AN ANALYSIS OF ON-FARM IMPACTS FOR SOIL CONSERVATION AND NON-POINT SOURCE POLLUTION ABATEMENT PRACTICES AND POLICIES ON REPRESENTATIVE FARMS IN SOUTHEAST MINNESOTA

By

Merritt Merrill Padgitt

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Resource Development

1980

of p
poli
a na
five
haza
of l
and
furt
erat
well

alte
asse
size
tati
incom

ABSTRACT

AN ANALYSIS OF ON-FARM IMPACTS FOR SOIL CONSERVATION
AND NON-POINT SOURCE POLLUTION ABATEMENT PRACTICES
AND POLICIES ON REPRESENTATIVE FARMS
IN SOUTHEAST MINNESOTA

By

Merritt Merrill Padgitt

A number of concerns have been expressed over the effectiveness of past soil conservation and non-point source pollution abatement policies in getting farmers to adopt needed control measures. Although a national soil and water conservation program has existed for forty-five years, nearly one-third of the nation's cropland with erosion hazards remain inadequately treated. The Resource Conservation Act of 1977 initiated an appraisal of the nation's soil and water resources and directed the Secretary of Agriculture to develop a program for furthering conservation and protection of these resources. Consideration in developing such a program is being given to voluntary as well as mandatory implementation strategies.

The purpose of this study is to estimate on-farm impacts from alternative soil conservation technology and policy options and to assess impact differences among farms because of differences in their size, soil composition and enterprise combinations. Eight representative farm models of southeast Minnesota are used to simulate net income, soil loss and applied soil conservation technology under

alter

farms

with

of s

Amon

Conse

Minn

under

and p

serva

manda

The r

cent.

toler

conse

cropp

cultu

techn

senta

in an

farms

While

with

alternative policy options. The farm models include small and large farms, farms with moderate and severe erosion hazard soils and farms with and without roughage consuming livestock enterprises. The impact of seven policy options is estimated for each representative farm. Among the policy options are a replication of the current Agricultural Conservation Program, mandatory soil loss controls as proposed by the Minnesota legislature, and a minimum conservation farm plan as necessary under a cross compliance type of strategy.

The results show that alternative soil conservation practices and policy options impact on farm incomes, soil loss and applied conservation technology. The largest reduction in income occurs under mandatory policies which reduce soil loss rates of tolerance levels. The range of income reduction on the eight farms is from 4 to 17 percent. The change in applied technology needed to achieve soil loss tolerance includes a reduction in row crop acreage, increased use of conservation tillages and added practices of contouring and strip cropping. It was found that cost-sharing as under the current Agricultural Conservation Program did not change applied soil conservation technology and results in no change in income or soil loss on representative farms. The adoption of a minimum conservation plan results in an income reduction of as much as 7 percent.

Mandatory policy options impact grain farms more than livestock farms. The income reduction on grain farms is from 7 to 17 percent while on livestock farms the reduction is 6 percent or less. Farms with severe erosion hazards have larger reductions in income under mandatory options than farms with moderate erosion hazards. Also, the percentage reduction in income on small farms is greater than on large farms for the policy options analyzed.

ACKNOWLEDGMENTS

The author wishes to express his deep appreciation to Dr. Raleigh Barlowe for his helpful guidance as dissertation advisor and chairman of my guidance committee. Appreciation is also expressed to Dr. Milton Steinmueller, Dr. Anthony Koo and Dr. Donald Holecek for the assistance they provided as members of the dissertation and guidance committee.

A debt of gratitude is extended to Dr. Anthony Grano, Dr. William Crosswhite and the administrators of the Natural Resource Economics Division of ESCS for providing technical and financial assistance for this study. Thanks are also due my colleagues of ESCS in East Lansing and in particular Priscilla Prophet for the data processing and programming she provided.

Appreciation also goes to Mr. William Stokes, Mr. Jerome Hildebrandt, Mr. Edgar Drogemuller of the Soil Conservation Service in Minnesota for the assistance they provided. Thanks is also extended to Dr. Fred Benson, Dr. James Bauder, and Mr. Mervin Freeman of the Minnesota Cooperative Extension Service and to Marilyn Lundberg of the Minnesota Rivers Basin Board for their assistance.

Finally for their encouragement, support and patience, I am deeply grateful to my wife Chloe Ann and daughter Andrea.

