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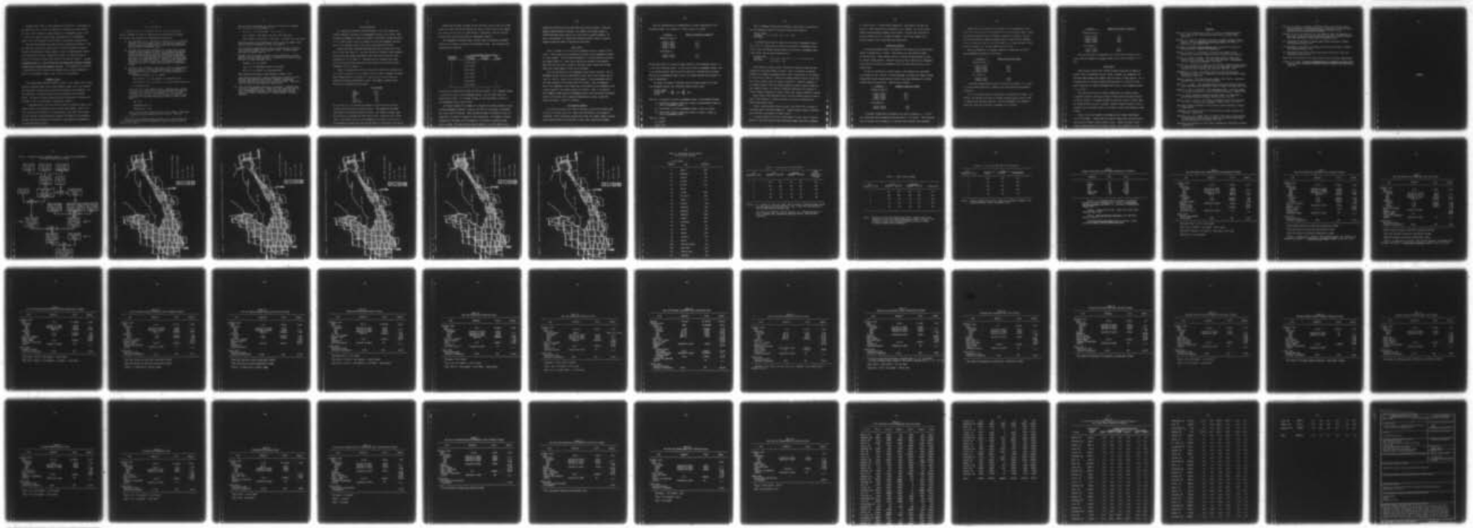

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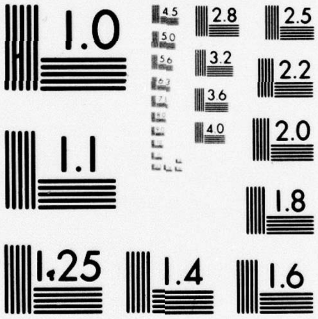

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ECONOMIC IMPACTS OF CHANGING TILLAGE PRACTICES IN THE LAKE ERIE BASIN.

9 Technical rept.,

by

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ABSTRACT

Reduced tillage technologies may be the most cost effective practices for reducing pollutant loadings from agricultural lands. A model has been developed to predict the changes in net farm income in the Lake Erie Basin based on soil types and their associated yield characteristics along with commodity prices and crop production costs. Output of the model includes (a) net return per acre by crop, by tillage system, by county, and by soil series; (b) acres in each county by soil management group; (c) net return for each county by "management scenario"; and (d) net return for the Lake Erie Basin by "management scenario".

Soil types determine the economic success of reduced tillage farming. Well drained soils may exhibit greater crop yields under reduced tillage practices than under conventional farming techniques. Conversely, crop yields from poorly drained soils under reduced tillage are less than those under conventional tillage practices. Therefore, the quantity of well and poorly drained soils within an area determines the economic success of reduced tillage methods.

For the Lake Erie Basin reduced tillage farming of well drained soils with concurrent conventional farming of poorly drained soils may result in a one to six percent increase in the Basin net income compared to conventional farming of the entire watershed. On the other hand, utilization of reduced tillage practices on poorly drained soils with concurrent conventional farming of well drained soils may produce a decrease in Lake Erie Basin net income of one to four percent.

ABSTRACT (continued)

The application of reduced tillage farming to extremely poorly drained soils such as certain organic, alluvial, and fine textured soils is not recommended as very large decreases in Basin net income are expected. The above findings may change if farmer expertise is greater or less than the expertise applied to the experimental plots used for input data to the model.

INTRODUCTION

The Lake Erie Wastewater Management Study of the U.S. Army Corps of Engineers is to develop a recommended management program for agricultural sources of pollution. The procedure is to identify land management practices which reduce pollutant loadings in the Lake Erie Basin, to quantify the effects of these practices on pollutant loadings, and to determine the economic cost of implementing management practices which reduce pollutant loadings.

A host of management practices to reduce pollutant loadings are available including terracing, contouring, crop rotations, winter cover crops, diversion, grass waterways, outlet protection, stream bank protection, windbreaks, sediment basins, and reduced tillage technologies. While all of these management practices may have an impact of improving water quality, reduced tillage technologies seem to be the most cost effective practices to improve water quality. These technologies allow intensive row crop production while maintaining winter cover of the soil during erosion sensitive winter and spring months. Results of an earlier study in small watershed in the basin indicate that initial reductions in soil loss are inexpensive if reduced tillage technologies are adopted on selected soils (Forster and Becker).

The general purpose of this study is to determine the economic effects of using minimum and no tillage technologies in the Lake Erie Basin.[1]

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[1] Conventional tillage is moldboard plowing in the fall, winter, or spring followed by a disc, harrow, or field cultivator. Minimum tillage replaces the moldboard plowing with chisel plowing, discing, or field cultivating. With no tillage, weed control is accomplished with chemcials and the soil is not tilled. Reduced tillage refers to either minimum tillage or no tillage.

Specific objectives are:

(1) to determine the soil series in Lake Erie basin and the characteristics of these soils,

(2) to estimate gross returns and costs of production for major crops on each soil series in the Basin,

(3) to determine the effect of reduced tillage technologies on gross returns and cost of production for corn and soybeans,

(4) to develop a simulation model which represents the economic impacts of alternative crop management practices in the Lake Erie Basin, and

(5) to estimate the economic impacts for the Basin of adopting minimum tillage and no tillage technologies on selected soils.

MODEL PARAMETER EVALUATION

Soil Series Data

Soils vary widely over the Lake Erie Basin. Some glaciated soils are highly productive with high organic matter and level to gently sloping topography. These soils cover much of the western part of the Basin and are important sources of corn, soybeans, tomatoes, sugar beets and other row crops. At the other extreme are soils formed over sandstone and shale parent material, having low organic matter content, and are relatively unproductive with gently to steeply sloping topography. These soils are found in the eastern portion of the Basin.

The Buffalo District of the Corps of Engineers and Resource Management Associates (RMA) provided soil series data for the Basin. Briefly, for each county in the Basin, soil series were identified and the number of hectares of each soil series was listed. The RMA soils data for Monroe County, Michigan is shown in Table 1 as an example.

All soil series with a series reference number of less than 600 were considered to represent the cropland acreage in the counties.

The characteristics identified for each soil series were:

(1) corn yield under conventional tillage,
(2) soybean yield under conventional tillage,
(3) wheat yield,
(4) oats yield,
(5) hay yield,
(6) tomato yield,
(7) sugar beets yield, and
(8) soil management group

Yield Data

Yields represented the average yields that could be obtained from each soil. The sources of this date were primarily county soil maps from Ohio, Michigan, Pennsylvania, and New York counties.[2] In addition, a preliminary draft of "Soil Productivity Guide" from the Department of Agronomy at The Ohio State University was reviewed. This publication contained yield estimates for major Ohio soils. Dr. Shaw Reid, Associate Professor of Soil Science at Cornell University, provided unpublished data on yeilds by soil series in New York state. This data was thought to be the best available since most of the New York county soil map yield data is obsolete. Dr. Lynn Robertson, Professor of Soil Science at Michigan State University, provided published data on yields by soils series for Michigan counties. In short, an attempt was made to obtain the best yield data available since the economic impacts of alternative tillage systems depend largely on these yield estimates.

Soil Management Groups

Each soil series was placed in one of five soil management groups. These soil management groups were those identified by Triplett, et al. for Ohio soils.

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[2] County soil maps used to estimate yields were Wood, Henry, Putnam, Allen, Van Wert, Paulding, Erie, Huron, Richland, Summit, and Ashtabula counties in Ohio; Monroe county, Michigan; and Erie county Pennsylvania.

Information supplied by the Department of Agronomy at Michigan State University, Robertson, Shaw, and Urban was used to classify soils not found in Triplett, et al.

The following brief description of each of the five soil management groups is provided by Triplett, et al.:

> Tillage group 1 - Soils included in this group should have yield response to no tillage equal to or greater than conventional tillage. Soils are moderately well, well, and excessively well drained. They have silt loam, loam, sandy loam, or loamy fine sand surface texture. They are low in organic matter.
>
> Tillage group 2 - These soils should have yield responses to no tillage nearly equal to conventional tillage if soil drainage has been improved. These soils are somewhat poorly drained in their natural state. They have a silt loam, loam, sandy loam, or loamy fine sand surface texture. They are low in organic matter.
>
> Tillage group 3 - These soils yield less with no tillage than conventional tillage. They are somewhat poorly to very poorly drained. Tile does not provide adequate drainage. Surface texture is loam, silt loam, or silty clay loam. Most of these soils are low in organic matter.
>
> Tillage group 4 - Soils in this group may yield less with no tillage than conventional tillage. They are very poorly drained. They have surface textures of silty clay loam, clay loam, silty clay, or clay. They contain relatively high amounts of organic matter in the surface.
>
> Tillage group 5 - These are organic soils, alluvial soils, and certain fine textured soils. These soils do not respond well to no tillage corn.

Yield Indices

Yield indices were developed for reduced tillage systems for corn and soybeans. Each of the five soil management groups was assigned yield indices for corn and soybeans as shown in Tables 2, 3, and 4. These indices were based on the best available information. Ohio data was the most complete of any of the states in assessing yields with reduced tillage. A number of experimental trials conducted by the Ohio Agricultural Research and Development Center in soil management groups 1, 2 and 4 were the basis for the Ohio indices. Soils found in Indiana were assigned the same indices as Ohio soils.

