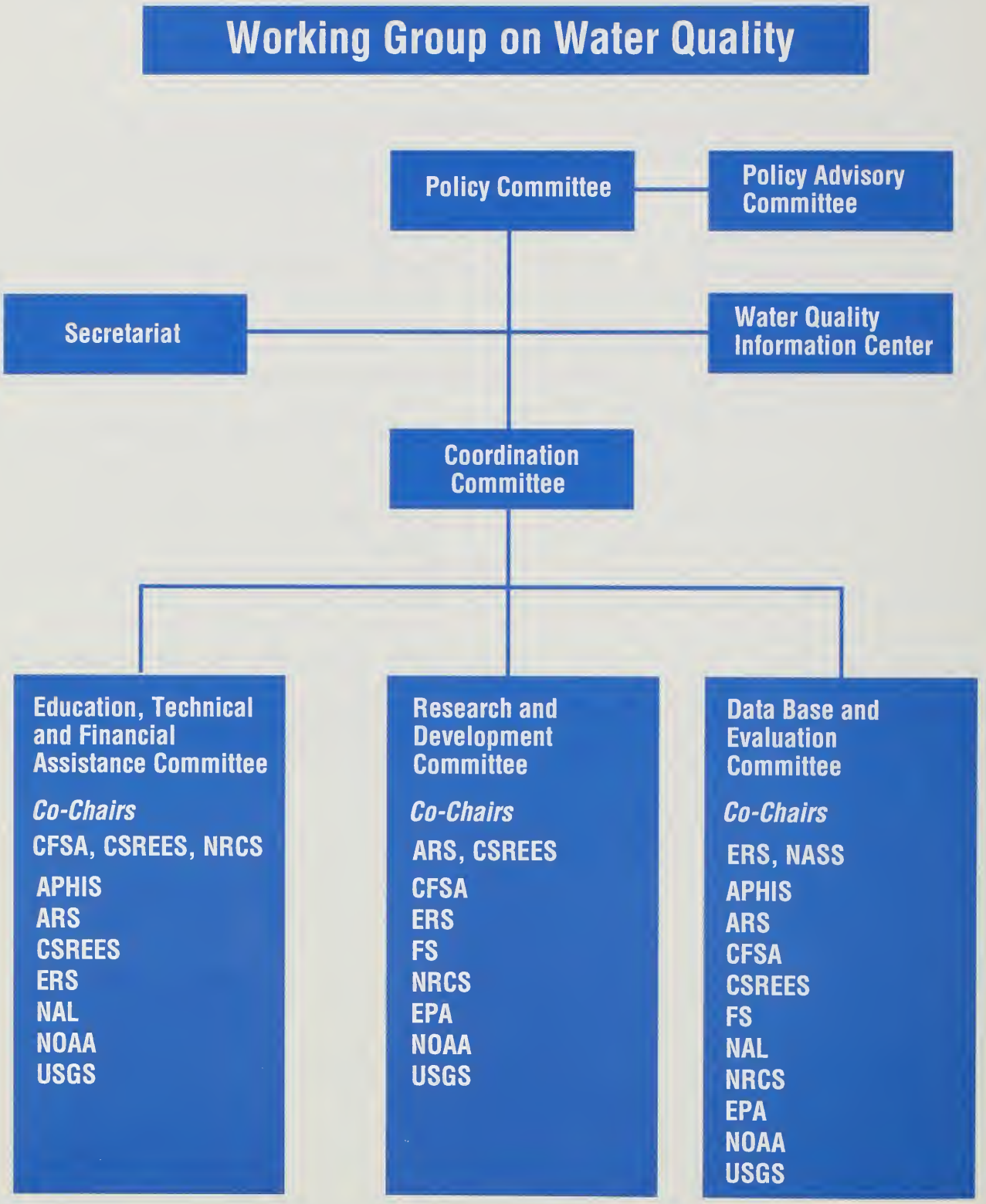
Since the projects addressed identified areas of agriculturally related water quality impairment (as identified by the State), such projects would certainly have made significant impacts on "agricultural nonpoint source" impairment of water resources.
The implementation of the program plan was assigned to three "action committees" (see structure diagram, page iv.)

- The "Research and Development Committee" oversees research by the USDA-ARS and cooperative research conducted by the State Agricultural Experiment Stations and USDA-CSREES. This committee has played the major role in developing the "Management Systems Evaluation Area" projects in the Corn Belt, and in the development of component research.