TABLE OF CONTENTS

APPEN

B

C

LIST

TABL

4-

4-

4-

4-

4-

4-

4-

4-

4-

4-

LIST OF TABLES

TABLE		Page

TABLE		Page

TABLE | Page

prog

U.S.

obje

duct

prod

for

eros

repo

sedi

---

of In
It wa
Depar
Priva

ment
non-p

Ninth
1978)

Energ

CHAPTER I

INTRODUCTION

Setting

Soil conservation is an established public policy and numerous programs have been implemented over the last forty-five years by the U.S. Department of Agriculture to achieve various objectives.[1] Early objectives were to reduce soil loss and maintain long-term soil productivity as well as aiding farm incomes during periods of surplus production. Later, during the 1970s when there was a rising demand for a cleaner environment, water quality objectives were added.[2]

The ninth Environmental Quality report indicates that soil erosion continues to be a problem of great magnitude.[3] It has been reported that three-fourths of the nation's four billion tons of sediment delivered to watercourses come from agricultural lands.[4]

---

[1]The Soil Erosion Service was created in the U.S. Department of Interior in 1933 out of concern for soil erosion on public lands. It was renamed Soil Conservation Service and transferred to the U.S. Department of Agriculture in 1936 out of concern for soil erosion on private lands.

[2]Section 208 of the Federal Water Pollution Control Act Amendment of 1972 (P.L. 92-500) identifies agricultural activities as causing non-point source pollution and requires planning for abatement.

[3]Council on Environmental Quality, Environmental Quality, 1978, Ninth Annual Report (Washington, D.C.: Government Printing Office, 1978), p. 274.

[4]David Pimentel et al., "Land Degradation: Effects on Food and Energy Resources," Science 194 (October 1976): 149.

In addition, since 1935, about 100 million acres have been depleted to the point they cannot be economically cultivated and on another 100 million acres, more than 50 percent of the topsoil has been eroded.[1] National inventories in 1958 and 1967 showed only 31.2 percent and 30.1 percent, respectively, of the cropland with erosion hazards being treated adequately.[2]

A number of questions and concerns over the effectiveness of past policy has been expressed. In testimony before the U.S. Senate Subcommittee on Environment, Soil Conservation and Forestry, Marion Edley stated that "programs have not accomplished as much as we have hoped; in fact, there is evidence of serious backsliding."[3] In a survey, the General Accounting Office found that soil losses on farms participating in soil and water conservation programs were no less than those that did not participate.[4]

Currently, policy makers are assessing soil and water conservation programs and strengthening financial incentives for adoption of practices. The Soil and Water Resources Conservation Act (P.L. 95-192)

---

[1]Council on Environmental Control.

[2]U.S. Department of Agriculture, Conservation Needs Inventory Committee, Basic Statistics of the National Inventory of Soil and Water Conservation Needs (Washington, D.C.: Statistical Bulletins 317 and 461, August 1962 and January 1971).

[3]Hearings before the Subcommittee on Environment, Soil Conservation and Forestry of the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, 95th Congress, on S. 1280, Washington, D.C., August 2 and 4, 1977, p. 64.

[4]General Accounting Office, Report to the Congress by the Comptroller General of the United States (Washington, D.C.: Government Printing Office, 20 December 1977).

calls

plann

conse

effe

an "

cons

of s

and

whic

bene

The

19

Secr

prog

anti

As a

Dep

del

sche

The

19
Off

calls for a continuing appraisal of soil resources and for program planning to assist private land owners in furthering land and water conservation. The program is to include "an evaluation of the effectiveness of soil and water conservation ongoing programs,"[1] an "identification and evaluation of alternative methods for the conservation, protection, environmental improvement and enhancement of soil and water resources in the context of alternative time frames, and a recommendation of the preferred alternative and the extent to which they are being implemented"[2] and an "analysis of costs and benefits of alternative soil and water conservation practices."[3] The Rural Clean Water Program (P.L. 95-217) passed by Congress in 1977 amends the Federal Water Pollution Control Act to authorize the Secretary of Agriculture to allocate funds in addition to ongoing programs to land owners who adopt pollution abatement measures.