Michigan soils (Table 4) were adaptations of Ohio data. In Michigan, no published data could be found to support the contention that yield indices were above 100 for reduced tillage systems on soil management groups 1 and 2. Hence, the reduced tillage yields on Michigan soils in management groups 1 and 2 were assumed to be the same as conventional tillage yields.

New York yield indices were based on little experimental evidence. Reid felt that well drained soils might result in the same yields for reduced tillage and conventional tillage systems. However, somewhat poorly drained soils would yield less than conventional tillage, and reduced tillage on poorly to very poorly drained soils would not be feasible (Table 4). On soil management groups 3, 4, and 5 in New York and Pennsylvania, yields on minimum tillage and no tillage were assumed to be zero. This assumption was expected to significantly affect results since minimum and no tillage systems were used on soil management groups 3 and 4 in part of the analysis.

Commodity Prices

After establishing each soil series' yields for corn (under three tillage systems), soybeans (under three tillage systems), wheat, oats, hay, tomatoes, and sugar beets, product prices and costs of production were estimated. For each commodity, a standard product price was estimated for the 1978-81 period. The basis for these estimates was price projections by Davidson and Ericksen of the U.S. Department of Agricultural (Table 5).

If implementation of soil loss control occurs on a national basis, price impacts need to be considered as done by Taylor and Frohberg. That is, as soil loss affects the quantity of crops produced, crop prices would change. For this analysis, incorporating price impacts was thought to be needlessly complex since the proportion of the nation's crop production represented by the Lake Erie Basin is small.

Costs of Production

Production costs were estimated by crop, by tillage system and by county. Estimates for costs of production are found in Tables 6 through 30. Briefly, the procedure for establishing the costs were:

(1) Data from Lines, et al. were used as a basis for cost of production estimates for Ohio and Indiana crops. Data from Nott, et al. were used as a basis for Michigan crops, and New York and Pennsylvania costs were based on Knoblaugh, et al.

(2) Equipment costs and labor requirements for minimum and no tillage technologies were adjusted to reflect cost estimates from Rask and Forster. These estimates resulted in minimum tillage equipment costs being about 8 percent less than conventional tillage equipment costs. No tillage equipment costs were about 10 percent less than those for conventional tillage. Similarly, labor requirements (hours/acre) were about 8 percent less with minimum tillage and 10 percent less with no tillage than requirements of conventional tillage.

(3) Fertilizer inputs depended on yield levels and soil characteristics found in each county. For Ohio and Indiana soils, the 1978-79 Agronomy guide was used to estimate the following relationship for each crop.

$$\text{Nitrogen (lbs/acre)} = a_o + a_1 \text{ (yield)}$$

$$P_2O_5 \text{ (lbs/acre)} = b_o + b_1 \text{ (yield)} + b_2 \text{ (phosphorus test)}$$

$$K_2O \text{ (lbs/acre)} = c_o + c_1 \text{ (yield)} + c_2 \text{ (cation exchange capacity)} + c_3 \text{ (potassium test)}$$

County data for cation exchange capacity, phosphorus test, and potassium test were county soil test results from the Ohio cooperative Extension Service (Follett and Trierweiler).[3] Thus, each soil series in each county had a uniquely determined fertilization rate. For example, the following values were obtained for Seneca county, Ohio.

CEC = 17.1

Phosphorus test = 37.

Potassium test = 224.

One of the soil series found in Seneca county is Blount. Conventional tillage corn yield was estimated at 102 bu./acre. Thus, the

---

[3] Values for cation exchange capacity phosphorus test, and potassium test for soils in Indiana counties were assumed to be equal to those on soils in adjacent Ohio counties.

fertilizer application rate for conventional tilled corn on Blount soil in Seneca county was assumed to be

$$\text{Nitrogen} = -110 + 1.876\ (102) = 81.4\ \text{lbs./acre}$$

$$P_2O_5 = 18.838 + .333\ (102) - .355\ (37) = 39.4\ \text{lbs./acre}$$

$$K_2O = 84.844 + 1.616\ (17.1) + .25\ (102) - .33\ (244) = 64.1\ \text{lbs./acre}$$

Equations developed for fertilization rates on Ohio and Indiana field crops are shown in footnotes of Tables 6 through 14.

Ohio and Michigan specialty crop costs of production were from "Ohio Crop Enterprise Budgets, 1978, Specialty Crops." Detailed budgets are found in Tables 15 and 16.

Michigan field crop costs of production were developed in a similar method as the Ohio field crop costs. Information from Warnke, et al. was used to develop equations such as

$$\text{Nitrogen} = a_o + a_1\ (\text{yield})$$

$$P_2O_5 = b_o + b_1\ (\text{phosphorus test}) + b_2\ (\text{yield})$$

$$K_2O = c_o + c_1\ (\text{yield}) + b_3\ (\text{potassium test})$$

These equations are found in the footnotes of Tables 17-25.

Less precision was used to estimate Pennsylvania and New York fertilization rates than was done for Ohio, Indiana, and Michigan. Nutrient application rate was only a function of yield. These functions are shown in the footnotes of Tables 26-30.

(4) Land costs were excluded from costs of production. Although these costs are an important cost of production, they remain the same for all crop management practices. Thus, their exclusion does not affect the relative profitability of tillage systems or cropping patterns.

MODEL DESCRIPTION

The computerized simulation model developed for this study enables the economic impacts of alternative crop management practices to be traced. While the model was designed to compare the impacts of alternative tillage practices, it also could be used to trace the impacts of other crop management practices such as crop rotations, winter cover crops, contouring, and so forth.

Several data bases mentioned previously were used to develop the return and cost data (see Figure 1). The gross return data contained return estimates for each crop and tillage technology in each county and on each soil series (designated by "A" in Figure 1). Similarly the cost estimates were unique for each crop and tillage technology in each county and on each soil series (designated by "B" in Figure 1).

County crop acreage data (U.S.D.A.) was used to develop the proportions of each county's cropland in corn, soybeans, oats, hay, wheat, tomatoes, and sugar beets (designated by "C" in Figure 1). Every crop acre in the county was assumed to grow these proportions of crops. For example, Crawford county, Ohio had the following crop proportions:

	% of cropland
corn	31.7
soybeans	35.3
wheat	19.7
oats	5.3
hay	8.0
tomatoes	0.0
sugar beets	0.0

This proportion of crop acreage was assumed to be grown on each of the 38 distinct soil series found in Crawford county. This assumption overlooked some important differences between soil series. For example, sloping, unproductive soils were assigned the same crops as level, productive soils in each county. While hardly accurate, this assumption was necessary since data was not available to estimate the crops actually grown on each county's soil series.

Output from the model includes (a) net return per acre by crop, by tillage system, by county, and by soil series; (b) acres in each county by soil management group; (c) net return for each county by "management scenario"; and (d) net return for the Lake Erie Basin by "management scenario."

The "management scenarios" depict returns under the adoption of minimum tillage or no tillage on selected soil management groups. The following chart illustrates the scenarios.

Management Scenario	Soil Management Groups Using Conventional Tillage	Minimum Tillage	No Tillage
A	1,2,3,4, and 5		
B	2,3,4, and 5	1	
C	1,3,4, and 5	2	
D	1,2,4, and 5	3	
E	1,2,3, and 5	4	
F	2,3,4, and 5		1
G	1,3,4, and 5		2

In scenario A, conventional tillage is used on all soils. In B, minimum tillage is used just on soils in soil management group 1, and all other soils are conventional tilled. In C, minimum tillage is used exclusively on soils in soil management group 2 and so forth.

The primary purpose of the model is to analyze the economic impacts of each of these management scenarios. However, the model is structured to accomodate many other types of analyses. Basic assumptions might be modified to test the sensitivity of results to changes in these assumptions. For example, critical parameters in the model are the response of crop yields to minimum tillage and no tillage. The yield indices shown in Tables 2, 3, and 4 easily can be changed and the Basin simulation made with these modified indices. Other management scenarios might be analyzed. For example, the economic impact of substituting small grain crops for row crops could be quickly analyzed. In short, the advantage of a computerized simulation model is that it is able to analyze quickly any number of hypothetical situations.

MODEL RESULTS

First, the number of hectares by soil management group are shown for each county. These results aid in explaining the impacts of each management scenario on county incomes. Over 3.76 million hectares (9.30 million acres) in the Basin are modeled (Table 31). Fifty three counties are included in the analysis. While there are over sixty counties in the Basin, those counties are excluded where only a small number of acres are in the Basin.

Note the distribution of soil management groups within the Basin. Soil in management groups 1 and 2 are distributed in each county over the Basin and account for over 52 percent of the total cropland. Soils in management group 3 are found primarily in the eastern half of the Basin. Soils in management group 4 are negligible in the eastern part of the Basin but are predominant soils in many counties in the western portion of the Basin. Thus, it is expected that changing tillage systems on management group 3 soils will affect the eastern portion of the Basin, while changing tillage systems on group 4 soils will affect the western portion of the Basin.

Net Income by Scenario

Net income (excluding land costs) in the Basin totals $338.2 million under conventional tillage (Table 32). Again, the distribution of this income is noteworthy. While the western counties enjoy large net incomes, eastern counties have relatively small net incomes and, in some cases, negative net incomes.

With the implementation of minimum and no tillage technologies on soil management groups, net income in the Basin changes as follows:

Scenario	Change in Basin Net Income (%)
Minimum Tillage on	
- Group 1 soils	+1.3
- Group 2 soils	+4.9
- Group 3 soils	-3.7
- Group 4 soils	-1.2
No Tillage on	
- Group 1 soils	+2.2
- Group 2 soils	+5.9

The economic impacts of reduced tillage systems on soil management groups 1, 2, 3, and 4 are relatively minor. In the case of soils in management groups 1 and 2, net income actually improves with the adoption of minimum and no tillage. With soils in management groups 3 and 4, net income declines when minimum tillage is implemented.

To project the impact of adopting reduced tillage systems on all four soil management groups, the following formula would be used:

$$\begin{array}{l}\text{Precent change} \\ \text{in Basin Net} \\ \text{Income}\end{array} = \sum_{i=1}^{4} p_i a_i + \sum_{j=1}^{2} q_j a_j$$

where p_i = the percent of soils in management group i using minimum tillage,

a_i = the percent change in Basin net income by using minimum tillage on soils in management group i,

q_j = the percent of soils in management group j using no tillage,

a_j = the percent change in Basin net income by using no tillage on soils in management group j.