- The "Education, Technical and Financial Assistance Committee," co-chaired by CFSA, CSREES, and NRCS, implemented programs to induce farmer adoption of enhancement strategies in problem areas. These problem areas have been addressed by Demonstration Projects, Hydrologic Unit Area projects (a total of 90 projects), and some 110 Water Quality Special Projects.

- The Database and Evaluation Committee," co-chaired by ERS and NASS, is charged with the specific task of collecting nationally reliable data on the use of agricultural chemicals, and with conducting evaluations of the effectiveness of the program.

A compendium of selected results and outputs from each of these program are as follows.


Working Group on Water Quality
Policy Committee
Policy Advisory Committee
Secretariat
Water Quality Information Center
Coordination Committee
Education, Technical and Financial Assistance Committee
Co-Chairs
CFSA, CSREES, NRCS
APHIS
ARS
CSREES
ERS
NAL
NOAA
USGS
Research and Development Committee
Co-Chairs
ARS, CSREES
CFSA
ERS
FS
NRCS
EPA
NOAA
USGS
Data Base and Evaluation Committee
Co-Chairs
ERS, NASS
APHIS
ARS
CFSA
CSREES
FS
NAL
NRCS
EPA
NOAA
USGS

Results/Impacts

Research and Development

Objectives:

- To improve and expand our knowledge of agricultural practices related to water quality.

- To integrate such practices into production management systems that are economically and environmentally sound.

The most urgent issues are being addressed during the first five years of the USDA's Water Quality Initiative. Future operations depend upon identification of other important issues and concerns.

Strategy:

The USDA Water Quality Program supports research by the Agricultural Research Service (ARS) and by the State Agricultural Experiment Stations and other institutions in cooperation with the Cooperative State Research, Education and Extension Service. This consists of two elements:

(1) Priority Component Research: These projects expand our knowledge of specific aspects of the interactions of agricultural chemicals, soils, and water: reactions, degradation, persistence, movement, and other aspects of how current systems functions.

(2) Management System Evaluation Areas (MSEA): This program integrates the most promising individual research components into agricultural management systems for improved crop and livestock production including economic and environmental considerations within a region.

The first MSEAS were established in the Midwest. A sixth is being established in Mississippi.

The research strategy addresses six areas:

- Assessment, Sampling, and Testing Methods: To develop improved, inexpensive methods of risk assessment for existing or potential problem areas; including sampling, measuring, and evaluating water quality.

- Fate and Transport: To increase our understanding of factors and processes that control the fate and transport of agricultural chemicals.

- Management and Remediation Practices or Systems: To develop agricultural production management practices and systems that substantially reduce the movement of agricultural chemicals into water sources.

- Sensors, Geographical Information Systems, and Landscape/Watershed Scale Models: To develop sensors, Geographic Information Systems, models, and expert systems that apply water quality research results to other locations or at larger scales.

- Social, Economic, and Policy Considerations: To evaluate the economic, social, and political impacts of alternative agricultural production practices and systems, policies, and institutional strategies to protect water quality.

- Nitrogen Testing: To develop, evaluate, and integrate nitrogen tests for soils, plants, manures, and other organic materials into farm-scale recommendations.

Progress Assessment: Priority Component Research
ARS conducted 62 projects at 26 locations for FY 1990 through 1994. For the same years, CSREES awarded 245 competitively selected projects. Many involve collaboration with other agencies and scientific institutions.

Progress (Examples):
A decision support system that links several simulation models and an economic accounting package has been developed. It is used for the selection of site-specific management practices that consider both water quality and farm economics. (Arizona)

Research in the San Joaquin Valley has shown that subsurface drip irrigation will result in less drain water disposal and provide higher water use efficiencies than surface irrigation. This will reduce drainage waters, and associated salt and agricultural chemical loadings. (California)

The NLEAP (Nitrogen Leaching and Economic Analysis Package) computer model has been transferred to education and technical assistance agencies as a training package, available to water quality specialists in all 50 States. (Colorado)

NLEAP is being used to improve nitrogen management on farmers' fields in the San Luis Valley of Colorado. (Colorado)

The injection of corn and soybean oil around a well is an effective method for nitrate removal. Nitrate in the water is removed as a larger number of denitrifiers utilize the oil as a carbon source. (Colorado)

