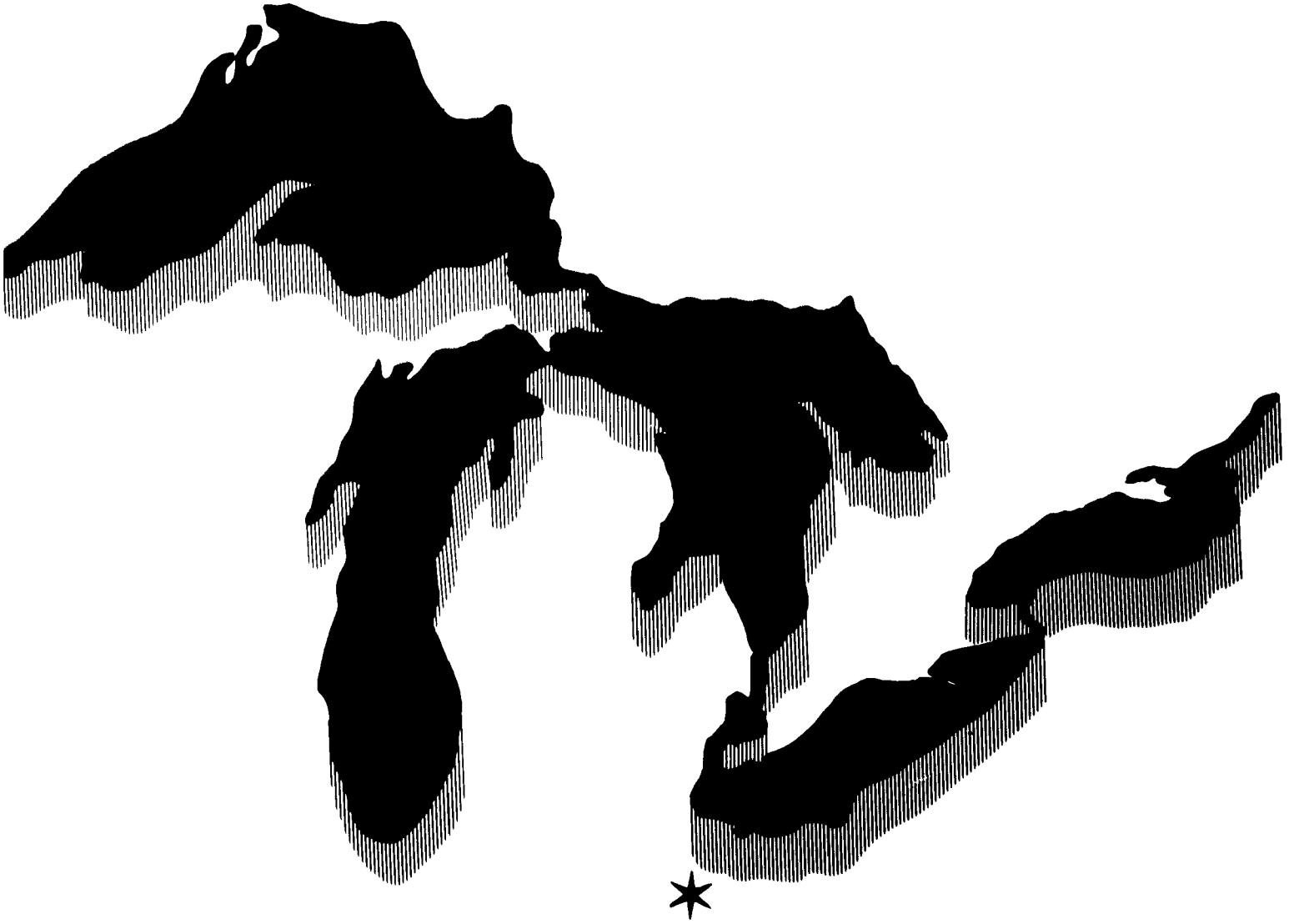
United States
Environmental Protection
Agency

Great Lakes National
Program Office
230 South Dearborn Street
Chicago, Illinois 60604

EPA-905/2-87-004
GLNPO No. 87-09
July 1987

EPA

Accelerated Conservation Tillage Demonstration Program 1981-1985



FOREWORD

The U.S. Environmental Protection Agency (USEPA) was created because of increasing public and governmental concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment.

The Great Lakes National Program Office (GLNPO) of the USEPA was established in Region V, Chicago, Illinois to provide specific focus on the water quality concerns of the Great Lakes. The Section 108(a) Demonstration Grant Program of the Clean Water Act (PL 92-500) is specific to the Great Lakes drainage basin and thus is administered by the Great Lakes National Program Office.

Several sediment erosion-control projects within the Great Lakes drainage basin have been funded as a result of Section 108(a). This report describes one such project supported by this Office to carry out our responsibility to improve water quality in the Great Lakes.

We hope the information and data contained herein will help planners and managers of pollution control agencies to make better decisions in carrying forward their pollution control responsibilities.

Valdas V. Adamkus
Administrator, Region V
National Program Manager for the Great Lakes

EPA-905/2-87-004
July 1987

GLNPO Report No. 87-09

ACCELERATED CONSERVATION TILLAGE DEMONSTRATION PROGRAM 1981-1985

FINAL REPORT

by

Ed Crawford
Jerry Wager

Division of Soil and Water Conservation
Ohio Department of Natural Resources
Fountain Square, Columbus, Ohio 43224

Section 108A Demonstration Program
Grant No. S005692

Ralph G. Christensen
Project Officer

John C. Lowrey
Technical Assistance

U.S. Environmental Protection Agency
Great Lakes National Program Office
230 South Dearborn Street
Chicago, Illinois 60604

December 1986

Disclaimer

This report has been reviewed by the Great Lakes National Program Office, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

PROJECT PARTICIPANTS

Auglaize SWCD
Crawford SWCD
Fulton SWCD
Hancock SWCD
Hardin SWCD
Henry SWCD
Huron SWCD
Lorain SWCD
Lucas SWCD
Medina SWCD
Mercer SWCD
Ottawa SWCD
Paulding SWCD
Putnam SWCD
Sandusky SWCD
Seneca SWCD
Van Wert SWCD
Williams SWCD
Wood SWCD
Wyandot SWCD

PROJECT STAFF

Jerry Wager, Program Manager
Ed Crawford, Field Coordinator

ACKNOWLEDGEMENTS

This report could not have been completed without the assistance of the following members of the Division of Soil and Water Conservation: Larry Vance, who provided departmental guidance; Paul Baldridge, who helped develop and guide the project's quarterly financial-match reporting system; Ed Crawford, who provided local leadership and supervision to the SWCDs on project management and Diane Browning who typed the report.

Thanks are also due to the following individuals for their technical expertise: Bruce Julian of the SCS, and Jim Lake of the CTIC who were instrumental in developing the project's plot data reporting sheets, as well as the analysis and reporting of the data; Ralph Christensen of the USEPA who provided quarterly project review and understanding supervision of the grants; John Lowery, SCS-Liasion to USEPA whose advice was invaluable to success of the project; and Dr. Donald Eckert of the Cooperative Extension Service - OSU, who provided assistance to the project administrators and participated in numerous workshops and tours.

Although the research described in this report was supported in part by grants from the Great Lakes National Program Office, USEPA, the agency makes no claim concerning the scientific accuracy of the information presented in this report.

TABLE OF CONTENTS

TABLES

FIGURES

INTRODUCTION

The Great Lakes contain the world's largest supply of fresh surface water. Lake Erie is the southernmost of the Great Lakes, the shallowest, and the lake with the most urban shoreline. These features have contributed to its current water quality problems. Lake Erie has a surface area of 10,000 square miles with a drainage area of about 12,000 square miles in Ohio. The State of Ohio controls approximately thirty percent of the Lake surface, including 240 miles of shoreline. Lake Erie contains 95 percent of Ohio's impounded waters. Twenty-five percent of the State's registered watercraft are used primarily on Lake Erie. In 1983, 750,000 anglers spent 9.8 million hours fishing its waters. The Lake serves as a water supply for more than two million Ohioans and is enjoyed by over thirteen million visitors through use of lakeside beaches, resorts and parks. Lake Erie represents one of Ohio's greatest economic, recreational and environmental resources, thus deserving to be one of Ohio's major environmental protection priorities (Ohio Phosphorus Reduction Strategy for Lake Erie, 1985).

Lake Erie is experiencing a "comeback" from the decades of the 1950's and 60's when national media announced its "death" due to excessive pollution. Problems associated with municipal sewage, industrial effluents, disposal of dredged spoils and land runoff eliminated or reduced many species of fish and aquatic organisms, closed beaches and contaminated water supplies. The most signficant water quality problem affecting the Lake was excessive inputs of phosphorus from urban and rural sources. Phosphorus contributed to large increases in algal populations, which created severe oxygen depletion in Lake waters as a result of decomposition. By 1965, over 5,000 square miles of Lake Erie

had oxygen levels less than 2 mg/l; thereby eliminating all but the most pollution tolerant life forms.

The degraded quality of Lake Erie, as evidenced by excessive algal growths, oxygen depletion and contaminated near shore areas, was the compelling reason why the governments of the United States and Canada signed a supplement to Annex III of the Great Lakes Water Quality Agreement in October 1983. The supplement calls for reducing annual phosphorus loads from more than 13,000 to 11,000 metric tons based on research indicating that such a level will return the Lake to a mesotrophic status and reduce the water quality degraded (oxygen depletion) area to less than 10 percent of the total Lake.

While initial efforts at phosphorus control focused on municipal and industrial waste treatment, current programs are now aimed at nonpoint source pollution control, principally agricultural runoff. The infusion of over $7.7 billion in federal funding since 1972 has reduced municipal discharges of phosphorus to Lake Erie from 11,900 metric tons to under 3,000 today. Municipal and industrial point sources contributed over seventy-five percent of all phosphorus in 1970; however, by 1984 these sources represented less than thirty percent. Today, agricultural runoff contributes nearly two-thirds of all phosphorus inputs into Lake Erie. Most of the nonpoint phosphorus transported to the Lake by its tributaries is attached to sediments eroded from intensively farmed cropland.