Also, $p_1 + q_1 \leq 1$,

$p_2 + q_2 \leq 1$,

$p_3 \leq 1$, and

Thus, if minimum tillage would be adopted on 100 percent of the soils in the four management groups, the Basin net income would change by:

Percent change
in Basin = 1.3 + 4.9 - 3.7 - 1.2 = 1.3%
Net Income

If minimum tillage would be adopted on 50 percent of management groups 1 and 2 soils, no tillage adopted on the other 50 percent of management groups 1 and 2 soils, and minimum tillage adopted on 100 percent of management group 3 and 4 soils, the net income change would be:

Percent change
in Basin = (.5) (1.3) + (.5) (4.9) - 3.7 - 1.2 + (.5) (2.2) +
Net Income (.5) (5.9) = 2.3%

While Basin net income actually improves with reduced tillage, the distribution of the income change is crucial. First, the adoption of minimum tillage or no tillage on management group 1 soils is beneficial to all counties as illustrated in Figure 2. Adoption of minimum tillage on group 2 soils does have adverse impacts on eastern counties (Figure 3). Similarly, adoption of no tillage on group 2 soils has adverse impacts on eastern counties (Figure 4). Even though the Basin's net income is improved dramatically with adoption of reduced tillage technologies on group 2 soils, some counties incomes are lowered.

Most counties would experience income loss when minimum tillage is used on group 3 soils (Figure 5). Western counties not facing an income loss are those without group 3 soils.

Finally, using minimum tillage on group 4 soils would affect counties in the western part of the Basin (Figure 6). Eastern counties would be relatively unaffected due to the absence of group 4 soils.

A detailed analysis of the net income impacts for each county is given in Table 32. Note the relatively large percentage changes occurring in Ashtabula

Co., Ohio; Erie Co., Pennsylvania; Crawford Co., Pennsylvania; and New York Counties. These counties have relatively low net incomes. Any yield changes produce large percentage changes in net incomes. Contrast this situation to western counties where net incomes are higher. There yield changes alter percent changes in net income much less dramatically.

Sensitivity Analysis

A critical assumption made in the model is the response of corn and soybean yields to minimum and no tillage. Yield indices are used which are based on research plots. These indices could be criticized as being biased in favor of reduced tillage systems. Reduced tillage may take a high level of management which exists on university experimental plots but which does not exist on the average farm.

To test the sensitivity of model results, yield indices are constrained to a maximum of 100. That is, no yield advantage is allowed for reduced tillage systems even though research results clearly show yield advantages for reduced tillage systems on some soils. Results are as follows:

Scenario	Change in Basin Net Income
Minimum Tillage on	
- Group 1 soils	+1.3
- Group 2 soils	+2.5
- Group 3 soils	-3.7
- Group 4 soils	-1.2
No tillage on	
- Group 1 soils	+2.3
- Group 2 soils	+4.4

If minimum tillage would be adopted on all soils in groups 1, 2, 3, and 4, net income under these assumptions would decrease by -1.1 percent. This contrasts with an increase in net income of 1.3 percent under expected yield responses.

Another test of the sensitivity of results to yield assumptions is conducted by varying reduced tillage yields for all soil management groups. First, each expected reduced tillage yield index is reduced by 5 percent. That is, the corn yield index for minimum tillage on group 1 soils in Ohio is assumed to be 95 rather than 100, the corn yield index for no tillage on group 1 soils in Ohio is assumed to be 98 rather than 103, and so forth.

With this assumption, the changes in basin net income under the alternative management strategies are as follows

Scenario	Change in Basin Net Income
Minimum Tillage on	
- Group 1 soils	-0.5
- Group 2 soils	+0.8
- Group 3 soils	-4.5
- Group 4 soils	-5.5
No Tillage on	
- Group 1 soils	+0.3
- Group 2 soils	+1.8

If minimum tillage would be adopted on all soils in groups 1, 2, 3, and 4, net income would decline by 9.7 percent in the Basin under these pessimistic assumptions.

Next, each expected reduced tillage index is increased by 5 percent. For example, the soybean yield index for minimum tillage on group 2 soils in Ohio is assumed to be 108 rather than 103. With this assumption, the changes in basin net income with alternative strategies are as follows:

Scenario	Change in Basin Net Income (%)
Minimum Tillage on	
- Group 1 soils	+3.2
- Group 2 soils	+9.1
- Group 3 soils	-2.9
- Group 4 soils	+3.1
No Tillage on	
- Group 1 soils	+4.1
- Group 2 soils	+10.0

Under these optimistic assumptions, net income would increase by 12.5 percent with the adoption of minimum tillage on all soils in groups 1, 2, 3, and 4.

CONCLUSIONS

These results indicate that reduced tillage systems have an impact on yields, costs of production, and net income. However, net incomes for the Lake Erie Basin change only slightly with the advent of these systems. It is estimated that net incomes actually would increase 0 to 3 percent if minimum tillage and no tillage technologies were used on soil management groups 1, 2, 3, and 4.

Not every soil series is suitable economically for reduced tillage. If minimum tillage is used only on group 3 soils, Basin net income declines by about 4 percent. If minimum tillage is used only on group 4 soils, Basin net income declines by about 1 percent. Reduced tillage on group 5 soils is excluded from the analysis since it is thought to have severe negative income effects.

Group 1 soils are suitable for minimum and no tillage technologies over all the Basin. Yields remain the same or improve and costs are reduced when reduced tillage is used on group 1 soils. Almost all group 2 soils produced improved profits with reduced tillage. The exception is in the

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APPENDIX

Figure 1. Simulation Model of Economic Impacts of Alternative Crop Management Practices in the Lake Erie Basin

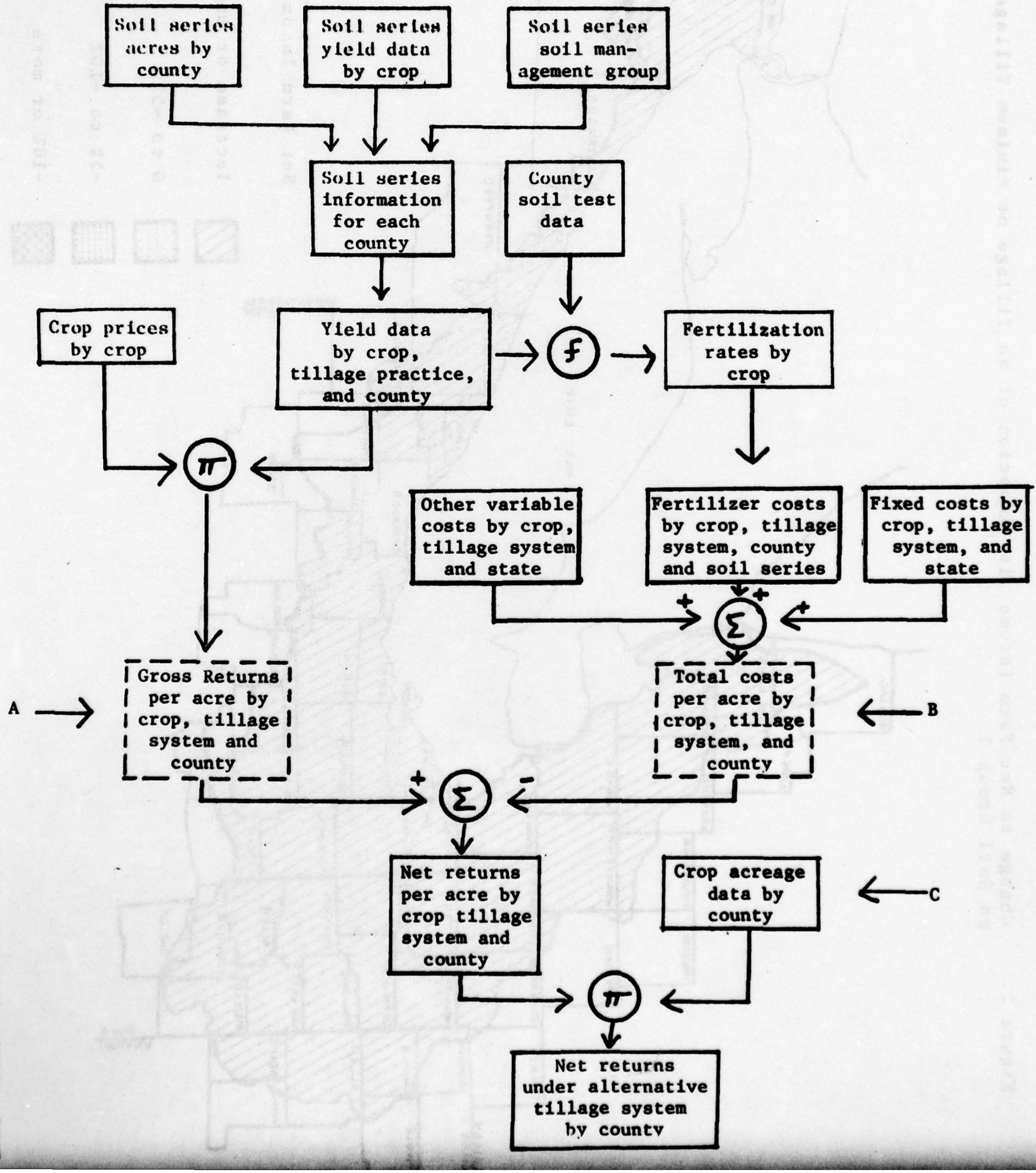

Figure 2. Change in Net Farm Income With Adoption of No Tillage or Minimum Tillage on Soil Group 1