Five water quality models (AGNPS, SWRRB, EPIC, GLEAMS, and NLEAP) have been delivered to the NRCS for tracking the impact of changing land management practices on pollutant load reductions. ARS and NRCS are in the process of training State specialists on the use of the models. NRCS is developing a Geographic Information System (GIS) interface for four models (AGNPS, SWRRB, EPIC, and GLEAMS) for ecosystem-based planning. (Colorado, Texas, Georgia, and Minnesota)

The Root Zone Water Quality Model is being used to study the effects of management practices on tile outflow and water quality in the Midwest. It predicts water and nitrate-nitrogen flow to tile drains. (Colorado, Iowa, Minnesota, Missouri, Nebraska, and Ohio)

Growing irrigated corn and then winter wheat after alfalfa uses the nitrogen from plant residues, and minimizes the potential for nitrate leaching. (Idaho)

Irrigating the furrow on one side of a corn row and banding nitrogen fertilizer on the opposite, dry side of the furrow improves nitrogen uptake efficiency and reduces nitrate leaching. (Idaho)

Runoff losses of herbicides can be reduced by 20 to 30 percent during the first 2 weeks after application, with controlled shallow water tables. This technique increases the value of subsurface drainage systems. (Louisiana)

Magnetic resonance imaging (MRI) is used to detect fish liver anomalies. These are correlated with the presence of pollutants and contaminants in marine estuaries. The approach monitors live aquatic organisms for evidence of water quality problems. (Maryland)

Pre-sidedress soil nitrate tests can identify sites with adequate nitrogen levels and reduce over-fertilization. Adoption of the test in Maryland has saved about 30 pounds of nitrogen per acre per year. (Maryland)

A 10 percent sales tax on commercial nitrogen fertilizers might reduce nitrate-nitrogen levels by about one-tenth of what could be expected from a complete restriction on intensive agricultural land use. (Massachusetts)

Several deep-rooted alfalfa varieties have been identified; they remove nitrates from the soil more efficiently than reed canarygrass or switchgrass. (Minnesota)

Nitrogen and pesticides in the soil moved upward toward the freezing front in early winter, but moved downward during late winter and early spring. The net result was a downward movement of about 5 inches during the annual freeze/thaw process. (Minnesota)

Preliminary results indicate that 2,4-D degradation in compost may not be greater than that in soils. (Minnesota)

A new system that applies herbicide in paraffinic oil achieved better weed control than conventional application equipment at half the herbicide rate. (Mississippi)

A constructed wetland effectively manages wastes from catfish ponds by reducing the levels and the range of fluctuations of ammonia, nitrate, nitrite, phosphorus, chlorophyll, and phaeophytin. (Mississippi)

A new test has been developed to determine nitrogen availability to crops and its leaching potential. Mint, sugar beets, corn, and small grains are sensitive to rates of nitrogen application, irrigation management, and other factors influencing nitrate-nitrogen leaching. (Montana)

An intermittent herbicide sprayer controlled by an optical sensor has been developed. A machine vision system is being developed to make extensive field
evaluations of the spot spraying systems. (Nebraska, Mississippi)

An electrochemically mediated iron/hydrogen peroxide system has been developed as a field method for treating pesticide waste water. The system removed 90 percent of the parent compound in all cases. (New York)

Fluidized bed and fly ash wastes from power plants applied to high-phosphorus soils substantially reduced the water-extractable phosphorus; application of these materials to critical areas may substantially reduce the export of dissolved phosphorus to streams. (Pennsylvania)

Crop rotations can significantly reduce nitrate pollution. In the Pacific Northwest, nitrate lost from the root zone of irrigated potatoes can be effectively recaptured by following grain or forage crops. (Washington, Oregon)

Nitrate concentrations were measured in several karst springs in West Virginia, to determine the impact of agriculture on water quality.

A relationship between nitrate-nitrogen concentration and percent agricultural land and animal grazing was shown. Improved waste management practices and capping of some sinkholes are being evaluated. (West Virginia)

Management Systems Evaluation Areas

The Management Systems Evaluation Area (MSEA) program in the Midwest began in FY 1990. It includes USDA agencies, the U.S. Geological Survey, U.S. Environmental Protection Agency, State Agricultural Experiment Stations, the State Cooperative Extension System, and other State and local agencies. Leadership is provided by ARS and CSREES.