As a result of these recent legislative actions, it is anticipated that a new soil and water conservation policy will emerge. As a part of the Resource Conservation Act planning process, the U.S. Department of Agriculture is developing alternative strategies to deliver soil and water conservation programs. These strategies are scheduled for executive, Congressional and public review in 1980. The strategies include voluntary incentives as well as mandatory

---

[1]U.S. Congress, Soil and Water Resources Conservation Act of 1977, P.L. 95-192, Sec. 6(a)-3 (Washington, D.C.: Government Printing Office, November 1977).

[2]Ibid., Sec. 6(a)-4.

[3]Ibid., Sec. 6(a)-7.

app

res

nar

the

of t

imp

agr

Dep

stat

prop

impa

esti

othe

Trib
Serv
Serv

Stud
(Des
Fore

Reso
Serv

Sour
Ameri

Iowa

approaches. Whatever policy eventually develops, it will be the result of a complex political process considering many broad and narrow private and public interests. This study addresses some of the private interests of farmers in a soil conservation policy.

Study Objectives

Earlier studies have attempted not only to assess the magnitude of the soil loss and non-point source pollution problem, but also the impacts of alternative control practices and policies on aggregate agricultural production. River basin studies conducted by U.S. Department of Agriculture in Minnesota, Iowa, Wisconsin and other states have estimated soil loss rates under current conditions and under proposed comprehensive land treatment plans for the area. The regional impacts of these plans on the agricultural economies of the basins were estimated. A national economic assessment by Heady and Wade[4] as well others has made estimates of the magnitude and potential impacts of

---

[1]U.S. Department of Agriculture, The Southeast Minnesota Tributaries Basin Report (draft) prepared by the Soil Conservation Service (St. Paul, Minn.: Economics, Statistics and Cooperatives Service, and Forest Service, 1980).

[2]U.S. Department of Agriculture, Southern Iowa River Basin Study Main Report (draft prepared by the Soil Conservation Service (Des Moines, Ia.: Economics, Statistics, and Cooperatives Service and Forest Service, February 1979).

[3]U.S. Department of Agriculture, Water and Related Land Resources, Wisconsin River Basin (Madison, Wis.: Soil Conservation Service, 1979).

[4]James C. Wade and E. O. Heady, "Controlling Non-Point Sediment Sources with Cropland Management: A National Economic Assessment," American Journal of Agricultural Economics 59 (February 1977): 13-14.

[5]R. P. Beasley, Erosion and Sediment Pollution Control (Ames: Iowa State University Press, 1972).

abateme

of some

Frohber

to diff

evaluat

river b

the far

The U.S

Tributa

for rec

increas

erosion

ficantl

total c

region

from sh

tributi

---

of Poli
Cornbel
1978):

Erosion
cation
59 (Feb

and Res
Agricul

abatement measures. Osteen and Seitz[1] measured economic impacts of some alternative policies in the corn belt region. Taylor and Frohberg[2] estimated certain welfare impacts of public policies related to different levels of agricultural pollution control. Walker[3] evaluated the economic impact of alternative policies at the river basin level.

This study attempts to measure resource use implications at the farm level from alternative practices as well as different policies. The U.S. Department of Agriculture study of the Southeast Minnesota Tributaries Basin outlined a rather specific land treatment plan for reducing sheet and rill erosion. The plan calls for significant increases over the next twenty years in acres treated by different erosion control practices. The plan as proposed was shown to significantly reduce sheet and rill erosion with only slight changes in total crop production and aggregate income. The study treated the region as a farm unit and did not address the possible implications from shifts in production between soil types and the possible redistribution of income among landowners. The objective of this study is

---

[1]Craig Osteen and Wesley D. Seitz, "Regional Economic Impacts of Policies to Control Erosion and Sedimentation in Illinois and Other Cornbelt States," American Journal of Agricultural Economics 60 (August 1978): 510-517.

[2]C. Robert Taylor and Klaus Frohberg, "The Welfare Effects of Erosion Controls, Banning Pesticides, and Limiting Fertilizer Application in the Corn Belt," American Journal of Agricultural Economics 59 (February 1977): 25-36.

[3]David J. Walker, "An Analysis of Alternative Environmental and Resource Policies for Controlling Soil Loss and Sedimentation from Agriculture" (Ph.D. dissertation, Iowa State University, 1977).

to me

policy

Basin

tice

varia

It is

diffe

used

1

2

3

In th

hazar

treat

40 pe

Water

to measure the probable impacts of alternative practices and different policy options on a farm production system.