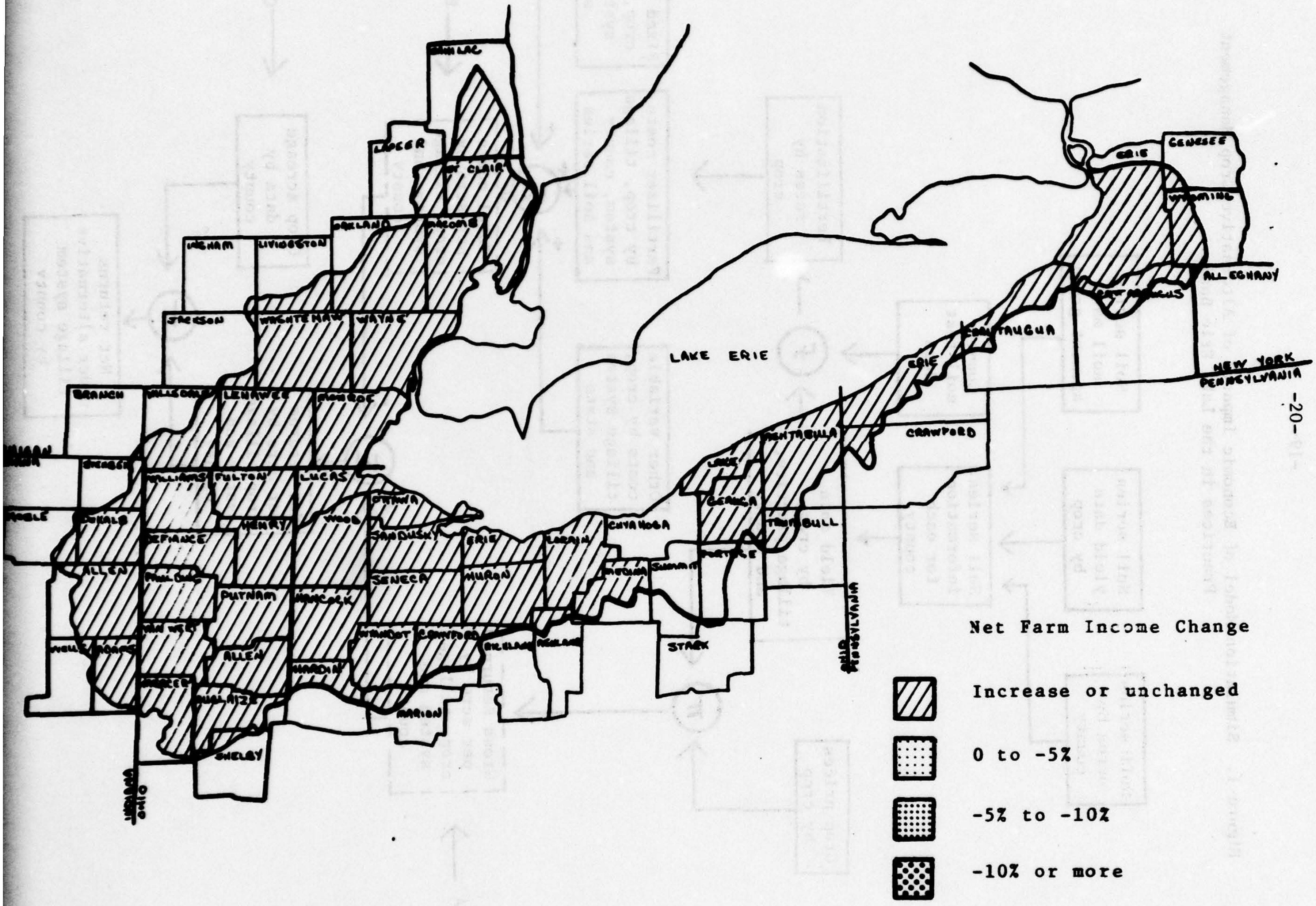

Figure 3. Change in Net Farm Income With Adoption of Minimum Tillage on Soil Group 2

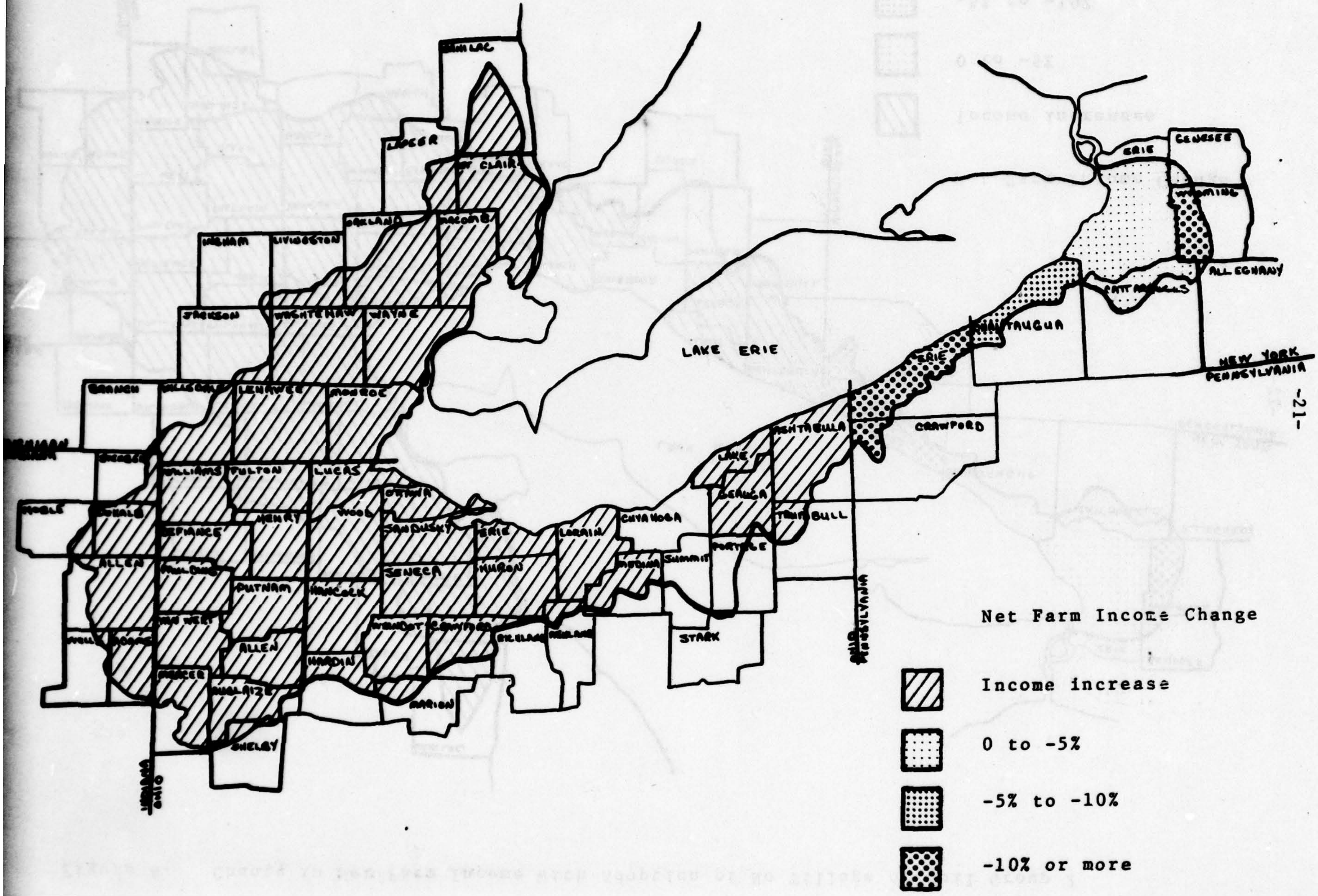

Figure 4. Change in Net Farm Income With Adoption of No Tillage on Soil Group 2

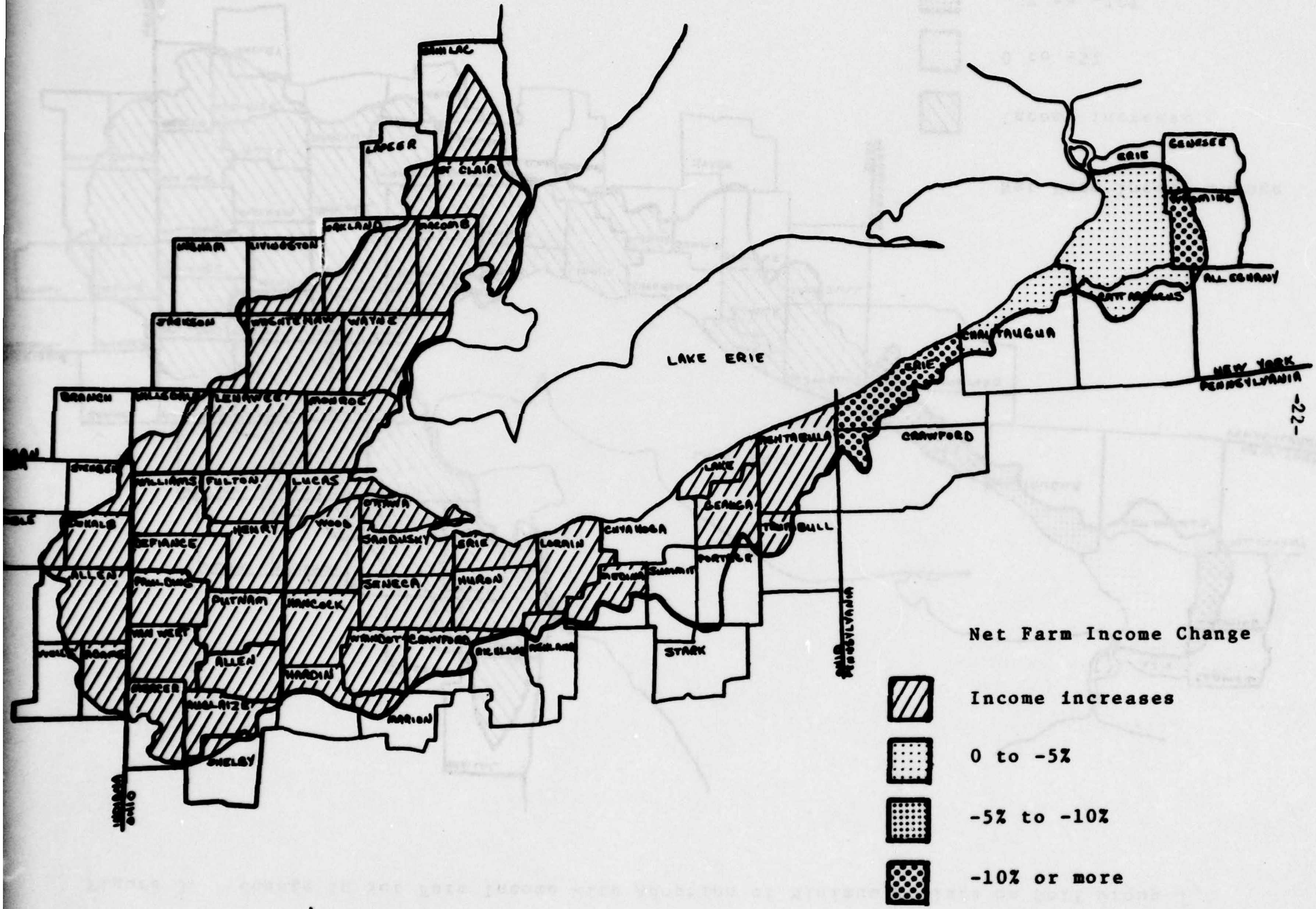

Figure 5. Change in Net Farm Income With Adoption of Minimum Tillage on Soil Group 3