The program evaluates the effect of agricultural management practices and systems on water quality; and it develops cost-effective strategies to reduce water and environmental contamination from pesticides and plant nutrients. A new MSEA program began in the Mississippi Delta (Lower Mississippi River) in FY 1994.

Midwest Management Systems Evaluation Areas

The Midwest MSEA program includes 10 field sites operated by five coordinated research teams in Iowa, Minnesota, Missouri, Nebraska, and Ohio. Scientists monitor soil, water, and weather parameters, and determine the effects of various crop management systems on water quality. Modified cropping systems are being developed and evaluated to document the impacts on water quality.

The program has six objectives:

- Measure the impact of prevailing farming systems on water resources.
- Identify and increase understanding about the processes that control the fate and transport of agricultural chemicals.

- Assess the impact of agricultural chemicals and practices on associated ecosystems.
- Assess the water quality impacts of modified farming systems in the Midwest.
- Evaluate the social and economic impacts of using alternative management systems.
- Transfer appropriate technology for use on the land.

Midwest MSEA: Impacts

The **Iowa MSEA** project has three sites: the western site near Treynor, the northeast region site near Nashua, and the Walnut Creek watershed, near Ames.

The deep loess soils of the Treynor area are characterized by surface runoff and seepage flow from the interface of the loess soil and the underlying glacial till. Continuous corn is grown on four field-sized watersheds. Surface runoff events are common in these steep soils.

- Atrazine concentrations exceeding 40 parts per billion (ppb) have been observed in the surface runoff from spring snowmelt on frozen soil.
- During one summer runoff event in 1993, the metolachlor concentrations exceeded 150 ppb.
- Metolachlor concentrations in the shallow wells have concentrations between 0.1 and 10 ppb.

In northeastern Iowa (the Nashua site) the water quality problems are associated with surface runoff and tile drainage that empties into streams.

- Atrazine moves rapidly into the tile drains after a rain; preferential flow may be transporting chemicals rapidly through the soil profile.
- Drainage is higher under the no-till and ridge tillage treatments, and increases the total nitrogen load in the drainage waters.
- Although the nitrogen loading is higher, increased drainage from these treatments reduces the concentrations of nitrate-nitrogen; compared to the chisel-plow and moldboard tillage systems.
- Ridge tillage and no-till practices reduce surface runoff.

Walnut Creek watershed represents about 15 percent of the State, which is extensively tile drained. Tile drains rapidly transport the shallow ground water to the streams.

- The highest concentrations of nitrate-nitrogen in the tile drainage water range from 15 to 20 parts per million (ppm).
- Atrazine concentrations in the tile drainage water are generally below 3 ppb.
- Less than 2 percent of the applied atrazine or metolachlor is lost in the streamflow.
- Nitrate losses range from 40 percent in 1991 and 1992 to over 100 percent in (extremely wet) 1993.
- Detections of atrazine and nitrate-nitrogen are found in the shallow wells; however, below 5 m there are only a few detections and below 10 m there are no detections of any of the herbicides, and nitrate concentrations are less than 2 ppm.
- Atrazine concentrations in rainfall were less than 2 ppb.
- Farmers are willing to use filter and buffer strips and strip-cropping in some cases to reduce non-point source contamination of streams.
- Farmers are seeking more information on weed control and nitrogen management for no-till farming systems. Interest in alternative chemical application methods is increasing.

The **Northern Cornbelt Sand Plain MSEA** project extends along a 4-State (Minnesota, North Dakota, South Dakota, and Wisconsin) transect. The primary site is in Princeton, Minnesota, with satellite sites at Oakes, North Dakota; Brookings, South Dakota; and Arena, Wisconsin. The common farming system at all locations is a corn-soybean rotation using ridge tillage, band application of herbicides, nitrogen applications when needed, and irrigation to supplement rain.

- The ridge-till system reduces total chemical use by two-thirds and also reduces damage caused by wind and water erosion.

- Atrazine concentrations in ground water never exceeded the maximum contaminant level (MCL) of 3 ppb at any location.

- Applied atrazine did not reach the aquifers in Minnesota or North Dakota, while detections rarely exceeded 1 ppb in ground water in South Dakota and Wisconsin.

- Atrazine and its metabolites were detected occasionally beneath the cropped area in Minnesota at concentrations less than 0.1 ppb. They also were detected in similar concentrations beneath areas where atrazine was not applied.

- Nitrate-nitrogen was present in ground water at all locations initially, ranging from 0.5 to 52 ppm.