Conservation tillage, particularly no-till has the potential of decreasing total phosphorus loading to Lake Erie by over 2,000 metric tons per year (LEWMS, 1982). This amount of phosphorus control has the potential of achieving the international phosphorus loading reduction objective of 11,000 metric tons annually. More precisely, in the western basin of Lake Erie, conservation tillage, particularly no-till

methods, could reduce the annual gross erosion by 70 percent. Approximately 53 percent of the United States' Lake Erie Basin cropland is considered economically suitable for no-till and 80 percent is considered economically suitable for some form of conservation tillage.

In view of this, the United States Environmental Protection Agency's Great Lakes National Program Office (GLNPO) provided over one million dollars to twenty counties in Ohio between 1981 and 1985 to accelerate adoption of no-tillage and ridge-tillage systems. The Division of Soil and Water Conservation, Ohio Department of Natural Resources, administered the Accelerated Conservation Tillage (ACT) Program. Technical and educational assistance were provided by county soil and water conservation districts and coperative extension service offices, with coordination from the National Association of Conservation Districts' Conservation Tillage Information Center (CTIC). The Soil Conservation Service (SCS) and Agricultural Stablization and Conservation Service (ASCS) of the U.S. Department of Agriculture (USDA) assisted the efforts of local agencies. USDA efforts include the provision of Agricultural Conservation Program cost-sharing for conservation tillage and other best management practices. In addition to these efforts, Ohio's colleges and universities conducted a variety of investigations relevant to soil conservation and Lake Erie's water quality problems.

The primary objective of the ACT Project was to promote the adoption of no till and thereby reduce phosphorus delivery to Lake Erie by reducing cropland erosion. Through the project, soil and water conservation districts (SWCDs) were to:

1) make no till and ridge till equipment available for farmers,
2) provide on-site technical assistance to individual farmers to assist them in using new tillage techniques and equipment,

3) carry out an "accelerated information" education program including workshops, field days, tours, etc., and

4) evaluate the effectiveness of the program with respect to farmer participation, phosphorus and sediment load reductions and cost of treatment by comparing the cost of production for no till to conventional tillage on various soils.

The Cooperative Extension Service complemented the activities of SWCDs by providing information on pesticide and fertility management, as well as assisting the overall education effort.

CHAPTER I

AREA BACKGROUND

Physical Setting

The Accelerated Conservation Tillage (ACT) project was conducted in all or portions of 20 counties in north central and northwestern Ohio. Two additional counties in northwestern Ohio, Allen and Defiance carried out similar conservation tillage programs under separate grants from the Great Lakes National Program Office of USEPA. The specific counties included in the project and cooperating agencies are listed in Table 1. The project area encompassed approximately 6,600 square miles of cropland, the runoff from which eventually enters Lake Erie (Figure 1).

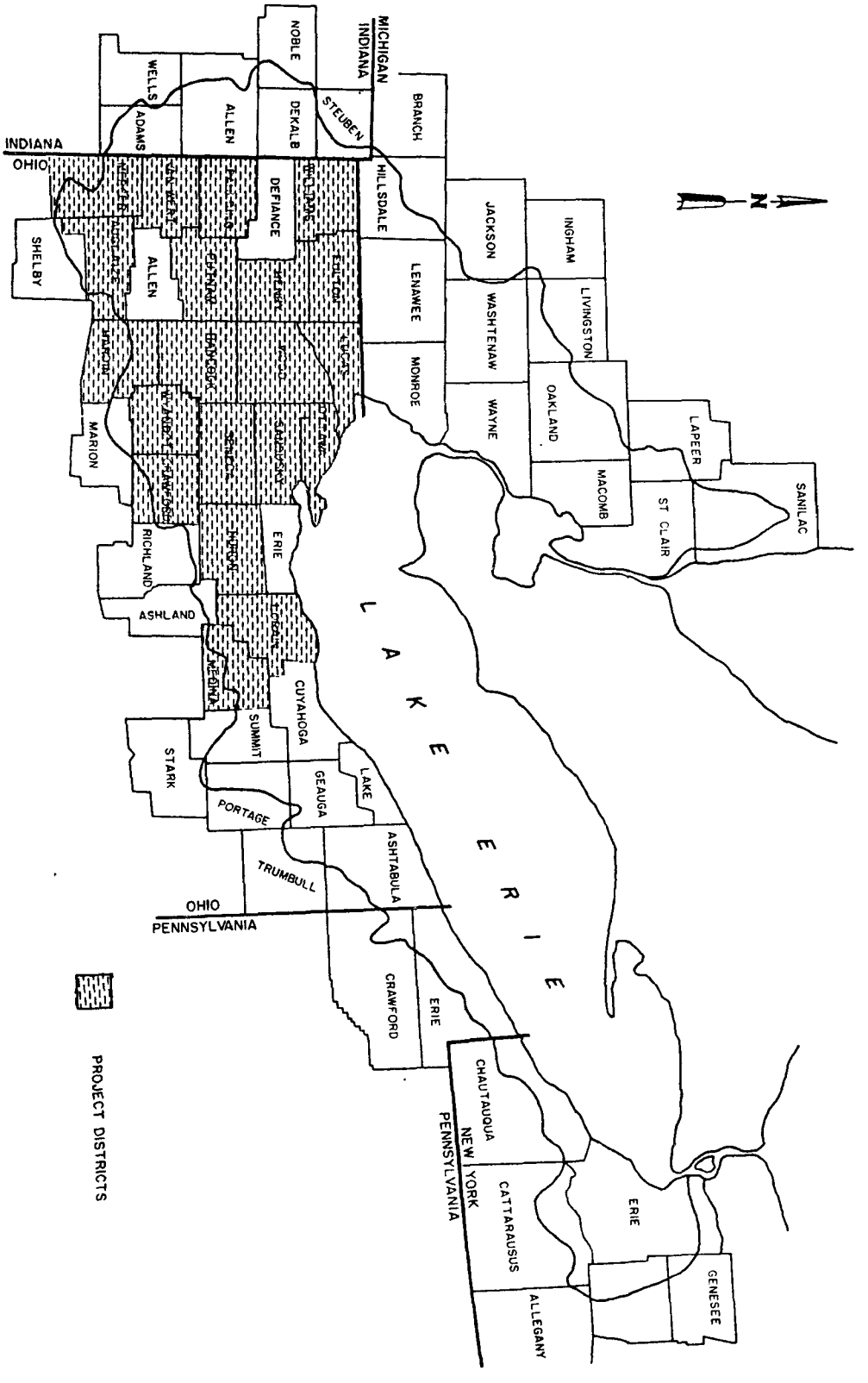
Table 1
Cooperating Agencies

Soil Conservation Service
Cooperative Extension Service
Agricultural Stabilization and Conservation Service
National Association of Conservation Districts
Ohio Department of Natural Resources

Ohio Soil and Water Conservation Districts

Auglaize SWCD	Mercer SWCD
Crawford SWCD	Ottawa SWCD
Fulton SWCD	Paulding SWCD
Hancock SWCD	Putnam SWCD
Hardin SWCD	Sandusky SWCD
Henry SWCD	Seneca SWCD
Huron SWCD	Van Wert SWCD
Lorain SWCD	Williams SWCD
Lucas SWCD	Wood SWCD
Medina SWCD	Wyandot

Figure 1: Ohio Accelerated Conservation Tillage Project Area



The project area is drained by several major rivers including the Maumee, Portage, Sandusky, Vermilion, Huron, Black, and Rocky Rivers. These rivers generally originate in Ohio's moraine region and flow north through the lake plain prior to entering Lake Erie. The two major tributaries, the Maumee and Sandusky, drain most of the project area. These streams are fed by smaller tributaries, the flow of which is derived from surface runoff and an extensive network of artificial surface and subsurface field drains.

Land Use

The predominant land use in the project area is crop production, including both cash grain and mixed farming enterprises. Only one county, Lucas (which includes the city of Toledo), can be classified as predominantly urban. Seventy-five percent of the farmland in the project area is used for the production of corn, soybeans, and soft red winter wheat; and although the specific crop mix varies somewhat between counties, most farmers follow a corn-soybean or corn-soybean-wheat rotation. Livestock farming is not important to the region as a whole; however, two important dairy areas are centered in Mercer/Auglaize and Lorain/Medina Counties. Commercial vegetable production (pickles and tomatoes) is important in Sandusky, Wood, Henry, Ottawa and Putnam Counties. An agricultural profile of ACT counties is provided in Table 2.

Table 2

Agricultural Profile of ACT Counties*

County	No. of Farms	Lands in Farms	Crop Acreage		
			Corn	Soybeans	Wheat
	(Thousands of Acres)				
Auglaize †	1020	180	47	57	19
Crawford †	760	171	50	66	19
Fulton	1290	227	78	64	19
Hancock	1310	295	81	134	48
Hardin †	620	135	35	51	16
Henry	1290	244	78	100	31
Huron	1090	249	59	80	20
Lorain	1080	150	25	53	10
Lucas	580	89	25	38	8
Medina †	930	99	21	14	5
Mercer †	1080	188	51	60	20
Ottawa	660	121	23	56	12
Paulding	790	229	52	92	37
Putnam	1600	290	70	120	43
Sandusky	1080	214	67	86	15
Seneca	1540	310	78	120	30
Van Wert	980	252	51	102	20
Williams	1080	217	55	64	26
Wood	1520	320	105	122	52
Wyandot	840	232	53	92	31
Total	21,140	4,212	1,104	1,571	481

* Data from Ohio Crop Reporting Service 1983
† Estimated as portion of county within Lake Erie drainage basin

Cropping Practices

Conventional tillage practices, including fall plowing, are dominant. The lack of perceptible erosion problems and the pervasiveness of poorly drained soils has inhibited the use of conservation tillage. For example, in 1981 prior to the onset of the ACT program, only five counties in northwestern area reported more than five percent no till corn, and only two reported more than one percent no till soybeans.

Soils

Soils and topography of the project area can be divided into two rather well defined regions, the glacial lakebed region and the moraine and till plain region surrounding it. The lakebed region includes all or portions of Ottawa, Sandusky, Lucas, Wood, Henry, Fulton, Putnam, Paulding, and Van Wert Counties. The remaining counties are in the moraine and till plain region.