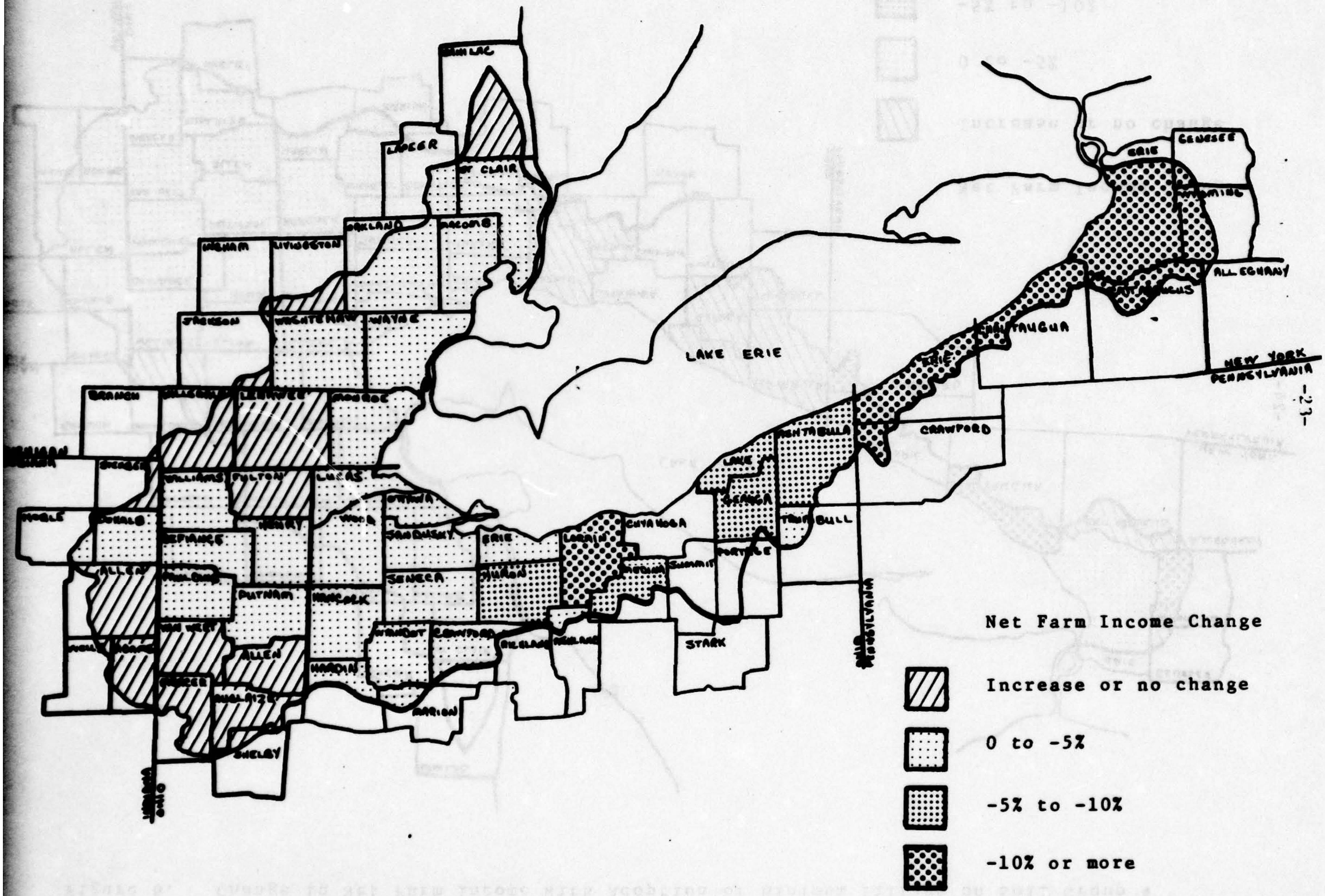

Figure 6. Change in Net Farm Income With Adoption of Minimum Tillage on Soil Group 4

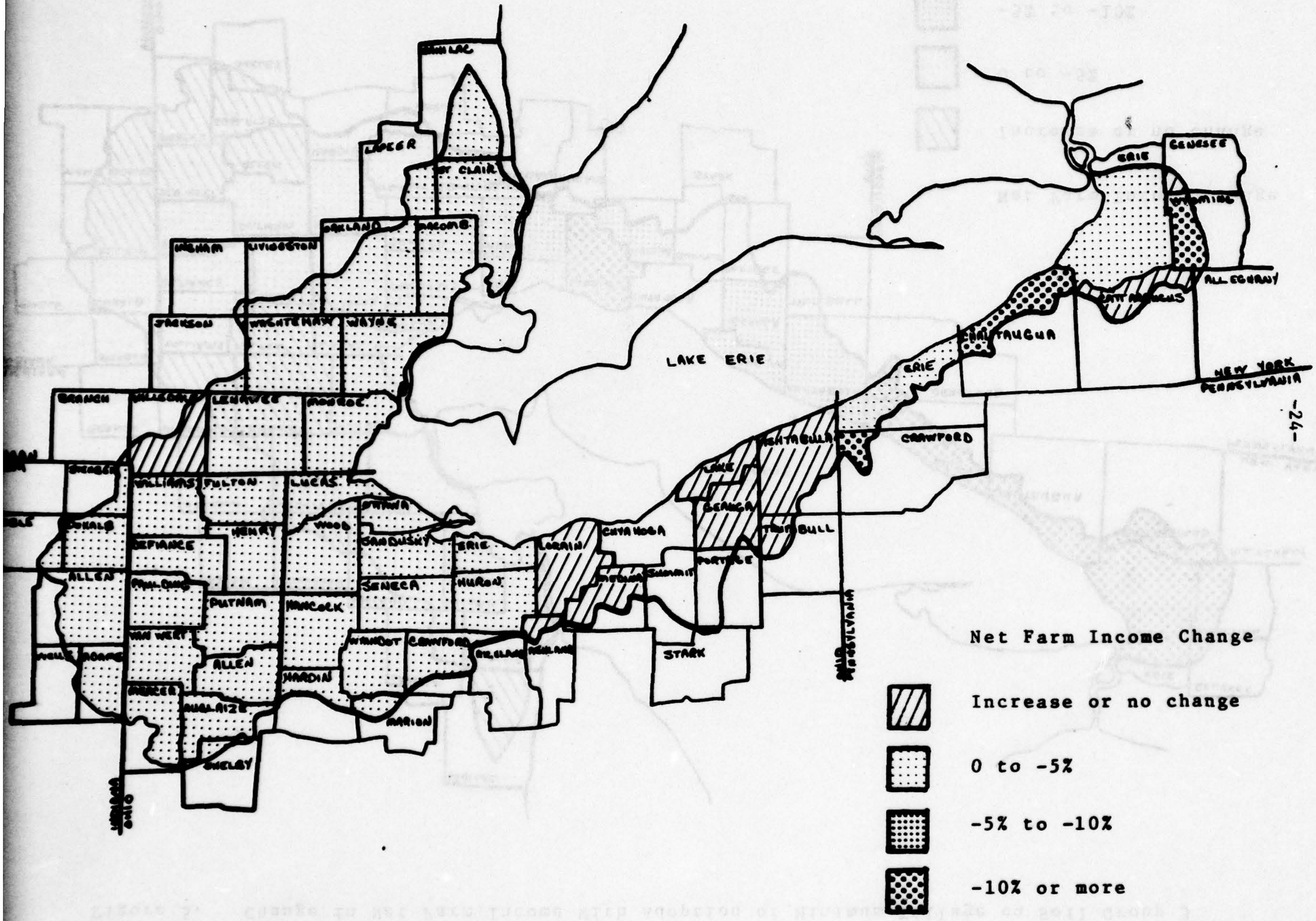

Table 1. Total Area of Soil Series, Monroe County, Michigan

Soil Series Reference Number	Name	Area (Hectares)
9	Blount	1560
10	Randolph	220
23	Colwood	404
24	Corunna	612
28	Del Rey	2580
38	Fulton	8
40	Granby	2232
43	Hoytville	1768
46	Kibbie	532
50	Lenawee	2720
57	Metamora	708
62	Nappanee	296
63	Oakville	2920
73	Pewamo	3080
82	Selfridge	1444
88	Sloan	216
89	Spinks	300
93	Tedrow	2612
94	Thetford	676
98	Wasepi	84
600	Multiple series	452
610	Non soils	1428
615	Missing data	268
620	Variants	592

Table 2. Yield Index, Ohio and Indiana

Soil Management Group	Corn Minimum	Corn No till	Soybeans Minimum	Soybeans No till	Corn Soybeans Conventional Tillage
1	100	102	100	100	100
2	105	104	103	103	100
3	90	85	90	85	100
4	96	87	95	91	100
5	NA	NA	NA	NA	100

Sources: D.L. Forster, N. Rask, S.W. Bone, and B.W Schurle, "Reduced Tillage Systems for Conservation and Profitability," Dept. of Ag. Econ. and Rural Soc., ESS 532, Ohio State University, 1976.

S.W. Bone, D.M. VanDoren, and G.B. Triplett, Jr., "Tillage Research in Ohio," Bulletin 620, Cooperative Extension Service, The Ohio State University.

Table 3. Yield Index, Michigan

Soil Management Group	Corn		Soybeans		
	Minimum	No till	Minimum	No till	Conventional
1	100	100	100	100	100
2	100	100	100	100	100
3	90	85	90	85	100
4	96	87	95	91	100
5	NA	NA	NA	NA	100

Source: Adaptation of Ohio and Indiana Yield Index. Groups 1 and 2 were adjusted to allow for no yield advantage from reduced tillage. This assumption is made since published research could not be found to support higher yields in Michigan.

Table 4. Yield Index, New York and Pennsylvania

Soil Management Group	Corn		
	Minimum	No till	Conventional
1	100	100	100
2	90	90	100
3	NA	NA	100
4	NA	NA	100
5	NA	NA	100

Source: Personal communication with W. Shaw Reid, Associate Professor, Soil Science Extension, Cornell University, 1978.