- Nitrogen management successfully protected groundwater quality under the corn and soybean farming system for normal weather conditions.

- Nitrate-nitrogen concentrations upgradient, beneath, and downgradient of the ridge-tilled corn and soybean rotation areas were indistinguishable from background concentrations. Hence, this farming system has not degraded groundwater quality.

- Most of the farmers surveyed (73 percent) used reduced tillage and were concerned about pesticide (primarily herbicide) use.

- About 86 percent of these farmers use chemical weed control, and oppose more taxation of pesticides and fertilizers.

- Only 50 percent of these farmers reduced fertilizer applications based on manure applications and legume history.

- Research findings were presented at many regional and national conferences. Over 150 participants shared information at the Farming Sandy Soils Conference in St. Cloud, Minnesota.

The **Missouri MSEA** project is located in north-central Missouri, and typifies the claypan soils which occur throughout much of the southern Corn Belt. Research is being conducted at watershed, field, and plot scales.

- Corn grain yields vary as much as 50 bushels per acre within fields and are highly correlated with claypan depth.

- Mean annual streamflow from the Goodwater Creek watershed is 11.4 inches, about 30 percent of the mean annual precipitation.

- Ground water is not being contaminated by any of the herbicides presently used within the watershed.

- Approximately 25 percent of the groundwater wells have nitrate-nitrogen concentrations above 10 ppm.

- Atrazine and nitrate-nitrogen can leach to about 36 inches below the soil surface within 24 hours following rainfall. Much of the water flow in claypan soils is through soil cracks or other preferential flow channels.

- The adoption of banded herbicide applications are limited by the difficulties of timely cultivation for weed control on poorly drained claypan soils.

The **Nebraska MSEA** project in the Central Platte Valley is evaluating the impacts on groundwater quality of conventional and improved management systems for irrigated crop production.

- Improving irrigation water management improves water quality. Concentrations of nitrate-N in drainage water leaving the crop rootzone and in ground water beneath the fields are lower under the improved furrow irrigation system than under the conventional system. They are lower still under the center pivot irrigated fields.

- Splitting N applications between preplant and sidedress fertilization, reducing N amounts to what the plant requires, and controlling irrigation-amounts have reduced nitrate-N levels in the upper 4-5 meters of the ground water.

- Improved nitrogen management including soil testing; chlorophyll meters; fertigation; and water management practices, such as irrigation scheduling, surge-flow irrigation, and sprinkler irrigation, can maintain yields with 10 to 20 percent less N fertilizer.

- Surge-flow irrigation uses half as much water as conventional furrow irrigation, and produces identical crop yields.

- Several best management practices offer producers win-win situations. Managing nitrogen and water applications more closely often increases profits by reducing costs and groundwater pollution.

The **Ohio MSEA** is representative of the recharge area for alluvial valley aquifers, which represent significant water supply resources throughout the Midwest. They supply as much as 50 percent of the groundwater use in Illinois and 75 percent in Ohio.

- No pesticides have been detected in 7,000 groundwater samples.

- The absence of atrazine in the aquifer indicates that the amounts being applied do not exceed the capacity of the soil profile to adsorb, degrade, or otherwise dissipate the applied atrazine.

- Where atrazine is applied every year, it is dissipated from the soil at a higher rate than where it is applied less frequently.

- Microorganisms that degrade atrazine are more abundant where atrazine is used more frequently.

- Crop rotations reduce the amount of pesticides used to control weeds or insects.

- Banding of herbicides requires only one-third as much ingredient as full-coverage placement; however, cultivation adds fuel and labor costs.

- Landowners/operators surveyed (1,305) indicated that they believe nitrate and pesticide contamination of ground water pose a minor threat to the health of family members.

- Efficiency and profitability are important considerations when farmers make decisions about using new methods.

Joint MSEA Project Progress:
The MSEA modeling group has adapted, improved, and verified the usefulness of the Root Zone Water Quality Model as a tool for extending MSEA results beyond the research sites. The model predicts the movement of water and agricultural chemicals.

The MSEA projects are creating regional databases. Integration of MSEA information into a regional assessment of water quality is continuing.

Educational, Technical and Financial Assistance

Objectives:

- To advise and assist in the development of agrichemical management and agricultural production systems that enhance or protect water quality;

- To induce the adoption of appropriate (enhancement or protection) systems at significant levels in problem areas.