The lakebed region is characterized by very level topography with very poorly drained, fine-textured soils. Several areas of sandy soils are also found within and surrounding the lakebed. The predominant soils are associated with the Hoytville, Paulding and Toledo series. These soils normally require drainage improvements for optimum crop production, particularly under conservation tillage. If these soils are provided with improved drainage, no till corn produces yields comparable to those achieved by moldboard plowing (conventional tillage). No till soybeans can be successful if phytophthora root rot pressures are not too great and appropriate steps are taken to manage the disease.

The moraine-till plain region borders the lake plain, mainly to the south and east. Topography is rolling to level; and soils of silt loam to silty clay loam texture are predominant. The major soil series of this region are associations of Morley-Glynwood-Blount-Pewamo and Alexandria-Cardington-Bennington-Pewamo. Ellsworth-Mahoning soils are present at the eastern end of the project area. Most individual fields consist of associations of two or more soils and require drainage improvements. Where drainage is installed, all but the most poorly drained fields can produce no till yields comparable to those obtained with conventional tillage.

Climatological/Weather Conditions

The general climatic patterns across the project area are shown in Table 3. Data were taken from the weather stations at Toledo, in the west-central area of the project, and from Cleveland, just east of the project area. The climate is generally quite similar across the entire area; however, a slight trend toward cooler and wetter conditions occurs from west to east.

Average climatic conditions are quite favorable for crop growth under most tillage systems. Adequate rainfall occurs throughout the growing season, which is approximately six months long. Spring field work and planting may be delayed intermittently by wet soil conditions, but fall weather is generally quite favorable for grain harvesting.

Table 3

Average Annual Growing Season Conditions in the ACT Project Area

Month	Precipitation		Growing Degree Days‡	
	Toledo	Cleveland	Toledo	Cleveland
	-----inches---------		---------GDD----------	
April	2.9	3.2	166	165
May	3.0	3.4	352	342
June	3.4	3.4	546	523
July	3.3	3.4	652	629
August	3.1	3.3	614	596
September	2.5	2.3	430	432
October	2.1	2.6	243	256
Total	20.3	21.6	3003	2943

Source: Ohio Crop Reporting Service

‡ GDDs represent heat accumulated and are calculated based on average daily temperature

Each of the ACT project years 1982-1985 were quite different, but not atypical of general growing conditions. The following yearly summaries describe general weather conditions during the ACT project.

1982

It first appeared that spring would be late and be a repeat of the cold, wet conditions in 1981. However, about mid April warm weather appeared and continued through late May. Farmers had almost six weeks of uninterrupted field work. These warm conditions had some drawbacks - soils became very dry about mid May, delaying planting. The lack of rainfall hindered herbicide effectiveness and allowed weeds to germinate later in the season. Showers came later in May and were timely all summer long. Growing temperatures as measured by growing degree days were above normal; this factor, in combination with the early planting dates, produced record yields of corn and beans in many areas.

1983

This was a frustrating year for farming. Starting in April, constant precipitation kept soil moisture at a surplus until mid June. Corn acreage was reduced considerably by the PIK Program[1]. The wet spring further reduced corn planting. Immediately following this wet season was a period of high temperatures and drought that persisted all summer. Harvest was delayed due to a wet fall. Statewide yields were down substantially.

[1] Payment-In-Kind (PIK) Program was a federal program implemented to reduce acreage devoted to several crops including corn.

1984

Almost a repeat of 1983, with a very wet spring which delayed field work and depressed soil temperatures until mid May. The cool wet spring changed to hot dry weather in June and July. Most crops received adequate moisture, but some experienced drought conditions. Weed control in soybeans was inconsistent and generally poor. Wet fall weather prohibited timely harvest, with some crops left standing. Statewide yields were above average.

1985

Planting started mid April and went on uninterrupted through May. Many farmers delayed planting until moisture levels increased. Herbicide effectiveness was hindered due to lack of rainfall, resulting in weed pressure later in the season. Rainfall returned in June and was adequate throughout the growing season. Crops matured earlier and were harvested in October. Rain came in November; in fact only a couple days were without rain, and unharvested crops were left standing. Yields were above average and better than 1982.

The 1982 and 1985 growing seasons were identical in that farmers had 6-8 weeks of uninterrupted field work. Both years farmers complained about the lack of soil moisture needed for germination. In some cases a neighbor using conventional tillage would lose soil moisture because of excessive tillage, while next door a no-tiller was planting. The no till crops got out of the ground more quickly and looked better all season.

Weather was not the only reason farmers were becoming interested in no-till. During this four year period (1982-1985), the profitability of crop production dropped drastically as interest rates and production costs increased. Many farmers were forced out of business, while others looked for cost cutting measures. To cope with falling prices and rising production costs, farmers sought ways to reduce time, capital and energy necessary for crop production. The search for more efficient production methods helped increase interest in reduced tillage.

Field Selection and Yield

Field selection is an important part of selling a conservation tillage system. Most soils in Ohio can be successfully converted to conservation tillage if managed properly. However, factors such as drainage, residue management, crop rotation, nutrient management, planting dates, variety selection, etc. become more problematic in poorly drained soils. In the ACT project area, 86% of the soils are poorly drained, with 44% being very poorly drained and 42% somewhat poorly drained.

To see how various forms of tillage responded to various soil types, analyses of yield by soil type and tillage type were performed: two major groups of soils, lacustrine and glacial till, which are common in the project area were studied. Typical lacustrine soils are Paulding and Toledo which are very poorly drained (VPD); glacial till soils are: Blount - somewhat poorly drained (SPD); Hoytville - very poorly drained (VPD); and Glynwood - moderately well drained (MWD). The data in Table 4 compare no-till and ridge till corn yields to those of conventional tillage on various soil types. Although these results do not necessarily reflect side-by-side field tests, the data clearly demonstrate the ability of no-till to do well on even some very poorly drained soils.

Sediment and Nutrient Transport

Several characteristics of the northern Ohio portion of the Lake Erie Basin have significant water quality impacts. Although much of the Basin in Ohio is relatively flat (less than 2% slope), fine textured soils and a dense drainage network result in very high transport of sediment and nutrients to the Lake. A nationwide survey of land uses and stream nutrient levels (Omernik 1977) indicated the following mean values for phosphorus and nitrogen export:

Watershed Land Use	Ortho-phosphorus kg/ha/yr	Total phosphorus kg/ha/yr	Inorganic Nitrogen kg/ha/yr	Total Nitrogen kg/ha/yr
≥ 75% Agriculture	0.094	0.255	3.26	5.54
≥ 90% Agriculture	0.118	0.266	7.81	9.54

However, total phosphorus export rates for the northwestern Ohio watersheds are four times higher than the mean values in the nationwide survey. Likewise, the orthophosphorus and inorganic nitrogen export rates are two - three times higher than the mean value in the nationwide survey (Lake Erie Wasterwater Management Study, 1982, p. 98).

For example, total phosphorus loads for the Sandusky and Maumee Rivers were 2.34 kg/ha/yr and 1.86 kg/ha/yr, respectively, in 1984. Suspended sediment loads for these rivers in 1984 were 843 kg/ha and 669 kg/ha, respectively. In 1984, nitrate-nitrogen area loads were 22.1 kg/ha for the Sandusky and 21.7 kg/ha in the Maumee.

High unit area loads result from intensive cropping, the lack of crop residue, very high soil phosphorus levels, fine textured clay soils, and a well developed artificial drainage system.

Fertilization

Another characteristic of the Lake Erie Basin affecting water quality is fertilization practices. Since the 1960s, phosphorus, nitrogen and potassium have been applied to cropland in ever larger amounts. Phosphorus levels in soils throughout Ohio increased over 300% between 1961 and 1985 according to data assembled by the Ohio State University Research Extension Analytical Laboratory (REAL) in Wooster, Ohio. Table 5 indicates the increase in phosphorus levels in the ACT counties between 1961 and 1985. Average soil phosphorus levels in the ACT counties are consistently higher than the state as a whole, but have increased at a comparable rate. It should be noted that average soil phosphorus levels in the ACT counties now exceed the recommended level of 60 lbs/acre by nearly 30%, with several counties having levels in excess of 100 lbs/acre.

Table 4

Corn and Soybean Yields for Various Soil Types

Soil Type	No-Till	Conventional	Ridge-Till
	Corn (bu/a)		
Glynwood (MWD)	95 (54)[1]	104 (171)	---
Blount (SPD)	99 (340)	97 (205)	101 (19)
Hoytville (VPD)	125 (138)	117 (87)	116 (32)
Paulding (VPD)	105 (147)	90 (19)	91 (22)
Toledo (VPD)	115 (17)	118 (15)	107 (12)
	Soybeans (bu/ac)		
Glynwood (MWD)	34 (38)	35 (12)	---
Blount (SPD)	32 (196)	33 (89)	32 (4)
Hoytville (VPD)	38 (92)	38 (62)	38 (24)
Paulding (VPD)	28 (27)	33 (29)	35 (18)
Toledo (VPD)	37 (51)	35 (30)	30 (11)

[1] numbers in ( ) indicate the number of test plots providing data. Data represent weighted average yields from side-by-side demonstration plots (1983-1984).

Table 5

Average ACT County Soil Phosphorus Levels,* 1961 - 1985

County	1961	1971	1980	1983	1984	1985
Auglaize	21	31	61	62	76	58
Crawford	21	36	56	59	57	52
Fulton	43	64	97	94	129	121
Hancock	25	43	62	67	78	58
Hardin	22	41	55	54	59	61
Henry	22	50	84	86	85	105
Huron	21	51	66	52	68	141
Lorain	14	26	49	47	49	47
Lucas	82	67	86	123	133	109
Medina	20	30	41	49	47	56
Mercer	30	36	68	66	67	73
Ottawa	27	49	79	61	80	84
Paulding	19	29	42	42	54	46
Putnam	25	49	60	50	107	67
Sandusky	23	52	70	78	93	101
Seneca	19	37	67	61	66	52
Van Wert	31	40	56	67	62	71
Williams	24	42	65	65	77	80
Wood	26	50	60	73	98	109
Wyandot	22	37	54	64	65	61

Project Avg.	26	43	63	66	77	77
State Average	18	35	58	60	67	70

*Bray P test, expressed as lbs/acre

Source: OSU, OARDC Research Extension Analytical Laboratory

CHAPTER 2

PROGRAM DEVELOPMENT

The Ohio Department of Natural Resources, Division of Soil and Water Conservation, administered the ACT program in Ohio and was the recipient of federal funds. ODNR passed funds through to county soil and water conservation districts for program implementation. Each district was given the latitude to tailor its program to achieve the following goals: the planting of ridge or no till demonstration plots ranging from 10 to 20 acres with 25 different farmers the first year, an additional 20 farmers the second year, and 15 more farmers the third year; with project goal of 40 cooperating farmers using no till or ridge till techniques as a routine practice in each county. As a long term goal, the project was aimed at continuing conservation tillage programs in each district, using trained personnel and equipment acquired as a result of the project.