Table 5
Product Prices Used for All States (Projected for 1978-81)

Commodity	Unit	Price
Corn	bu.	2.00[1]
Soybeans	bu.	5.90[1]
Wheat	bu.	2.65[1]
Oats	bu.	1.29[2]
Hay	ton	53.25[3]
Sugar beets	ton	24.00[3]
Tomatoes	ton	63.00[4]

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[1] Source: C.E. Davidson and M.H. Ericksen, "Alternative Economic Settings for Agriculture: 1977-81," Agricultural-Food Policy Review, ERS AFPR-1, U.S. Department of Agriculture, January 1977.

[2] Source: Average 1975-76 Oats: Wheat Price Ratio Times Projected Wheat Price

[3] Source: Ohio Agricultural Statistics, Crop Reporting Service, 1975-76.

[4] Ohio Crop Enterprise Budgets-1978, Department of Agricultural Economics, The Ohio State University.

Table 6
Ohio and Indiana Corn Production Costs (Conventional Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1/3 bu.	$ 36/bu.	12.00
Fertilizer			
Nitrogen[1]	function of yield	.12/bu.	———
P_2O_5[2]	function of yield	.15/lb.	———
K_2O	function of yield	.10/lb.	———
Lime	1000 lb.	900/ton	4.50
Chemicals			
Atrazine	2 lb.	2.65/lb.	5.30
Lasso	2 qt.	3.50/qt.	7.00
Fuel, oil grease			11.00
Drying[4]	function of yield	.06/bu.	———
Repairs, misc.			21.00
Labor and mgmt.	4	5.00/hr.	20.00
Interest on operating captial	function of yield	9%	———
Fixed costs			
Deprec. and interest on machinery	$120	25%	30.00

[1] Nitrogen (lbs) = -110 + 1.876 (yield)

[2] P_2O_5 (lbs) = 18.838 + .333 (yield) -.335 (P test)

[3] K_2O (lbs) = 84.844 + .25 (yield) + 1.618 (CEC) .33 (K test)

[4] Drying cost = $ .06 (yield)

Table 7

Ohio and Indiana Corn Production Costs (Minimum Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1/3 bu.	$ 36/bu.	12.00
Fertilizer			
Nitrogen	function of yield[1]	.12/lb.	
P_2O_5	function of yield[2]	.15/lb.	
K_2O	function of yield[3]	.10/lb.	
Lime	1000 lb.	9.00/ton	4.50
Chemicals			
Atrazine	2 lb.	2.65/lb.	5.30
Lasso	2 qt.	3.50/qt.	7.00
Paraquat	.5 pt.	38/gal.	2.38
Fuel, oil, grease[4]			8.90
Drying	function of yield	.06/bu.	
Repairs, misc.[4]			19.50
Labor & mgmt.[4]	3.7	5.00	18.50
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery[4]	$111	25%	27.75

[1] Same Nitrogen function as used with conventional tillage

[2] Same P_2O_5 function as used with conventional tillage

[3] Same K_2O function as used with conventional tillage

[4] Source: N. Rask and D.L. Forster, "Corn Tillage Systems - Will Energy Costs Determine the Choice?" in <u>Agriculture and Energy</u>, Academic Press, Inc., 1977.

Table 8
Ohio and Indiana Corn Production Costs (No Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1/3 bu.	$ 36/bu.	12.00
Fertilizer			
Nitrogen	function of yield[1]	.12/lb.	
P_2O_5	function of yield[2]	.15/lb.	
K_2O	function of yield[3]	.10/lb.	
Lime	1000 lb.	9.00/ton	4.50
Chemicals			
Atrazine	2 lb.	2.65/lb.	5.30
Lasso	2 qt.	3.50/qt.	7.00
Paraquat	.5 pt.	38/gal.	2.38
Fuel, oil, grease[4]			7.50
Drying	function of yield		
Repairs, misc.[4]			18.90
Labor & mgmt.[4]	3.6		18.00
Interest of operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery[4]	$108	25%	27.00

[1] Same nitrogen function as used with conventional tillage

[2] Same P_2O_5 function as used with conventional tillage

[3] Same K_2O function as used with conventional tillage

[4] Source: N. Rask and D.L. Forster, "Corn Tillage Systems - Will Energy Costs Determine the Choice?" in Agriculture and Energy, Academic Press, Inc., 1977.

Table 9

Ohio and Indiana Soybean Production Costs (Conventional Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1 bu.	\$ 13.00/bu.	13.00
Fertilizer			
P_2O_5[1]	function of yield	.15/lb.	
K_2O	function of yield	.10/lb.	
Lime	1000 lb.	9.00/ton	4.50
Chemicals			
Lorox	2 lb.	3.70/lb.	7.40
Lasso	2 qt.	3.50/qt.	7.00
Fuel, oil, grease			8.00
Repairs, misc.			19.00
Labor & mgmt.	3 hr.	5.00/hr.	15.00
Interest of operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	\$ 120	25%	30.00

[1] P_2O_5 (lbs) = 26.06 + .555 (yield) - .355 (P test)

[2] K_2O (lbs) = 80.556 + 1.333 (yield) + .75 (CEC) - .33 (K test)

Table 10
Ohio and Indiana Soybean Production Costs (Minimum Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1 bu.	$ 13.00	13.00
Fertilizer			
P_2O_5	function of yield[1]	.15/lb.	____
K_2O	function of yield[2]	.10/lb.	____
Lime	1000 lb.	9.00/ton	4.50
Chemicals			
Lorox	2 lb.	3.70/lb.	7.40
Lasso	2 qt.	3.50/qt.	7.00
Fuel, oil, grease[3]			5.74
Repairs, misc.[3]			17.50
Labor & mgmt.[3]	2.75 hr.	5.00/hr.	13.75
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on machinery[3]	$111	25%	27.75

[1] Same P_2O_5 function as used with conventional tillage

[2] Same K_2O function as used with conventional tillage

[3] Source: N. Rask and D.L. Forster, Ibid.

Table 11
Ohio and Indiana Soybean Production Costs (No Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	1 bu.	$ 13/bu.	13.00
Fertilizer			
P_2O_5	function of yield[1]	.15/lb.	____
K_2O	function of yield[2]	.10/lb.	____
Lime	1000 lb.	9.00/ton	4.50
Chemicals			
Lorox	2 lb.	3.70/lb.	7.40
Lasso	2 qt.	3.50/qt.	7.00
Fuel, oil, grease[3]			5.40
Repairs, misc.[3]			16.90
Labor[3]	2.67 hr.	5.00 hr.	13.35
Interest on operating capital			
Fixed costs			
Depreciation and interest on machinery[3]	$ 108	25%	27.00

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[1] Same P_2O_5 function as with conventional tillage

[2] Same K_2O function as with conventional tillage

[3] Source: N. Rask and D.L. Forster, Ibid.

Table 12
Ohio and Indiana Wheat Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	2½ bu.	$ 6.00/bu.	15.00
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	______
P_2O_5	function of yield	.15/lb.	______
K_2O	function of yield	.10/lb.	______
Lime	1000 lb.	9.00/ton	4.50
Fuel, oil, grease			6.00
Repairs, misc.			16.00
Labor	3 hrs.	5.00/hr.	15.00
Interest on operating capital	function of yield	9%	______
Fixed costs			
Depreciation and interest on machinery	$ 100	25%	25.00

[1] Nitrogen (lbs.) = -10 + yield

[2] P_2O_5 (lbs.) = 79.673 + .667 (yield) - 1.339 (P test)

[3] K_2O (lbs.) = 90.417 + .194 (yield) + 1.375 (CEC) - .308 (K test)

Table 13
Ohio and Indiana Oats Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	3 bu.	$3.50/bu.	10.50
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	———
P_2O_5[2]	function of yield	.15/lb.	———
K_2O[3]	function of yield	.10/lb.	———
Lime	1000 lb.	9.00/ton	4.50
Fuel, oil, grease			7.00
Repairs, misc.			13.00
Labor	3 hr.	5.00/hr.	15.00
Interest on operating capital	function of yield	9%	———
Fixed costs			
Depreciation and interest of machinery	$ 100	25%	25.00

[1] Nitrogen = -60 + yield

[2] P_2O_5 = 50 + 15 (yield) - 1.357 (P test)

[3] K_2O = 80.717 + .194 (yield) + 1.375 (CEC) - .308 (K test)

Table 14
Ohio and Indiana Hay Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	10 lb./A	$.10/lb.	1.00
Fertilizer			
Establishment	$20/A		$20 ÷ yrs. in ha
Nitrogen[1]	function of yield	.12/lb.	____
P_2O_5[2]	function of yield	.15/lb.	____
K_2O[3]	function of yield	.10/lb.	____
Lime	1000 lb.	9.00/ton	4.50
Fuel, oil, grease			10.00
Repairs, misc.			27.00
Labor	5 hr.	5.00/hr.	25.00
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on machinery	$120	25%	30.00

[1] Nitrogen + -48.33 + 26.67 (yield)

[2] P_2O_5 = 50 + 15 (yield) - 1.0 (P test)

[3] K_2O = 91.5 + 61.298 (yield) - .353 (K test)

Table 15
Ohio and Michigan Processing Tomato Production Costs

Item	Quantity	Price	Amount
Returns	22 tons	61.50/ton	1353.00
Variable costs			
Plants	9000	9.50/1000	85.50
Fertilizer			
Starter	4 gal.	1.00/gal	4.00
Nitrogen	95 lb.	.12/lb.	11.40
P_2O_5	175 lb.	.15/lb.	26.25
K_2O	275 lb.	.10/lb.	27.50
Lime	1000 lb.	9/ton	4.50
Chemicals			115.00
Fuel, oil, grease			34.00
Repairs, misc.			27.00
Inspection	function of yield	.25/ton	
Hampers			17.00
Labor			
Hired-setting and hoeing	20 hr.	3.00/hr.	60.00
Hired-harvesting	function of yield	18.20/ton	
Operator-labor and mgmt.	12 hr.	8.00/hr.	96.00
Interest on operating capital		9%	
Fixed costs			
Depreciation and interest on machinery	$ 400	25%	100.00

Table 16
Ohio and Michigan Sugar Beet Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	1 lb.	\$ 6/lb.	6.00
Fertilizer			
Nitrogen	80 lb.	.12/lb.	9.60
P_2O_5	80 lb.	.15/lb.	12.00
K_2O	200 lb.	.10/lb.	20.00
Lime	1000 lb.	9.00/ton	4.50
Chemicals[1]			39.00
Fuel, oil, grease			6.00
Repairs, misc.			20.00
Harvesting, hauling, and topping	function of yield	5.00/ton	
Labor & mgmt.	7 hr.	5.00/hr.	35.00
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	\$120	25%	30.00

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[1] Pyramin, 2 lbs.; TCA, 1 2/3 qt.; 273, 1 pt.; Betanal, 1 qt.; Sevin, 2 lb.; Benlate, 1/2 lb.