Strategy:

Programs for education, technical assistance, and financial assistance are coordinated at the Federal, State, and local levels. Such coordination and cooperation is reported to be unprecedented in agricultural programs.

Efforts to induce the adoption of enhancement systems at significant levels in problem areas are accomplished through local projects, chosen with the concurrence of State water quality officials and having high State priorities for remediation.

There are three categories of projects; Demonstration Projects (16); Hydrologic Unit Area projects (74) and Water Quality Special Projects (110).

Selected impacts for Demonstration Projects and Hydrologic Unit Area projects are presented.

This voluntary program attempts to change farmers' production systems. Such changes present varying degrees of risk to the farmers. These must be addressed; and farmers must be convinced that such changes are compatible with their solvency and security.

The USDA delivery system continues to be a credible mechanism for voluntary, incremental change.

Products and Impacts:

In Connecticut, Pre-Sidedress Nitrogen Testing has been adopted on 1,000 acres of cropland, reducing nitrogen fertilizer applications by 68,000 lbs (34 tons) in one season; the adoption of IPM by four producers reduced pesticide applications by 1,000 pounds (active ingredient) in one growing season.

In Florida (Lake Apopka), nitrogen applications were reduced by 200 tons; phosphorus by 390 tons; and potassium by 425 tons in 1991-93.

In Georgia (Little Rooty), the improved management of 45,000 tons of animal waste reduced the use of commercial nitrogen by 113 tons in 1 year; adoption of conservation practices reduced soil erosion by 15,000 tons; and farmers who adopted nutrient management practices reduced their fertilizer costs by $5,000 to $25,000 per year.

In Hawaii (Kaiaka-Waialua), sediment loading to bays was reduced by 21,000 tons per year and phosphorus loading was reduced by 5,200 lbs per year.

In Maine (Long Lake), the band application of pesticide reduced fungicide applications by 5,400 lbs in 1 year; phosphorus fertilizer applications were reduced by 18 tons, and nitrogen fertilizer by 16 tons.

In Maryland (German Branch) nitrogen use has been decreased by 114 tons, and phosphorus use by 72 tons, saving the cooperating farmers some $159,000 during the project lifetime.

In Michigan (Sycamore Creek), 18 farm members of the Sycamore Creek Crop Management Association (established with USDA - WQP leadership) reduced

fertilizer inputs by 65 tons, pesticide inputs by 1,500 lbs, and input costs by $18,000 in a single year.

In Arizona (Maricopa), improved irrigation efficiency is saving an estimated 2,400 acre-feet of water each year, greatly reducing the potential for nitrogen leaching to the underlying aquifer.

In Arkansas (Long Creek), farmers adopted nutrient management plans on 4,700 acres of cropland, reducing nitrogen applications by 405 tons and phosphorus applications by 223 tons.

In California (West Stanislaus), farmers adopted improved irrigation technology, saving some 6,500 acre-feet of irrigation water and reducing sediment-laden return flows and sediment inputs to the San Joaquin River.

In Delaware (Inland Bays), farmers adopted nutrient management practices on 44,000 acres, reducing nitrogen applications by 2,600 tons and phosphorus applications by 2,100 tons.

In Indiana (Tri-county), a pesticide disposal field day attracted 33 farmers and resulted in the collection and safe disposal of 2,400 lbs of unwanted pesticides.

In Nebraska (Elm Creek), the adoption of integrated crop management on 2,800 acres resulted in a 35-lb/acre reduction in nitrogen applied — a total of 49 tons in 1 year.

In Oregon (Tualatin River), soil testing and subsequent adjustment of fertilizer applications reduced phosphorus applications by 400 lbs/acre on 150 acres (30 tons).

In Texas (Upper North Bosque), water conservation practices adopted by 11 dairy farms saved 14 acre-feet of water from the waste system.

In Utah (Little Bear River), adoption of irrigation improvements saved 1,200 acre-feet of water on 2,000 acres in 1994.

In Vermont (Lower Missiquoi), seven farmers on 700 acres reduced phosphorus fertilizer applications by 32 tons over 3 years, saving some $20,000 in fertilizer costs.

Data and Evaluation

Objectives:

- To develop, analyze, and report timely and statistically reliable data on the aggregate levels of use and composition of pesticides, fertilizers, and related inputs.
- To analyze the expected environmental improvements and economic effects of a comprehensive program of research,education, and technical assistance for reducing potential water quality problems in agriculture.