Technical assistance and equipment were provided by districts to help demonstrate and teach the fundamental skills and principles necessary to successfully implement no till and ridge till crop production. Expertise of soil and water conservation districts was utilized to select cooperating farmers with soils and drainage conditions suited for no till and ridge till methods.

Each of the 20 soil and water conservation districts established a local tillage task force to help develop and oversee the program. Districts provided no till and ridge till equipment to farmers for 10 to 20 acres of side-by-side comparison plots. District employees provided one-on-one technical assistance regarding site selection, soil testing,

planting techniques, and yield checks. District and county extension agents initiated information and education programs to emphasize conservation tillage systems and pest management, as a complement to the demonstration plots. Stronger local involvement between the district and other agricultural agencies insured project goals and objectives were met.

Agency Roles and Responsibilities

Seldom have so many agencies worked together on a single conservation project of this size in Ohio. This multi-agency approach had a common goal "to accelerate the adoption of conservation tillage" to help combat the water quality problems in Lake Erie. The following briefly summarizes each agency's involvement.

USDA Soil Conservation Service (SCS) - SCS assisted in promoting conservation tillage in conjunction with conservation planning, training and supervising district staff, and providing technical assistance on the installation of erosion control practices.

USDA Agricultural Stabilization and Conservation Service (ASCS) - ASCS provided cost-sharing on tillage demonstration plots to offset costs of equipment rental and pesticides. They also provided lists of potential cooperators to assist districts in mailing information to landowners.

Cooperative Extension Service - County extension agents and agronomists provided information on nutrient and pesticide management. Extension analyzed soils for their suitability for no till and made fertility recommendations. The Department of Natural Resources, as part of the project, subcontracted with CES for help in conducting educational meetings, field days, grower workshops, and other activities.

ODNR, Division of Soil and Water Conservation - In Ohio, the Division is responsible for soil and water conservation and agricultural pollution abatement. The ACT project was administered by the Division, which passed through federal funds to 20 SWCDs. Division staff at the state and area level provided a variety of assistance, including fiscal accounting, recordkeeping, preparation of annual reports and collecting tillage data.

National Association of Conservation Districts (NACD) - NACD helped coordinate the ACT project on a regional level for Ohio, Indiana, and Michigan. The NACD Conservation Tillage Information Center (CTIC) at Ft. Wayne, Indiana, collected and disseminated conservation tillage information obtained from the projects. It also served as liaison between soil conservation agencies, USEPA, agricultural organizations and private industry.

Project Funding

The ACT program began in 1981 with the award of $500,000 by the Great Lakes National Program Office (GLNPO) to the Division of Soil and Water Conservation. The Division used these funds to contract with nine SWCDs, and created the position of a regional field coordinator. Twenty-four thousand dollars was provided to CES (OSU) to expand tillage education programs and publish technical information. In 1982, USEPA provided an additional $420,000 to the Division to contract with 11 additional SWCDs. In order for all district projects to end at the same time (December 1985), USEPA provided an additional $100,000 to extend the program of the nine original counties through the 1985 planting season. Total federal funds were $1,020,000.

The Division signed three year contracts with each SWCD, which then prepared a three-year financial plan to purchase, rent or lease equipment and/or hire personnel. Special Tillage Accounts were established by the districts. ODNR provided at least one quarter's anticipated funding needs so districts would have funds on hand with which to pay personnel and make equipment purchases.

District financial records were maintained and financial statements were submitted quarterly to the ODNR field coordinator who checked, compiled and published them in a quarterly progress report which the Division submitted to USEPA. These reports were reviewed and approved by USEPA, GLNPO officials during visits to the Defiance Area Office.

Maintenance of "in-kind" contributions of office space, personnel, etc. were a responsibility of each district. Since the grant required a local match of 25 percent, standard rates were established for time and materials contributed by the district and documented on bi-weekly time sheets. Time contributed by cooperators and supervisors was also utilized as match. Monthly time sheets were maintained for each cooperator and supervisor.

Table 6 summarizes federal, state, and district financial contributions. It is significant that the $1.02 million in federal funds actually "bought" a program whose total value was over $2.4 million, with the State of Ohio and the Soil and Water Conservation Districts contributing over 58% of total program costs.

State contributions included personnel, supplies, and office space. Contributions by districts included personnel, equipment, office space, materials and cooperator time. From a cost effectiveness point-of-view, federal funding of demonstration projects through soil and water conservation districts makes sense. Districts have very low overhead costs and

Table 6
Accelerated Conservation Tillage Project
Financial Summary

Soil & Water Conservation Districts	District/State Share	Federal Share
Auglaize	$89,833	$34,200
Crawford	35,452	58,300
Fulton	59,699	32,000
Hancock	47,755	58,300
Hardin	53,105	58,300
Henry	53,990	30,000
Huron	44,668	58,300
Lorain	48,711	58,300
Lucas	29,896	30,000
Medina	105,506	58,300
Mercer	56,506	30,600
Ottawa	79,156	29,600
Paulding	45,179	30,000
Putnam	58,347	58,300
Sandusky	35,730	30,000
Seneca	31,065	58,300
Van Wert	47,598	44,500
Williams	89,594	32,000
Wood	65,997	30,000
Wyandot	53,477	58,300
OSU Cooperative Extension Service	249,658	24,000
Div. of Soil & Water Cons.	47,644	118,400
	$1,428,487	$1,020,000
Total Project Cost	$2,448,487	State/Local 58.3% Federal 41.7%

usually contribute more resources to projects than they receive from federal grants.

Project Evolution

Most SWCDs in the project area have much in common: similar soils, drainage problems, level to gently rolling topography, and a preponderance of cash grain farming. Assuring adequate surface and subsurface drainage is a common programmatic concern of districts in northwestern Ohio. Several districts have large ditch maintenance programs, while others work closely with county engineers on group and/or petition ditches to improve agricultural drainage. District staff are highly trained in surface and subsurface drainage, which is a necessity when 95 percent of farmers' requests concern drainage. Drainage problems are foremost in supervisors minds. In lake bed soils for example, drainage improvements are usually a prerequisite to profitability.

Although drainage problems are a chief concern of most districts, in the late 1970's staff began to work with farmers on conservation tillage. Shifting priorities was slow, but as districts got into the ACT program, more of them began to understand and promote water quality related practices.

As technical advisor to districts, SCS, also began to shift its emphasis from drainage to more erosion oriented programs to improve water quality.

Since the beginning of the ACT program in 1981, all twenty SWCDs have shifted their priorities and goals to address conservation tillage and water quality in their long range programs. (Districts' long range programs identify conservation needs and opportunities to develop natural resources within each county.)

Project Staffing

Staffing of the ACT program differed from past demonstration efforts. The districts received only "seed money," rather than a large grant. Therefore, they were not able to add a full time experienced staff position. Districts received a total of approximately $35,000 for their three years of involvement. Several district boards were concerned about hiring individuals on "soft money" that would prevent retaining employees at the end of the project. Counties used a variety of approaches to overcome this problem; for example, Seneca and Crawford districts pooled their funds to retain an experienced project coordinator.

Using county appropriations and project funds, Fulton, Henry, Huron, Lorain and Williams districts hired full time technicians to work as tillage specialists. However, most districts utilized existing staff.

Although most technicians were trained mainly for engineering survey and design work, they adapted well to working on conservation tillage practices on a day-to-day basis. Because of their work with farmers on waterways and other engineering practices, most technicians could establish rapport with farmers and introduce them to the benefits of conservation tillage. Since basic training in conservation tillage was needed, training became an on going priority of state and federal support agencies.

At the state level, the Division's position of the Pollution Abatement Specialist for the northwestern Ohio area was expanded to serve as regional program coordinator. This person was charged with overseeing fiscal management, recordkeeping and project reporting. Other duties included training of district staff on planter adjustments, weed identification, soil testing, integrated pest management, general agronomy and program procedures. The project coordinator served as the link between ODNR,

Division of Soil and Water Conservation, and USEPA's Great Lakes National Program Office.

Equipment Management

SWCD boards arranged for use of no till equipment after consulting with cooperating agencies and others on the type of equipment (drills, planter with splitter, tractors) needed. Boards purchased or leased equipment by inviting local dealers to submit competitive bids. Arrangements varied from district to district on whether the district or the dealer moved the equipment. An insurance policy was provided to cover liability, theft, damage, etc. in either case. Some districts felt it was important to lease a tractor to stay with the planter to minimize drawbar and counter adjustments.

Project Guidelines

The guidelines for the ACT Project were listed as terms to be met by participating districts. The following summarizes the general responsibilities of the Boards of Supervisors and their staffs:

1. The Board shall create and/or cooperate with a conservation tillage task force in the development and operation of a no till and/or ridge till demonstration program. Such task force should involve representatives of pertinent agricultural agencies, farmers, agricultural and chemical industries,news media, and other representatives deemed helpful by the Board.
2. The Board will implement a tillage demonstration program with multi-agency involvement, providing information and education equipment and technical assistance.
3. The Board will secure or arrange through gift, lease, loan, or purchase the necessary no till and ridge till planting and

cultivation equipment, yield evaluation equipment or other equipment necessary to aid in demonstrating the use and effect of these methods of planting on cooperating farms.

4. The Board will recruit, employ in accordance with the employment policies of the Board and/or use existing personnel as most appropriate, and prioritize time of technical staff as necessary to operate an effective tillage demonstration program. Such program shall include, but not be limited to, soliciting cooperating farmers, teaching the fundamentals of no till and/or ridge till systems, equipment use, and fertilizer and pesticide management and assist with adjustment, calibration and operation of spraying, planting, fertilizer, and pesticide application equipment, assist with and/or arrange for adequate pest monitoring programs, and assist with and/or arrange for the evaluation of crop results and yield comparisons.