Table 17
Michigan Corn Production Costs (Conventional Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.23 bu.	$ 42/bu.	9.70
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	
P_2O_5[2]	function of yield	.15/lb.	
K_2O[3]	function of yield	.10/lb.	
Lime			.80
Drying	function of yield	.06/bu.	
Chemicals			10.80
Fuel, Repair			14.40
Utilities, misc.			8.00
Labor	6.1 hr.	5.00/hr.	30.50
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	$ 120	25%	30.00

[1] If yield is less than 105 bu/acre, Nitrogen (lbs.) = - 5 + 1.0 (yield)
If yield is greater than or equal to 105 bu/acre, Nitrogen (lbs.) = - 54 + .54 (yi

[2] P_2O_5 (lbs.) = .833 (yield) - 1.25 (P test)

[3] K_2O (lbs.) = 40 + 1.25 (yield) - .80 (K test)

Table 18
Michigan Corn Production Costs (No Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.23	$ 42/bu.	9.70
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	____
P_2O_5[1]	function of yield	.15/lb.	____
K_2O[1]	function of yield	.10/lb.	____
Lime			.80
Drying	function of yield	.06/bu.	____
Chemicals			12.89
Fuel, Repairs			9.82
Utilities, misc.			8.00
Labor & mgmt.	5.50 hr.	5.00/hr.	27.50
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on machinery	$ 120	25%	30.00

---

[1] See budget for Michigan corn production, conventional tillage.

Table 19
Michigan Corn Production Costs (Minimum Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.23 bu.	$ 42/bu.	9.70
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	
P_2O_5[1]	function of yield	.15/lb.	
K_2O [1]	function of yield	.10/lb.	
Lime			.80
Drying	function of yield	.06/bu.	
Chemicals			12.89
Fuels, repairs			11.65
Utilities, misc.			8.00
Labor & mgmt.	5.6 hr.	5.00/hr.	28.00
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	$ 120	25%	30.00

[1] See budget for Michigan corn production, conventional tillage.

Table 20
Michigan Soybean Production Budget (Conventional Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.83 bu.	$ 10/bu.	8.30
Fertilizer			
P_2O_5[1]	function of yield	.15/lb.	
K_2O[2]	function of yield	.10/lb.	
Lime			.80
Chemicals			13.00
Fuel, repairs			9.60
Utilities, misc.			6.60
Labor and mgmt.	3.7 hr.	5.00/hr.	18.50
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on equipment	$ 120	25%	30.00

[1] $P_2O_5 = 25 + 1.25$ (yield) - 1.25 (P test)

[2] $K_2O = 54 + 2.0$ (yield) - .60 (K test)

Table 21
Michigan Soybean Production Budget (Minimum Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.83 bu.	$ 10/bu.	8.30
Fertilizer			
P_2O_5[1]	function of yield	.15	
K_2O[1]	function of yield	.10	
Lime			.80
Chemicals			13.00
Fuel, Repairs			6.89
Utilities, misc.			6.60
Labor & Mgmt.	3.4 hr.	5.00/hr.	17.00
Interest on operating capital	function of yield		
Fixed costs			
Depreciation and interest on equipment	$ 120	25%	30.00

---

[1] See budget for Michigan soybean production, conventional tillage.

Table 22

Michigan Soybean Production Budget (No Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.83 bu.	$ 10/bu.	8.30
Fertilizer			
P_2O_5[1]	function of yield	.15/lb.	
K_2O 1	function of yield	.10/lb.	
			.80
Chemicals			13.00
Fuel, repairs			6.48
Utilities, misc.			6.60
Labor & mgmt.	3.3 hr.	5.00/hr.	16.50
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	$ 120	25%	30.00

[1] See budget for Michigan soybean production, conventional tillage.

Table 23
Michigan Wheat Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	1.75 bu.	$ 8.00/bu.	14.00
Fertilizer			
Nitrogen	60 lb.	.12/lb.	7.20
P_2O_5[1]	function of yield	.15/lb.	———
K_2O[2]	function of yield	.10/lb.	———
Lime			.80
Fuel, repairs			8.40
Utilities, misc.			9.40
Labor	3.8 hr.	5.00/hr.	19.00
Interest on operating capital	function of yield	9%	———
Fixed costs			
Depreciation and interest on machinery	$ 100	25%	25.00

[1] $P_2O_5 = 34 + 1.66$ (yield) $- 1.25$ (P test)

[2] $K_2O = 35 + 2.66$ (yield) $- .66$ (K test)

Table 24
Michigan Oats Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	2.25 bu.	$ 4.50/bu.	10.10
Fertilizer			
Nitrogen	40 lb.	.12/lb.	4.80
P_2O_5[1]	function of yield	.15/lb.	
K_2O[2]	function of yield	.10/lb.	
Lime			.80
Fuel, repairs			8.40
Utilities, misc.			11.90
Labor	5.6 hr.	5.00/hr.	28.00
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	$ 100	25%	25.00

---

[1] $P_2O_5 = 16 + .714$ (yield) $- 1.25$ (P test)

[2] $K_2O = 54 + 1.0$ (yield) $- .66$ (K test)

Table 25
Michigan Hay Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed	2 lb.	$ 1.50/lb.	3.00
Fertilizer			
Nitrogen	80 lb.	.12/lb.	
P_2O_5[1]	function of yield	.15/lb.	
K_2O[2]	function of yield	.10/lb.	
Lime			
Fuel, repairs			16.30
Utilities, misc.			12.40
Labor	9 hr.	5.00/hr.	45.00
Interest of operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on machinery	$ 120	25%	30.00

[1] P_2O_5 = 62.5 - 1.25 (P test)

[2] K_2O = 120 - .66 (P test)

Table 26
New York and Pennsylvania Corn Production Costs (Conventional Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.26 bu.	34/bu.	8.85
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	
P_2O_5[2]	function of yield	.15/lb.	
K_2O[3]	function of yield	.10/lb.	
Lime			3.00
Drying	function of yield	.16/bu.	
Chemicals			10.00
Fuel, repairs			8.90
Misc. & utilities			20.70
Labor & mgmt.	6.6 hr.	5.00/hr.	33.00
Interest on operating capital	function of yield	9%	
Fixed costs			
Depreciation and interest on equipment			44.80

[1] Nitrogen = 1.0 (yield)

[2] P_2O_5 = .5 (yield)

[3] K_2O = .5 (yield)

Table 27
New York and Pennsylvania Corn Production Costs (Minimum Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.26 bu.	34/bu.	8.85
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	____
P_2O_5[1]	function of yield	.15/lb.	____
K_2O	function of yield	.10/lb.	____
Lime			3.00
Drying	function of yield	.06/bu.	____
Chemicals			11.93
Fuel, repairs			7.90
Misc. & utilities			18.37
Labor & mgmt.	6.1	5.00/hr.	30.50
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on equipment			41.44

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[1] See conventional tillage corn production costs

Table 28
New York and Pennsylvania Corn Production Costs (No Tillage)

Item	Quantity	Price	Amount
Variable costs			
Seed	.26 bu.	34/bu.	8.85
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	____
P_2O_5[1]	function of yield	.15/lb.	____
K_2O[1]	function of yield	.10/lb.	____
Lime			3.00
Drying	function of yield	.16/bu.	____
Chemicals			11.93
Fuel, repairs			7.34
Misc., utilities			17.08
Labor & mgmt.	5.95	5.00/hr.	29.75
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on equipment			40.32

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[1] See conventional tillage corn production costs

Table 29
New York and Pennsylvania Wheat Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed			10.00
Fertilizer			
Nitrogen[1]	function of yield	.12/lb.	—
P_2O_5[2]	function of yield	.15/lb.	—
K_2O[3]	function of yield	.10/lb.	—
Lime			2.00
Fuel, repair			6.45
Utilities, misc.			7.45
Labor	3.2	5.00/hr.	16.00
Interest on operating capital	function of yield	9%	—
Fixed costs			
Depreciation and interest on equipment			47.60

[1] Nitrogen = 1.33 (yield) - 19.8

[2] P_2O_5 = 1.33 (yield) - 19.8

[3] K_2O = .67 (yield)

Table 30
New York and Pennsylvania Hay Production Costs

Item	Quantity	Price	Amount
Variable costs			
Seed			9.30
Fertilizer			
P_2O_5[1]	function of yield	.15/lb.	____
K_2O[2]	function of yield	.10/lb.	____
Lime			2.00
Chemicals			2.00
Fuel, repair			10.20
Utilities, misc.			6.00
Labor	10.6 hr.	5.00/hr.	53.00
Interest on operating capital	function of yield	9%	____
Fixed costs			
Depreciation and interest on equipment			42.00

[1] P_2O_5 = 16.67 (yield) - 16.68

[2] K_2O = 16.67 (yield) + 8.33

Table 31
Area (Hectares) by Soil Management Group and County

County	Group 1	Group 2	Group 3	Group 4	Group 5	Total
Monroe, MI	3220.	12816.	540.	8180.	216.	24972.
Crawford, OH	13507.	33881.	1178.	10971.	4144.	63681.
Seneca, OH	8351.	63106.	10058.	16832.	4759.	103106.
Huron, OH	18022.	32846.	37088.	4053.	17208.	109217.
Ottawa, OH	60.	3520.	8780.	43488.	2140.	57988.
Sandusky, OH	11580.	4832.	7978.	35592.	12511.	72493.
Erie, OH	13996.	11620.	10072.	10044.	4264.	49996.
Wood, OH	2371.	31192.	2632.	102238.	4476.	142909.
Lucas, OH	7832.	4760.	1004.	42948.	14100.	70644.
Hancock, OH	9229.	69882.	2664.	49975.	6255.	137005.
Wyandot, OH	13712.	26171.	2035.	14750.	8708.	65376.
Hardin, OH	3717.	2367.	2115.	11997.	1791.	21987.
Marion, OH	423.	801.	1134.	1980.	576.	4914.
Richland, OH	3598.	7379.	1863.	1856.	579.	15293.
Henry, OH	4952.	27396.	2412.	62092.	6308.	103160.
Ashland, OH	3168.	9576.	1620.	252.	972.	15588.
Medina, OH	29728.	24635.	26894.	817.	8317.	90391.
Cuyahoga, OH	9004.	6301.	20268.	0.	2575.	38148.
Lake, OH	13261.	19671.	8290.	0.	3930.	45152.
Geauga, OH	9544.	12843.	13662.	0.	2965.	39014.
Ashtabula, OH	13252.	71166.	11226.	0.	67988.	163632.
Erie, PA	13124.	30868.	25552.	48.	4932.	74524.
Crawford, PA	2400.	6592.	3072.	1440.	9872.	23376.
Chautaugua, NY	24516.	14580.	24588.	2160.	288.	66132.
Erie, NY	38466.	13716.	22869.	576.	3078.	78705.
Cattaraugua, NY	117.	36.	72.	0.	72.	297.
Wyoming, NY	2952.	720.	5544.	108.	576.	9900.
Sanilac, MI	18936.	23020.	0.	36980.	5592.	84528.
Lapeer, MI	16812.	14600.	480.	2976.	6544.	41412.
St. Clair, MI	11733.	108984.	9239.	29645.	18645.	178246.
Livingston, MI	96988.	16451.	0.	8126.	24346.	145911.
Oakland, MI	20900.	3682.	299.	1364.	4286.	30531.
Macomb, MI	21025.	49661.	1089.	39016.	5679.	116470.