Pesticide Data Program

The Data Base & Evaluation Committee is conducting two data collection efforts. The Chemical Use Surveys are being conducted by NASS and ERS in several cycles, covering the major field crops, vegetables, fruits, and nuts. The surveys were started because of:

1. lack of current, reliable data.
2. concerns over chemical residues affecting ground and surface water.
3. concerns over chemical residues on food crops.

The Chemical Use Surveys provide a data base for trends in usage. Data from the surveys are used to develop statistical estimates of fertilizer and pesticide use on major field crops and to provide a research data base to analyze production inputs and practices associated with chemical applications. These data also significantly contribute to Situation and Outlook reports and other USDA research.

The Chemical Use Survey of Field Crops is conducted every year. It covers 7 to 10 field crops, and their major producing States. The Vegetable Chemical Use and Economic Survey, begun in 1990, is conducted semiannually and covers 25-30 vegetable crops. The Fruit and Nuts Chemical Use Survey is conducted semiannually (starting in 1991) and covers 25-30 fruit and nut crops.

Year-to-year changes have occurred in the crops and States which were surveyed. The States selected for the survey are those which represent the largest proportion of the national acreage. These States have changed as production has shifted among States.

A target sample size is selected for each crop to provide a sufficient number of completed interviews to make State-level, statistically reliable estimates of treated acres and application rates for most commonly used pesticides. Fields for this survey are selected using a multi-frame, stratified sampling procedure.

Trained staff conduct personal interviews with farm operators to collect data about the selected field. The interviews are scheduled late in the growing season so that operators can provide information covering the full growing season. Interviews for wheat are generally conducted between June and September while fall-harvested crops are conducted between August and December. Response frequency is generally over 75 percent.

Data gathered in all the surveys include types, application, timing, and amounts of fertilizer, pesticides, and other chemicals. Data are also obtained on irrigation, cropping, and production practices, and for a subset of sample points, economic information on the farm unit is collected.

In 1993 NASS conducted a survey of subscribers to its chemical use publications. Respondents overwhelmingly indicated that the chemical use reports prepared from the survey data are helpful. Respon-

dents found the data useful for determining trends in chemical use, rates of application, and methods of application. Respondents consider the data to be reliable, and useful for making market and policy decisions. Some suggested expanding coverage to additional crops and States, and publishing statistics for infrequently used products.

Chemical use data from each survey are reported in Chemical Usage Reports prepared by NASS. Data from the surveys are also being used to support policy research. Survey data have been used in an assessment of cotton production's impacts on water quality, the adoption of IPM on field crops, vegetables, fruits and nuts, and an assessment of the commodity program's influence on chemical use in corn production.

Area Studies Surveys

The Area Study survey uses a cross-sectional, multiple-frame sampling approach to collect data on chemical use and other production practices for particular geographic areas. These surveys are being conducted in areas where the U.S. Geological Survey is conducting extensive monitoring, modeling, and assessment of water resources as part of its National Water Quality Assessment (NAWQA) program. Together, this information will enable us to examine the effects on water quality of on-farm agricultural chemical use and production practices. USGS is assisting us in establishing the land use-water quality linkages.

Area study surveys were carried out in 12 NAWQA study regions. These study regions were selected on the basis of the presence of agricultural cropland, significance of agrichemical use, the presence of soils that leach, and a significant water quality demand. The study areas are: Albemarle-Pamlico Drainage, Central Columbia Plateau, Central Nebraska, Iowa-Illinois, Lower Susquehanna Basin, Mississippi Embayment, San Joaquin-Tulare, Southern Arizona, Southern Georgia, Southern High Plains, Upper Snake River Basin, and White River Basin. ERS and NASS have gathered chemical use and farm practice information to be correlated with soil, land use, water quantity and quality, and other hydrologic data. Some of the data collected include a 3-year land use history, including crop history and planting date; 3-year chemical use history; irrigation, tillage, cultivation, and conservation practices; and use of non-chemical practices to control pests.

All of the Area Study surveys have been completed. No new surveys are planned. Survey data are supporting a number of research projects. Data have been used in an economic assessment of nitrogen testing for fertilizer management, in the development of an economic model of the agricul-

ture sector in Nebraska, and in an evaluation of the Water Quality Incentive Projects. Chemical use data from the Lower Susquehanna project have been turned over to USGS to assist in their analysis of water quality monitoring data. Chemical data from four other projects are currently being prepared for USGS.