5. The Board and its staff will gather information, assemble data, and publish information in such a manner to be useful in promoting conservation tillage systems and in such form that results can be assembled and compared with data from other districts carrying out similar projects.

6. The Board and its staff will maintain adequate accounting and fiscal reports which fully disclose the amount, receipt, and disposition of the grant assistance provided and the total cost of the project, including the amount and identification of that portion of the cost of the project supplied by the district, the supervisors, cooperating farmers, other non-funded personnel and sources to provide the 25 percent local match; submit quarterly reports to the Chief or his representative within

seven days of the end of each calendar quarter; and assist with project evaluation, summarization and final report of achievements.

7. The Board and staff will promote adoption of conservation tillage in the critically erosive areas of the county. These critically erosive areas are identified by their potential soil loss according to their characteristics as outlined in the soil survey and other related studies.
8. The Board and staff will provide cooperating farmers with educational materials from Extension, et. al., on the latest information on fertilization, soils, pest management, and equipment use; and conduct training seminars jointly with various federal, state and local agency personnel.
9. During the growing season, the Board and staff will monitor demonstration plots, conduct tours, field days, and workshops to allow other farmers an opportunity to benefit from the program; and perform soil tests and provide results to the cooperator at little or no cost.
10. The Board will publish an annual report of comparisons and findings for distribution.

Agreements were drawn up by the districts with cooperating farmers, which included criteria on equipment use, maximum and minimum acreage to be planted, liability, acreage charges, and contribution of fuel for tractor after planting. The agreements emphasized the installation of side-by-side comparison plots planted under similar conditions. Instructions on proper seed, fertilizer, insecticide selection and application, record keeping and how to check yields were also a part of the agreements.

Uniform criteria for these agreements were developed for all ACT counties:

1. Planting will be done by the no till or ridge till method.
2. A conservation plan should be developed so all fields would not exceed acceptable soil loss value.
3. A minimum of 30 percent residue cover should be on the surface after planting. Measurements will be made within three weeks after the crop is planted.
4. The conservation treatment unit will be properly drained for the tillage system used.
5. Any other standards and specification for ridge till and no till planting in the individual states will apply.
6. The soil on each conservation treatment unit will be tested annually with fertilizer applied according to recommendations of the County Extension Agent.

Lastly, specific responsibilities were identified for district staff, including:

1. making contacts with farmers on a one-to-one basis in order to enroll active participants,
2. taking soil tests and weed inventories in plots;
3. helping with field selections (soils and drainage) and monitoring fields for weeds, insects, and disease before, during, and after the growing season,
4. helping farmers with the field adjustments and operation of equipment, and
5. promoting the program through tours, news articles, radio programs, fair displays, yield and soil loss reduction contests.

Project Funding

Over the four year project period three increments of federal funds were received by the Division of Soil and Water Conservation totalling $1,020,000. Table 6 summaries federal, state, and district funding. It is significant that the $1.02 million in federal funds actually "bought" a program whose total value was over $2.4 million, with the State of Ohio and the Soil and Water Conservation Districts contributing over 58% of total program costs.

State contributions included personnel, supplies, and office space. Contributions by districts included personnel, equipment, office space, materials and cooperator time. From a cost effectiveness point-of-view, federal funding of demonstration projects through soil and water conservation districts makes sense. Districts have very low overhead costs and usually contribute more resources to projects than received from federal grants.

The Lake Erie Tillage Task Force

During the first year of the Project (1981) a Lake Erie Tillage Task Force was set up to exchange technical and administrative information among federal, state, and local officials, provide interagency coordination and insure data collection and presentation were compatible to enable evaluation and comparison among projects.

The following agencies and institutions were invited to serve as members of the task force:

USEPA Great Lakes National Program Office

USEPA Region V Assignee from SCS

USEPA Region V Assignee from CES

USEPA Headquarters Water Planning Division

SCS State Conservationists from Ohio, Indiana, and Michigan

SCS Area Conservationists from Ohio, Indiana, and Michigan

SCS Headquarters, Water Quality Project Implementation Officer

ASCS State Directors from Ohio, Indiana, and Michigan

USACOE Lake Erie Wastewater Management Study Director

State Pollution Control Agencies from Ohio, Indiana, and Michigan

State Soil and Water Conservation agencies from Ohio, Indiana, and Michigan

State Cooperative Extension Service Directors from Ohio, Indiana, and Michigan

Area Extension Agents from Ohio, Indiana, and Michigan

National Association of Conservation Districts

Michigan State University

The Ohio State University

Purdue University

From this committee, four subcommittees were established for Training, Residue Cover, Agronomic Monitoring, and Water Quality Monitoring. Each county set up their farm assistance guidelines using the technical criteria drafted by the Lake Erie Tillage Task Force. The Agronomic Monitoring Committee developed a set of uniform data collection sheets for districts. A calendar of events also was drafted so counties could organize their project activities in a coordinated fashion.

CHAPTER 3

PROJECT ACCOMPLISHMENTS

Project Participation

Each ACT county had a primary goal, "to accelerate the adoption of conservation tillage". To accomplish this, they were given a specific objective of working with 20-25 farmers the first year; 15-20 farmers the second and 10-15 farmers the third year. This objective gave each district a common goal.

The counties experienced an overwhelming interest in the program, prompting many districts to create "standby lists" for farmers requesting assistance, but who were not able to be assisted during the initial stages of the project. From 1982 through 1985, the districts worked with 2159 cooperators (Table 7), averaging 32 cooperators per year, per district, over the last three years.

Table 7
Summary of Project Participation

Year	No. of Cooperators	No. of 1st Time Coop.	No. of Plots	Total Acres	No. Adopting**
1982*	216	194	415	4,053	92
1983	625	418	1,014	10,968	226
1984	684	355	1,251	14,443	290
1985	634	294	983	11,875	240
Total	2,159	1,261	3,663	41,339	848

*only 9 counties in project

**farmers continuing use of no till beyond the project's termination

Technical Assistance and Training

Ohio DNR staff took responsibility for setting up training for district, extension and SCS staff in Ohio, Indiana and Michigan, since the majority of participating counties were in Ohio. A two day technical training seminar was held in March 1982, followed by one day annual conferences for the tri-state area. A conservation tillage manual for all field staff was developed with the help of the project's Training Committee. Attendance at the tri-state sessions was generally in the 150-200 range.

Technical assistance to farmers and training of both staff and farmers were the most significant aspects of the project. Assistance included:

Site Selection - analysis of drainage, soil type, fertility, past insect or weed pressure, type and amount of previous crop residue.

Fertility Program - soil testing with recommendations for nitrogen, phosphorus, potash.

Herbicide Program - recommendations on substances, rates, methods of application, etc.

Integrated Pest Management - training of farmers to assess crop damage and use of pest scouts and district staff.

Equipment Use - teaching equipment adjustment to insure proper spacings and depth.

Calibration of Spray Equipment - setting up equipment or working with grain elevator personnel on custom applicator training.

Seed Variety Selection - encouraging use of hybrids that rated high in performance trials the previous year.

Grower Workshops - assisting County Agents and agricultural industries in providing farmers with updated chemical and fertility information.

Tours - holding tours following planting to get other farmers involved, and to show stand, weed control, and protective crop residue.

Harvest Checks - recording yield measurements.

Publications - preparing news articles and brochures to disseminate information and gain support of interested farmers.

Media - performing broadcasts on local radio and TV stations to inform the general public about the importance of the project, its results, and upcoming events.

Conservation Tillage Adoption

Table 8 indicates the total acres of no till from 1981 (prior to ACT) through 1985 in the 20 ACT counties for all farms. These county totals are based on estimates by SCS, SWCDs and other agricultural agency field personnel. Since 1983 they have been reported annually by the Conservation Tillage Information Center (CTIC) in Fort Wayne, Indiana.

As shown in Table 9, the ACT counties also experienced a rapid growth in ridge till acres, particularly in Auglaize, Hancock and Wood Counties.

Table 8
No-Till Acres, 1981-1985 For ACT Counties[1]

County	1981	1982	1983	1984	1985	Change From 82-85
Auglaize	4405	9553	16000	22200	17400	+ 7847
Crawford	5321	8910	18600	32750	36640	+ 27730
Fulton	1700	4000	4175	13060	26735	+ 22735
Hancock	1200	3680	3300	20700	19346	+ 15666
Hardin	7800	7800	7850	11060	12790	+ 4990
Henry	1450	3650	4300	5300	5139	+ 1489
Huron	4163	4744	21600	26800	35600	+ 30856
Lorain	5000	6500	6650	18000	23700	+ 17200
Lucas	50	500	1550	3220	2550	+ 2050
Medina	1944	2850	7155	22220	21375	+ 18525
Mercer	2000	4050	7100	9050	9840	+ 5790
Ottawa	-0-	1012	1700	9640	17950	+ 16938
Paulding	95	500	2300	3530	3923	+ 3423
Putnam	1870	2570	4600	5200	6350	+ 3780
Sandusky	119	613	2923	7040	9900	+ 9287
Seneca	4600	8000	15500	26750	21750	+ 13750
Van Wert	2092	2592	1875	2060	3800	+ 1208
Williams	2000	2050	4300	7001	12550	+ 10500
Wood	1050	1450	3350	10650	11510	+ 10060
Wyandot	5530	9400	13000	25300	25725	+ 16325
Totals	52,389	84,424	147,828	281,531	324,573	+240,149

1) Source: 1981 & 1982 - OSU Bulletin MM 399 "Tillage Practices & Equipment Used in Corn, Soybeans & Forage Products"; 1983-1985, CTIC, "National Survey Conservation Tillage Practices for Ohio".