Jackson, MI	468.	180.	0.	36.	684.	1368.
Washtenaw, MI	103086.	36245.	1886.	21789.	18224.	181230.
Wayne, MI	10251.	53870.	2287.	14906.	2962.	84276.
Hillsdale, MI	5400.	36.	0.	0.	13932.	19368.
Lenawee, MI	57168.	41580.	0.	48224.	5580.	152552.
Steuben, MI	9324.	2628.	0.	2448.	1116.	15516.
Williams, OH	23940.	37368.	4428.	13824.	10332.	89892.
Fulton, OH	3252.	23668.	108.	28992.	3240.	59260.
Noble, IN	7776.	648.	180.	2700.	1116.	12420.
Dakalt, IN	4356.	16056.	396.	4824.	1188.	26820.
Defiance, OH	2880.	10836.	12528.	13932.	25146.	65340.
Lorain, OH	10520.	12787.	59894.	2565.	8354.	94120.
Allen, IN	19980.	39852.	0.	49608.	6948.	116388.
Paulding, OH	828.	9792.	10944.	24912.	61128.	107604.
Putnam, OH	3060.	18948.	8928.	30296.	47196.	108428.
Adams, IN	2232.	12096.	0.	11808.	972.	27108.
Van Wert, OH	3636.	31788.	108.	56556.	8388.	100476.
Allen, OH	13608.	48564.	216.	32976.	3384.	98748.
Mercer, OH	2448.	28116.	0.	21240.	3312.	55116.
Auglaize, OH	5256.	18756.	36.	9864.	2412.	36324.
Basin	752629.	1207319.	368508.	932552.	485728.	376736.

Table 32
Net Income by County Under Conventional Tillage and Change in Net Income Under Alternative Scenarios

County	Conventional Tillage ($000)	Percent Income Change With					
		Minimum Tillage				No Tillage	
		Group 1	Group 2	Group 3	Group 4	Group 1	Group 2
Monroe, MI	2635.9	0.8	3.2	-0.5	-2.7	1.1	4.3
Crawford, OH	5894.1	2.4	12.3	-0.4	-0.6	4.0	14.1
Seneca, OH	10844.4	0.9	12.5	-1.2	-0.5	1.3	14.4
Huron, OH	7542.0	2.6	9.3	-7.4	-0.2	4.3	10.8
Ottawa, OH	10035.1	0.0	0.7	-1.5	-1.4	0.0	0.8
Sandusky, OH	10172.3	1.3	1.1	-0.4	-0.9	2.0	1.2
Erie, OH	5076.3	3.1	5.4	-3.4	-0.6	5.1	6.2
Wood, OH	24230.6	0.1	3.1	-0.2	-1.7	0.2	3.5
Lucas, OH	8643.7	1.0	1.3	-0.2	-1.7	1.5	1.5
Hancock, OH	17462.2	0.6	9.2	-0.3	-0.9	0.9	10.5
Wyandot, OH	7086.7	2.2	8.4	-0.6	-0.6	3.5	9.7
Hardin, OH	2859.6	1.5	1.9	-1.6	-1.3	2.3	2.2
Marion, OH	533.1	0.9	3.5	-4.1	-1.0	1.5	4.0
Richland, OH	900.4	3.2	13.8	-2.3	-0.6	5.8	16.0
Henry, OH	17630.4	0.3	3.8	-0.3	-1.4	0.5	4.3
Ashland, OH	684.1	2.8	18.9	-2.3	-0.1	5.4	21.7
Medina, OH	4260.3	4.9	8.3	-6.7	0.0	8.4	9.6
Cuyahoga, OH	776.4	0.0	0.0	0.0	0.0	0.0	0.0
Lake, OH	1824.9	4.7	16.2	-4.9	0.0	9.9	18.9
Geauga, OH	903.5	2.8	8.9	-7.1	0.0	6.2	10.4
Ashtabula, OH	-1123.6	4.4	50.5	-5.3	0.0	8.9	60.0
Erie, PA	414.0	19.2	-37.5	-679.5	-1.3	29.1	-14.2
Crawford, PA	-110.9	11.1	-26.9	-281.9	-125.5	16.9	11.1

Chautaugua, NY	1273.9	10.3	-6.7	-185.5	-18.9	15.5	-3.5
Erie, NY	2494.8	9.1	-3.8	-103.5	-3.0	13.7	-2.1
Cattaraugua, NY	19.3	5.0	-1.8	-56.3	0.0	7.6	-0.1
Wyoming, NY	17.5	123.6	-31.2	-432.4	-85.0	187.4	-15.6
Sanilac, MI	5038.2	0.5	0.6	0.0	-0.9	0.8	1.0
Lapeer, MI	1791.2	1.9	1.7	-0.2	-0.3	3.3	2.8
St. Clair, MI	11024.0	0.2	2.1	-0.7	-0.6	0.3	3.3
Livingston, MI	4332.7	5.5	0.9	0.0	-0.5	9.4	1.6
Oakland, MI	1553.4	2.5	0.4	-0.1	-0.2	4.4	0.8
Macomb, MI	8585.7	1.1	2.5	-0.2	-2.1	1.7	3.9
Jackson, MI	75.8	2.4	0.9	0.0	-0.2	4.1	1.6
Washtenaw, MI	11930.0	2.9	1.0	-0.2	-0.7	4.7	1.7
Wayne, MI	11499.8	0.5	2.7	-0.4	-1.1	0.7	3.6
Hillsdale, MI	1458.0	1.8	0.0	0.0	0.0	2.9	0.0
Lenawee, MI	16286.7	2.2	1.6	0.0	-2.5	3.3	2.4
Steuben, MI	1206.3	6.7	4.4	0.0	-0.6	13.2	5.1
Williams, OH	9354.4	2.7	8.8	-0.9	-0.5	4.4	10.1
Fulton, OH	8893.4	0.4	6.9	0.0	-1.3	0.7	7.8
Noble, IN	1174.3	6.4	1.2	-0.3	-0.8	12.1	1.4
Dekalb, IN	2854.4	1.6	12.8	-0.3	-0.5	2.8	14.7
Defiance, OH	8281.8	0.4	3.0	-2.9	-0.6	0.6	3.4
Lorain, OH	6495.4	1.6	3.9	-12.5	0.0	2.5	4.5
Allen, IN	15152.7	1.5	6.1	-0.0	-1.2	2.5	7.0
Paulding, OH	11820.1	0.1	1.7	-1.7	-0.8	0.1	2.0
Putnam, OH	15564.1	0.2	2.8	-1.1	-0.7	0.3	3.2
Adams, IN	3550.2	0.7	8.2	0.0	-1.1	1.2	9.4
Van Wert, OH	15004.4	0.3	5.2	0.0	-1.4	0.5	6.0

Allen, OH	11967.5	1.3	9.6	0.0	-0.9	2.1	11.0
Mercer, OH	6335.0	0.4	9.5	0.0	-1.0	0.7	10.9
Auglaize, OH	4018.9	1.4	10.1	0.0	-0.7	2.3	11.6
Basin	338228.6	1.3	4.9	-3.7	-1.2	2.2	5.9

REPORT DOCUMENTATION PAGE

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BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

Economic Impacts of Changing Tillage Practices in the Lake Erie Drainage Basin

5. TYPE OF REPORT & PERIOD COVERED

FINAL

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

D. Lynn Forster, Ph.D.

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Ohio State University
Dept. of Agricultural Economics and Rural Sociology

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

Lake Erie Wastewater Management Study
Buffalo District, Corps of Engineers

12. REPORT DATE

August 1978

13. NUMBER OF PAGES

66

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)

Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are available from National Technical Information Service
Springfield, VA 22151

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer Model
Tillage
Production Costs

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Reduced tillage technologies may be the most cost effective practices for reducing pollutant loadings from agricultural lands. A model has been developed to predict the changes in net farm income in the Lake Erie Basin based on soil types and their associated yield characteristics along with commodity prices and crop production costs. Output of the model includes (a) net return per acre by crop, by tillage system, by county, and by soil series; (b) acres in each county by soil management group; (c) net return

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Block 20 (Continued)

for each county by "management scenario;" and (d) net return for the Lake Erie Basin by "management scenario."

Soil types determine the economic success of reduced tillage farming. Well drained soils may exhibit greater crop yields under reduced tillage practices than under conventional farming techniques. Conversely, crop yields from poorly drained soils under reduced tillage are less than those under conventional tillage practices. Therefore, the quantity of well and poorly drained soils within an area determines the economic success of reduced tillage methods.

For the Lake Erie Basin reduced tillage farming of well drained soils with concurrent conventional farming of poorly drained soils may result in a one to six percent increase in the Basin net income compared to conventional farming of the entire watershed. On the other hand, utilization of reduced tillage practices on poorly drained soils with concurrent conventional farming of well drained soils may produce a decrease in Lake Erie Basin net income of one to four percent.

The application of reduced tillage farming to extremely poorly drained soils such as certain organic, alluvial, and fine textured soils is not recommended as very large decreases in Basin net income are expected. The above findings may change if farmer expertise is greater or less than the expertise applied to the experimental plots used for input data to the model.