Users of Survey Data

Listed below is a summary of known and potential users of the chemical use data collected by the Chemical Use Surveys and the Area Study surveys.

FDA
- chemical use data used to determine which pesticide residues need to be tested for.

USGS
- data used to support the NAWQA program.

ERS
- economic assessments of water quality programs.
- economic assessments of sustainable ag systems.
- assessment of farm use-residue relationships.
- economic assessments of legislative provisions.
- economic assessments of administration policies.
- economic assessments of pesticide alter natives.
- cost-benefit activities.

Others
- Universities - research, education
- chemical companies
- State Departments of Agriculture
- General Accounting Office
- private research companies

Epilog

The foregoing presents selected impacts of USDA water quality programs, but it does not capture the full range of activities of the Department, or of the participating agencies.

The 1990 Farm Bill (P.L. 101-624) directed the National Agricultural Library (NAL) to serve as a repository for information on water quality. The Water Quality Information Center at NAL currently offers more than 25 bibliographies on current topics related to water resources and NAL has added more than 15,000 citations covering water-related topics to the AGRICOLA data base since 1990. The center has responded to hundreds of inquiries for information concerning water quality and agricultural operations and makes many of its bibliographies and other information related to water quality available electronically via Internet.

The Farm Bill also established the Water Quality Incentive Program (WQIP), which is administered by the Consolidated Farm Service Agency (CFSA). The program provides incentive payments to achieve source reduction of agricultural nonpoint source pollutants by implementation of management practices in an environmentally sound and efficient manner. Through FY 1994, 177 WQIP projects had been approved.

The Working Group on Water Quality (WGWQ) has also developed and published consensus papers on "Water Quality and Nitrate," "Nitrate Occurrence in U.S. Waters," and "Atrazine in Surface Waters." These have been distributed widely within the agricultural and environmental communities.

The Farm*A*Syst program was developed jointly by the Universities of Wisconsin and Minnesota with the assistance of CSREES, the NRCS, and the U.S. Environmental Protection Agency. It provides farmers with self-conducted assessments of farm operations that help identify current or future environmental problems. It has been adapted for use in more than 40 States and Canada. A spinoff program, Home*A*Syst, is under development for rural homeowners. The USDA's Water Quality Program provided technical and financial support for its development.

Regional educational and technical assistance addressing agricultural nonpoint source pollution in the Great Lakes, Estuaries of National Significance, Chesapeake Bay, Colorado River Salinity Control, and Gulf of Mexico also are coordinated through the WGWQ.

Three national meetings on water quality have been sponsored by the Water Quality Working Group: a general session in Washington, D.C., in 1991 in collaboration with the U.S. Geological Survey, a research conference in 1993 in Minneapolis, Minnesota, and a conference emphasizing technology transfer in 1995 in Kansas City, Missouri.

The WGWQ continues to provide information through the distribution of fact sheets ("Waterfax") about various aspects of the program. These are sent monthly to a mailing list of about 100 cooperators and other interested individuals and groups.

The WGWQ interacts regularly with other organizations, and has been an active participant in:

- The Interagency Task Force on Monitoring, which seeks to establish uniform protocols on monitoring and reporting water quality data, and the establishment of more useful Federal data bases on water quality.

- Joint sponsorship, with USGS and the American Institute of Hydrology, of major international conferences with member states of the Commonwealth of Independent States (formerly, the USSR). One was held in the Washington, D.C., area (May 1993); a second is planned for Tashkent, Uzbekistan (September 1996).

- Joint sponsorship, with EPA and the International Association for Water Quality, of an international conference dealing with "diffuse pollution"; one in Chicago (September 1993) and one in Prague, Czech Republic (1995).

- The sponsorship of occasional seminars on issues of concern to the water quality community. Commonly, in cooperation with USGS, development of reports on pesticide loadings to surface waters in the Midwest.

The USDA Water Quality Program continues to facilitate farmers' adoption of agricultural production practices that enhance or protect the quality of the Nation's water resources. The lack of a comprehensive monitoring program, as well as the nature of the natural processes involved, makes it difficult to document changes in water quality. The USDA role has been, and continues to be, one of helping farmers adopt environmentally benign practices.

This program is working; farmers are adopting such practices; loadings of agricultural chemicals and sediment from agriculture are decreasing. A commensurate water quality monitoring program would reflect these facts.

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