Table 9
Ridge Till Acres, 1983-1985, for ACT Counties[1]

County	1983	1984	1985	From '83-'85
Auglaize	150	1200	3665	+ 3515
Crawford	100	400	275	+ 175
Fulton	-0-	300	-0-	+ -0-
Hancock	800	1905	2819	+ 2019
Hardin	300	1000	675	+ 375
Henry	600	1000	765	+ 165
Huron	-0-	-0-	200	+ 200
Lorain	-0-	-0-	-0-	+ -0-
Lucas	50	50	100	+ 50
Medina	55	-0-	55	+ -0-
Mercer	20	300	800	+ 780
Ottawa	202	100	-0-	- 202
Paulding	3500	5280	4013	+ 513
Putnam	400	550	200	- 200
Sandusky	644	1003	1600	+ 956
Seneca	1300	1650	1550	+ 250
Van Wert	225	500	750	+ 525
Williams	350	1100	400	+ 50
Wood	1000	1600	2050	+ 1050
Wyandot	1290	200	200	- 1090
Totals	10,986	18,138	20,117	+9,131

1 Source: 1983-1985, CTIC, "National Survey of Conservation Tillage Practices for Ohio."

Overall, the ACT program was very successful in accelerating the adoption of no till throughout northwestern Ohio. Table 10 compares the growth of no till in the ACT counties to the state as a whole. Although no till increased substantially in Ohio from 1982 to 1985, the ACT adoption rate was two and one half times higher. The existence of the ACT county tillage program during those years appears to be the major contributing factor for the large rate of adoption.

Information and Education

The information/education program was conducted by the Cooperative Extension Service in conjunction with SWCDs and SCS. All counties conducted educational programs, though the distribution of activities differed somewhat between counties. A summary of project wide activities is given in Table 11.

Information meetings for farmers consisted of planned programs generally held during the winter and early spring. Meetings dealt with all aspects of conservation tillage; however, some counties offered sessions on specialized topics such as sprayer calibration, fertilization, etc. Meetings for discussion purposes among project participants were also held in several counties.

Field tours included planned group visits to a farm or series of farms on which project plots and/or demonstrations were located. These tours (field days) were conducted during June and August and allowed farmers to observe and discuss the results of conservation tillage practices in the field. Tours often included presentations by state and area extension specialists, as well as technical representatives from agribusiness. Hands-on experience dealing with planter and sprayer calibration were included as a part of many of these events.

Press releases and articles included material prepared for mail distribution to farm operators and to local newspapers. Radio programs included both printed material sent to, and interviews on, local radio stations. Media efforts were quite important in that they reached a large group of farmers and others which would not otherwise participate in programs. Although a media audience count cannot be determined, it is conservatively estimated to be double the audience listed in the table.

Table 10

No Till and Conventional Acres
1982-1985

	Ohio		ACT Counties	
Year	No Till	Conservation Tillage	No Till	Conservation Tillage
1982	568,470	2,529,298	84,424	751,370
1983	671,180	2,719,914	147,828	730,805
1984	1,106,207	3,323,716	281,531	825,377
1985	1,263,351	3,722,901	324,573	1,114,529
Percent Change	122%		284%	

Table 11

Information and Education Programs Conducted During ACT

Activity	Number of events
Meetings	180
Field Tours	140
Press Releases & Articles	650
Radio Programs	200
TV Programs	15
Total estimated audience at meetings and tours	16,000*

* does not include mass media

Television is a relatively new outlet for Extension programming. Use often depends on the interest of local broadcasters and the availability of public service air time. Several counties utilized television as a part of their ACT programming, while others had no access to the medium.

In addition to county originated programs, state and area Extension specialists produced a yearly series of television programs dealing with crop production, which included several segments dealing with conservation tillage and water quality. These half hour programs were broadcast weekly throughout the winter from Bowling Green, Ohio and coverage included most of the project area.

In general, the information and education programs were quite successful in generating awareness and teaching the fundamentals of conservation tillage. The level of audience attendance and participation were quite encouraging, considering the historically limited interest in conservation tillage in the project area. Many of the County Extension Agents have commented, not only on the success of the program itself, but also upon the closer working relationships they have developed with their SWCDs as a result of the project.

Increased Farm Income

An issue facing anyone changing from an "old" established system to a "new" one is: "What are the costs, and is the system tested and proven?" "Can we no till on flat poorly drained soils without hurting farm income?" To answer these questions, the ACT program was set up to work closely with farmers to demonstrate workable conservation tillage methods that provided water quality benefits while enabling farmers to maintain or increase farm income.

The data in Table 12 reflect work done in Seneca County. The statistics shown here are not scientific or replicated, but are valuable in convincing farmers how no till performed in their county.

The measure of success in any new tillage system is net return. Table 12 data demonstrate that no till yields for corn and soybeans were consistently as good or better than conventional; and, in both cases, net returns for no till systems (corn & beans) were higher than conventional.

Profitability is a critical issue with farmers as they consider switching to conservation tillage. A survey of farm participants in the ACT program indicated that 73% would use conservation tillage (no till or ridge till) if these practices did not differ in profitability from conventional tillage. Thirty-two percent (32%) indicated they would make the switch if the net return of conservation tillage were within $10/acre of conventional. These survey results underscore the importance of careful record keeping to prove cost and net profit differences between conservation and conventional tillage.

Table 12
Average Yields and Net Return for Corn & Soybeans
(No Till vs. Conventional) Seneca County 1982-1985

Corn Demonstration Plots

Year	No Till		Conventional	
	Yield (bu/ac)[1]	Net Return ($/ac)[2]	Yield (bu/ac)	Net Return ($/ac)
1982	137	78	142	75
1983	111	119	106	93
1984	121	85	116	58
1985	149	88	144	62
Average	129 bu/ac	$92/ac	127 bu/ac	$72/ac

Soybean Demonstration Plots

Year	No Till		Conventional	
	Yield (bu/ac)	Net Return ($/ac)	Yield (bu/ac)	Net Return ($/ac)
1982	38	73	33	66
1983	39	173	39	177
1984	45	125	39	94
1985	49	108	50	116
Average	42 bu/ac	$119/ac	40 bu/ac	$113/ac

[1] Yields are weighted averages

[2] Costs include seed, lime, fertilizer, chemicals, machinery, and interest

Erosion and Phosphorus Reductions

The 1985 Ohio Phosphorus Reduction Strategy for Lake Erie estimated that 16 million tons of soil erodes each year from cropland in the Ohio portion of the Lake's watershed. Based on ACT demonstration plots, expanding conservation tillage, particularly no till, to an additional 1,000,000 acres could result in as much as a 60% reduction in gross erosion on these acres. Besides water quality benefits, erosion control reduces the cost of dredging Lake Erie's harbors. For example, the Maumee harbor, at Toledo, Ohio, has an annual dredging cost of $8,500,000, which is incurred by the Army Corps of Engineers for removing 1,215,000 tons of sediment each year.

Erosion rates are influenced by rainfall amounts, distribution, soil erodibility, percent and length of field slope, erosion control practices and surface cover. The last factor is one which farmers can most easily control through some form of conservation tillage. Demonstration plot data indicate an average reduction of slightly over 2 tons/acre in soil erosion on no till and ridge till plots compared with losses on conventional plots. Table 13 shows the estimated erosion and phosphorus reductions in the ACT counties from 1982 through 1985. Erosion estimates are based on differences in gross erosion between no till, ridge till and conventional tillage on ACT demonstration plots, 1983-1985. Values for 1982 were not available; therefore, 1983 erosion values were used to project 1982 erosion and phosphorus savings. Phosphorus reductions are based on estimates developed by Purdue University and reported by GLNPO and CTIC (1985), of 2 pounds per acre when conventionally tilled cropland is converted to conservation tillage.

Table 13

Estimated Erosion and Phosphorus Reductions Using No Till
ACT Counties, 1982 - 1985 (tons)

	1982	1983	1984	1985
Erosion Reductions	143,521	268,775	628,304	817,264
Phosphorus Reductions	84	159	300	345

While the ACT demonstration plots themselves did not produce significant phosphorus reductions, the acceleration of no till usage throughout the ACT counties did, annually reducing phosphorus loading by approximately 345 tons by 1985. Assuming that the ACT project was responsible for the disproportionate rate of increase in no till adoption in the project counties (284%) in relation to the entire state (122%), the ACT project may have been responsible for a significant portion of the Basin's total phosphorus load reduction.

It should be noted that conservation tillage increased from 751,370 acres to 1,114,529 acres during these same years. While sediment and phosphorus reductions are by no means as large on reduced tillage acres when compared with no till, nevertheless significant phosphorus reductions occur as a result of this practice. If phosphorus reductions from conservation tillage represent only a quarter that of no till, nearly three hundred tons of additional phosphorus load reduction occurred in 1985.

Given the large acreages yet to experience some form of conservation tillage in the Basin, it seems likely that an annual load reduction of 1000 metric tons is achievable through changing tillage practices on cropland.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

The ACT project capped several years of tillage system demonstrations in the Lake Erie Basin. State and federal agencies, particularly USEPA, recognized the need to address agricultural pollution during the mid-1970's. Using the findings of the PLUARG (Pollution from Land Use Activities Reference Group) Report in 1978, the Black Creek Project in Indiana, and special demonstrations in several Lake Erie Basin counties, a large scale region-wide application of conservation tillage practices was envisioned in 1980. Thirty-one counties in Ohio, Indiana and Michigan were enlisted to employ the methodologies developed by earlier demonstration projects.

While earlier projects were intensive, highly funded efforts, the ACT project was designed to demonstrate transition, making conservation tillage adoption a more routine activity with acceptable public costs.

Although the characteristics of soil and nutrient movement, the effects of conservation tillage, and the difficulties in securing adoption of the practice were largely known, the size and level of participation in the ACT project made it unique, and helped shape its outcome. The following summarizies the major conclusions of the project and offers recommendations for use by several levels of government in the design and implementation of future demonstration projects.

Conclusions

The United States and Ohio Phosphorus Reduction Strategies for Lake Erie rely on the widespread adoption of conservation tillage to meet the Lake's phosphorus loading goal of 11,000 metric tons/year. Although previous studies, particularly LEWMS, indicated the feasibility of this

approach, the ACT project has confirmed soundness of this strategy. By significantly influencing adoption rates in Northwestern Ohio and incorporating conservation tillage as a program priority of state, federal and local agencies, the ACT project provided the foundation for an ongoing, long term reduction of sediment and phosphorus transport.

Adoption of conservation tillage has not expanded at the rate envisioned by LEWMS; however, given the modest level of federal program funding for the ACT project, phosphorus reductions were significant. The ACT project, in combination with increased emphasis on conservation tillage nationwide, may already account for significant annual reductions in phosphorus loads to Lake Erie. Based on data developed by ACT and other projects, the conservation tillage strategy for achieving load reductions appears workable.

Another major outcome of the project was the broadening, and therefore strengthening, of soil and water conservation district programs. Districts have proven to be effective, low cost implementors of a variety of nonpoint source pollution control strategies. Their active involvement in agricultural pollution control in the Lake Erie Basin has proven to be a worthwhile state and federal objective. In the case of ACT, investment of federal demonstration funds not only resulted in a reordering of local conservation priorities, but also multiplied project dollars when matched with state and local personnel, equipment and materials. With limited funding in the federal future, the willingness of state and local agencies to match pollution control dollars should be a major criterion in pollution control planning and demonstration project selection.

The ACT project proved that existing district personnel can handle most special projects, with some specialized training. This finding is

significant in that it demonstrates that projects do not always require large sums to provoke a change. Small amounts of funds spread over several years help infuse project priorities into districts' long range programs. The key element of program maintenance occurs when Boards of Supervisors incorporate conservation tillage programs into the districts' overall conservation programs.

Attacking a pollution issue at such a broad level geographically and programatically also brought about a degree of interagency cooperation and focus unmatched previously. The Extension Service, SCS, ASCS, ODNR and districts were all involved in carrying out various parts of the program or providing complementary activities.

Chemical usage associated with no till is a major concern of environmentalists, and farmers as well. The ACT project, because of its length and geographic scope allowed local technicians to significantly improve their understanding of chemical use. As a result, recommendations for fertilizer use have become much more conservative. Evaluations of herbicide use on some 3,800 plots demonstrated that types and amounts used in no till were nearly the same as conventional tillage systems. Although the primary motive of the farmer is to reduce chemical input costs, a beneficial side effect of reduced chemical use will be improved water quality.

Project technicians also emphasized the need to reduce phosphorus fertilizer application by using proper soil testing programs to meet crop needs. On the average, farmers who did not get a soil fertility test, applied more than twice as much phosphorus as those who did. In one ACT study, participants who had soil tests applied an average of 24 pounds per acre, while those who did not applied an average of 55 pounds per acre. More than one-half of the farmers who had their soil tested elected not to apply any phosphorus fertilizer.

The project confirmed that significant erosion reductions occur under conservation tillage systems, even in flat, Northwestern Ohio. Actual no till field soil losses averaged 2 tons less per acre, or less than one-half the amount of conventionally tilled fields. Keeping the soil in place reduced delivery of sediment and phosphorus to streams and Lake Erie.

And, no till yields of corn and soybeans proved to be comparable with conventional tillage, in addition requiring less planting time and fuel consumption. While this finding came as no surprise to long term users of conservation tillage, it did prove the point to many who felt the practice should be restricted to hill ground and/or poorer soils.

Prior to the project, questions were continually raised as to how conservation tillage affected yields. Too many times it was assumed farmers could not use no till on flat fine textured soils without depressing yields by ten to fifteen (10-15) bushels per acre. As a demonstration project, ACT project participants set out to see if this was fact or fiction. Four years later, results from 3800 field plots demonstrated that no till can be successfully practiced. On a four year average, no till corn and bean yields were within one bushel an acre of conventional yields. Also, by rotating the crops, significant yield increases were observed. For example, no till corn in soybean stubble on a four year average was twelve bushels per acre higher than corn following corn, and no till soybeans in corn stalks on a four (4) year average were three bushels per acre higher than beans following beans.

Recommendations

Nearly ten years have passed since agricultural demonstration projects and intensive tributary monitoring began in the Ohio portion of the Lake Erie Basin. Much has been learned about nutrient and sediment export and farm practices, which both increase and reduce their movement.

Conservation tillage has come of age, and is now an integral part of local technical assistance programs. Lake Erie water quality has improved beyond expectations, resulting in a boom of expanding recreation and commercial development.

However, significant environmental problems remain, presenting challenges for public policy-makers and private landowners alike. Severe sedimentation, increased use of fertilizers and pesticides and loss of riparian habitat, all threaten the water achievements of the 70's.

Solving the environmental problems of Lake Erie in the future will require significantly greater investment resources by government. The nature of problems have changed, and traditional sources of funding have dried up. Nonpoint source problems will not be solved by quick fixes, or short term programs. A long term program of lake management, integrating the lake and its watershed, is essential. Continued improvement of the lake's ecosystem will also require consistent policies by federal, state and local governments. Otherwise, improvements in agricultural pollution may be offset by environmental losses brought about by near shore development.

The following recommendations focus on agriculture, attempting to reduce this source of pollution to acceptable levels. However, it is equally as important to develop a coastal management program to complement the efforts of the Lake's rural community.

Implementation of rural nonpoint pollution control should continue to rest with local agencies, primarily soil and water conservation districts. However, districts will require a variety of types of assistance from both state and federal government to meet agricultural pollution control expectations. Specifically,

1) Continued financial support, targeted for agricultural pollution control. While "no strings" program financing is necessary to maintain basic district services, special efforts aimed at critical areas and/or accelerated adoption of specific management practices should receive additional state and federal financial support. It is unrealistic to expect districts to expand their pollution control efforts in the face of declining local revenues, as well as the loss of federal demonstration funding which helped create pollution control priorities in the first place.

   Financial support should be stable and adequate to support the equivalent of a staff position in each SWCD, for the duration of Ohio's Phoshorus Reduction Strategy (1992).

   As a companion to program support, state and federal government should provide cost sharing or other incentive funding for installation of practices which have only long term benefits and/or require significant financial risk during trial periods.

2) Enhanced pollution abatement education aimed at farmers, must be a cornerstone of Extension programs and agricultural ciricula in Ohio. Pollution control responsibilities have often been taught grudgingly as something that farmers must do at a particular moment in time, rather than an essential part of earning a living on the land. Environmental ethics should be incorporated into university and high school vocational programs. Current farmers, and would-be farmers, need to understand that fertility and pesticide management, erosion control and manure utilization are cost effective practices that should be intergrated with their total farming operations. Greater liability for off-site damages, increased competition and lower government price supports dictate maximizing use of farm inputs while minimizing the risk of farming in a more complex society.

When major demonstration projects are initiated, extension and university programs should be heavily involved, providing guidance and data collection and reporting, farmer education programs, and planning periodic seminars and workshops to disseminate project fundings.

Farm industries and organizations need to be at the forefront of the education movement. Throughout the 70's and early 80's, these groups nervously watched the expansion of environmental regulation, often actively opposing incursions into the agricultural sector. However, both state and federal agencies have taken

the voluntary approach to agricultural pollution problems, focusing on the provision of assistance to the farmer rather than across-the-board regulation. Increasingly, farm organizations realize there is less to fear from these programs and more to be gained through cooperation. Public program managers need to build bridges with farm groups and solicit their involvement early in the project planning stage.

If grain and livestock associations, chemical manufacturers and distributors, and general farm organizations help devise management programs, they will feel more a part of any subsequent project and help publicize it.

Closer to home, local agencies can do much to foster the use of conservation practices. Demonstration plots, formation of local project steering committees comprised of farmers and farm distributors, and initiation of conservation tillage clubs all help expand knowledge about conservation programs.

Survey after survey of farm attitudes show that a majority of farm information comes not from public agencies, but from farm magazines, equipment and chemical distributors and farm organizations. Project and pollution abatement information should be directed through these outlets as much as possible.

3) Tracking pollution control progress needs to be given more attention by both state and federal agencies. Since conservation tillage is the cornerstone of Ohio's phosphorus reduction strategy, a reliable method is needed to assess adoption rates and their relative locations, the degree of residue cover being achieved, and the total chemical inputs in tributary watersheds. Several agencies need to cooperate in achieving more reliable data including the Cooperative Extension Service, the Soil Conservation Service, ODNR, Division of Soil and Water Conservation and soil and water conservation districts. Because of their contact with farmers and tillage assistance programs, districts should undertake the responsibility to collect data, within state guidelines. Information can then be provided to USEPA, ODNR and Ohio EPA for use in judging the effectiveness of control programs and determining areas where additional efforts are needed. Both the USEPA and Ohio EPA should share responsibility to help fund data collection efforts.

4) Identification of critical areas for application of resource management practices. Although adequate data exist to implement pollution abatement practices in the Basin, further refinement of critical problem areas should continue. Such areas should not be limited to areas of high gross erosion, but focus on areas which are sources of significant sediment and chemical loading, as well as areas which are not sources of pollutants, but can significantly reduce the delivery of pollutants if they are adequately protected, e.g. stream corridors.

Ohio EPA, ODNR and districts should cooperatively improve the state's delineation of critical areas to enable targeting of technical and financial assistance. Future technical assistance and financial resources should be directed at critical areas to maximize benefits and reduce treatment needs.

5) Federal and state support for research and monitoring must continue. A variety of research needs arose as a result of the ACT project, principally understanding the environmental consequences of increased use of conservation tillage. Although the demonstration plots indicated that pesticide use does not materially increase with conservation tillage, there is concern that the practice will increase total chemical use and accelerate the movement of chemicals into groundwater. The impact of conservation tillage on groundwater should be a major research priority over the next few years.

Secondly, the overall impact of herbicides on the ecosystem, particularly in tributary streams and nearshore areas should be examined. Understanding the complex interrelationships between chemicals and the environment, particularly in regard to chronic effects, requires long term research effort. Paired watershed research, as proposed by Heidelberg College and Ohio EPA, may help evaluate the comprehensive effects of changing tillage technology.

Extensive tributary monitoring should continue. Without this effort, there will be little ability to determine if changing

and management practices produce the qualitative changes as anticipated. It is a responsibility of both state and federal government to help support such monitoring. Continued support by GLNPO of the Lake Erie tributary monitoring program is essential. On the stateside, Ohio EPA should continue its support of USGS tributary stations and expand its overall monitoring program to address nonpoint source pollution issues.

6) Demonstration projects should continue to be a cornerstone of federal and state pollution abatement programs. Demonstration projects help focus agency attention on critical areas and resource issues which usually are not adequately addressed by on-going efforts. In designing future projects, program managers should make multi-year project commitments. At least one year is necessary to just put effective project management in place and begin to realize results of initial project publicity. Several years are necessary to incorporate changes into farm rotations and build a sense of program continuity and working relationships with cooperators. Multi-year commitments also are necessary to get maximum benefit from training farmers in new techniques, and to build momentum.

BIBLIOGRAPHY

Baker, David B., 1982, Fluvial Transport and Processing of Sediment and Nutrients in Large Agricultural River Basins, Heidelberg College, Tiffin, Ohio.

Beasley, David B., 1985, "Final Report of the Modeling Component Tri-State Tillage Project", Purdue University, West Lafayette, Indiana, 33 pp.

Great Lakes National Program Office, 1985, Lake Erie Conservation Tillage Demonstration Projects: Evaluating Management of Pesticides, Fertilizers, Residue to Improve Water Quality, Chicago, Illinois.

Ohio EPA, 1985, State of Ohio Phosphorus Reduction Strategy for Lake Erie, Columbus, Ohio.

U.S. Army Corps of Engineers, 1982, Lake Erie Wasterwater Management Study, Buffalo, New York.

APPENDICES

Conservation Tillage Definitions

Field Data Sheet for Conservation Tillage Demonstration Plots

Four Year Yield Summary for Corn and Soybeans (All ACT Plots)

CONSERVATION TILLAGE DEFINITIONS

Conservation Tillage - Any tillage or planting system that maintains at least 30 percent of the soil surface covered by residue after planting to reduce soil erosion by water; or where soil erosion by wind is the primary concern, maintains the equivalent of at least 1,000 pounds of flat grain residue on the surface during the critical erosion period.

Types of Conservation Tillage Systems

1) No-till - The soil is left undisturbed prior to planting. Planting is completed in a narrow seedbed approximately one to three inches wide. Weed control is accomplished primarily with herbicides.

2) Ridge-till - The soil is left undisturbed prior to planting. Approximately one-third of the soil surface is tilled at planting with sweeps or row cleaners. Planting is completed on ridges usually four to six inches higher than the row middles. Weed control is accomplished with a combination of herbicides and cultivation. Cultivation is used to rebuild the ridges.

3) Strip-till - The soil is left undisturbed prior to planting. Approximately one-third of the soil surface is tilled at planting time. Tillage in the row may consist of a rototiller, in-row chisel, row cleaners, etc. Weed control is accomplished with a combination of herbicides and cultivation.

4) Mulch-till - The total soil surface is disturbed by tillage prior to planting. Tillage tools such as chisels, field cultivators, disc, sweeps, or blades are used. Weed control is accomplished with a combination of herbicides and cultivation.

5) Reduced-till - Any other tillage and planting system not covered above that meets the minimum 30 percent residue requirement.

Technicians name:_____

District phone no.:_____

FIELD DATA SHEET

CONSERVATION TILLAGE DEMONSTRATION PLOT

1. Cooperators Name:_____
2. State:_____, County:_____, Year:_____
3. Plot Number:_____(Assigned by District)
4. Acres in Plot:_____
5. Comparison Plot Number(s):_____,_____,_____.
   (Complete another sheet on each comparison plot)
6. Predominant Soil Series:_____ (Enter only one) Example: Blount

   Slope: (Circle one) 0-2, 2-6, 6-12, 12-18, 18+.

   Erosion: (Circle one) Slight, Moderate, Severe.

   Drainage: (Circle one or more) Undrained, Random tile, Systematic tile, Surface.

   Soil loss: Average annual soil loss (USLE) with farmers normal rotation _____T/Ac./Yr.
7. Soil Test Result pH:_____, Available P_____lbs., Available K_____lbs.
8. Crop Planted: (Check one) Corn____, Soybeans____, Other (list)_____.
9. Previous Crop: (Check one) Corn____, Soybeans____, Other (list)_____.
10. Date Planted: ____/____/____ Type planter or drill used: [ ]
11. Planter Seed Drop:_____per Ac., Variety: [ ]
12. Row Width:_____inches.
13. Tillage Planting Method: (Check one or more)

    No-till_____, Ridge till_____, Conventional_____, Chisel_____,

    Disk_____, Other (list)_____
14. Residue Type: (Check one) If cover crop used, list

    Corn____, Soybeans____, Sm. Grain____, Sod_____, Sm. Grain/Green manure _____,

    Other (list)_____
15. Percent Soil Cover immediately after planting: (Circle one)

    Less than 25%, 25-50%, 50-75%, 75+%.
16. Emergence/Stand population _____(3 weeks after planting)
17. Ridge Height (3 weeks after planting) (Check one)

    Less than 3"_____, 3-6"_____, 6" +_____.
18. Cultivation (Number of times for) Weed control_____ Dates:____/____/_____,____/____/_____.

    Ridge Building_____ Dates:____/____/_____,____/____/_____.

19. Nitrogen Applied (Fill in as appropriate)
    a) Anhydrous Ammonia,_____lbs. actual N (Circle one) Fall applied,
    Spring preplant, side dress, other (list)_____ Date applied___/___/___.
    b) 28%,_____lbs. actual N (Circle one) Injected preplant, Injected sidedress, Broadcast,
    Dribbled in band, Other (list)_____ Date applied___/___/___.
    c) Urea,_____lbs. actual N, (Circle one) Broadcast, Incorporated Date applied___/___/___.
    d) Other (list)_____ _____lbs. actual N, Date applied___/___/___.

20. Total lbs. P205_____, (Circle) a) liquid, dry. b) broadcast, injected.

21. Total lbs. K20_____, (Circle) a) liquid, dry. b) broadcast, injected.

22. Row Starter fertilizer (Do not include above)
    Actual N_____lbs., P205_____lbs., K20_____lbs.

23. Herbicides:

Product	Check*	Date Applied	Rate/Ac.	Form	Carrier Gal/Ac.	Applied Farmer	Applied Custom

24. Insecticides:

Product	Check*	Date Applied	Rate/Ac.	Form	Applied Farmer	Applied Custom

* Check here for those pesticides NOT normally used in your conventional cropping operation.

25. Other Pesticides (List - Rodenticide, Fungicide, Product name, etc.)

Product	Date Applied	Rate	Applied Farmer	Applied Custom
	___/___/___			
	___/___/___			

26. YIELD:_____bu./Ac. "DRY"

27. Pest management monitoring by: (Check appropriate)
    Grower_____ Consultant_____ Extension Rep._____ SWCD Rep._____
    Other (list)_____, No Monitoring done_____

28. Limiting Factors (Circle one)
    Drainage, Herbicide Mngt., Insect Mngt., Fertilizer Mngt., Equipment, Weather,
    Other (Explain)_____

29. Rescue treatment used (describe)

30. $___.___/bu. Estimated production cost for this system by farmer (if known).

ACT Data for Corn & Soybeans during 1982 - 1985 (all plots)

CORN

Yield bu/ac (no of plots)

Tillage System & Rotation	1982	1983	1984	1985	4-Yr. Average
NoTill Corn after:					
Corn	120 (59)	101 (103)	123 (76)	139 (65)	121
Soybeans	141 (48)	101 (215)	139 (216)	151 (245)	133
Sod	136 (22)	85 (39)	135 (65)	134 (45)	123
Small Grain	121 (77)	83 (75)	139 (100)	144 (66)	122
No-Till all Rotations	123	97	134	145	125
Conventional	135	95	132	142	126
Ridge Till	126	96	113	141	119
Co. Stat. Report	112	90	121	130	115

SOYBEANS

Yield bu/ac (no of plots)

Tillage System & Rotation	1982	1983	1984	1985	4- Yr. Average
NoTill Soybean after :					
Corn	39 (41)	35 (202)	40 (122)	46 (121)	40
Soybeans	40 (16)	34 (121)	35 (96)	40 (44)	37
Small grain	36 (10)	21 (29)	37 (47)	37 (21)	33
NoTill, all Rotations	38	34	37	45	39
Conventional	41	34	39	46	40
Ridge-Till	53	42	33	44	43
Co. Stat. Report	33	35	37	41	37

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1 REPORT NO	2	3 RECIPIENT'S ACCESSION NO.
EPA-905/2-87-004		

4 TITLE AND SUBTITLE
Accelerated Conservation Tillage Demonstration Program 1981-1985, OHIO

5 REPORT DATE
July 1987

6. PERFORMING ORGANIZATION CODE
5GL

7 AUTHOR(S)
Ed Crawford
Jerry Wager

8. PERFORMING ORGANIZATION REPORT NO.
GLNPO No. 87-09

9 PERFORMING ORGANIZATION NAME AND ADDRESS
Division of Soil and Water Conservation
Onil Department of Natural Resources
Fountain Square
Columbus, Ohio 43224

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.
Grant No. S005692-01

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Great Lakes National Program Office
230 South Dearborn Street
Chicago, Illinois 60604

13. TYPE OF REPORT AND PERIOD COVERED
Final Report 1981-1985

14. SPONSORING AGENCY CODE
Great Lakes National Program Office, USEPA, Region V

15. SUPPLEMENTARY NOTES
Ralph Christensen-Project Officer
Section 108A Great Lakes Demonstration Grant

16 ABSTRACT

This project involved twenty counties in northwest Ohio to demonstrate no-till and conservation tillage methods to the farmers. Local Soil and Water Conservation District personnel were contracted by the Department of Natural Resources, Division of Soil and Water Conservation to demonstrate conservation tillage methods with their District farmers. Comparison fields of conventional and conservation tillage were done side-by-side and the data collected over a period of four years to evaluate yields, costs, time savings, fertilizer and pesticide use. Districts were allowed to purchase no-till equipment to be used in this project. The demonstration effort was to show sediment and phosphorus reductions in the runoff as result of the tillage practice to improve the water quality in Lake Erie.

17. KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b.IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Tillage No-till Conservation Tillage Conventional Tillage Fertilizer Pesticide Planters Erosion Water quality Sediment Nutrients		

18 DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Document is available to the public through the National Technical Information Service(NTIS), Springfield, VA 22161		68
	20. SECURITY CLASS *(This page)*	22. PRICE

EPA Form 2220-1 (9-73)

★U.S. GOVERNMENT PRINTING OFFICE: 1987 - 744-956