Drawing from the results of the Southeast Minnesota Tributaries Basin Study, it is hypothesized that acceptance of a conservation practice has different economic impacts on individual farms because of variations in their size, soil composition and enterprise combination. It is also hypothesized that different implementation programs have different impacts on farms because of these same elements. The model used in this study will test these hypotheses.

The specific objectives of the study are:

1. To determine net income on representative farms with and without erosion control systems.
2. To assess the net income and soil loss effects that occur under the current cost-share program.
3. To evaluate the impact of voluntary and mandatory policy options on increases in the adoption of erosion control systems.

Area of Study

The study area for this analysis is southeastern Minnesota. In the ten county area, over 70 percent of the cropland has erosion hazards associated with its use.[1] Although many acres are adequately treated by rotations, contours, stripcropping or terracing, about 40 percent of this area has average annual soil loss in excess of

[1]Minnesota Conservation Needs Committee, Minnesota Soil and Water Conservation Needs Inventory, St. Paul, Minnesota, August 1971.

long-t

Servic

conser

Conser

its lo

a neig

predo

develo

and ur

has be

along

tops a

til ar

south,

study

vegeta

Mollis

Jerome
Distri
Specia

unpubl
Needs

"Soil
Govern

long-term tolerance levels[1] established by the Soil Conservation Service. Not all farmers have the same willingness to adopt soil conservation practices on their farms.[2] In 1975, the District Conservationist estimated that Houston County had 73 percent of its land in tillage rotation adequately treated while Fillmore, a neighboring county, had only 34 percent adequately treated.[3]

The soils of southeastern Minnesota are classified as predominantly either Alfisols or Mollisols.[4] The Alfisols are developed from loess parent material which is of variable thickness and underlain by glacial till. The native vegetation on these soils has been mostly hardwood forest. The Alfisol soils are most prevalent along the eastern border of the state and occur on the narrower ridge tops and steeper side slopes. The Mollisols are developed from glacial til and under native prairie grass vegetation. The Mollisols occur in southcentral Minnesota on gently rolling to nearly level plains. The study area is within the transition zone of eastern deciduous forest vegetation and prairie vegetation. It contains both Alfisols and Mollisols.

---

[1]Soil loss tolerance levels are defined in Chapters II and IV.

[2]Personal interviews with Kenneth Rose, Area Conservationist; Jerome Hildebrandt, District Conservationist; Harold Drogmueller, District Conservationist; and Mervin Freeman, Area Extension Specialist.

[3]U.S. Department of Agriculture, Soil Conservation Service, unpublished data to update the Minnesota Soil and Water Conservation Needs Inventory to reflect the 1975 status, St. Paul, Minnesota.

[4]U.S. Department of Agriculture, Soil Conservation Service, "Soil Taxonomy," Agricultural Handbook No. 436 (Washington, D.C.: Government Printing Office, December 1974), pp. 411-428.

while (

urban (

ownersh

in the

descri

a defi

for as

and ph

pollut

analy

option

sets f

and Ch

are no

vation.

Conser

Ankeny

by the

About 15 percent of the total area remains in hardwood forest while 62 percent is cropland.[1] The remaining land area is in pasture, urban or other miscellaneous uses. Most of the land is in private ownership and used for agricultural production. Major crops grown in the area include corn, soybeans, oats, hay, silage and pasture.

Organization

In addition to the problem setting, study objectives and description of study area previously discussed, Chapter I includes a definition of terms. Chapter II provides a conceptual framework for assessing the problems and discusses the institutional, economic, and physical dimensions to the soil erosion and non-point source pollution problem. Chapter III outlines the analytic framework for analyzing on-farm impacts of soil erosion control systems and policy options. Chapters IV and V document the physical and economic data sets for the model. Chapter VI analyzes the results from the model and Chapter VII is a summary of the research and its findings.

Definition of Terms

The following definitions are presented to aid readers who are not familiar with terminology relating to soils and soil conservation management.[2] These definitions are of a general nature. For

---

[1] USDA, SCS, unpublished CNI data, 1975.

[2] Definitions of additional terms may be found in the Resource Conservation Glossary published by the Soil Conservation Society, Ankeny, Iowa in 1976 or in the Glossary of Soil Science Terms published by the Soil Science Society of America, Madison, Wisconsin, in 1978.

some t

chapte

Alfiso

In

th

or

Back-s

di

is

st

pe

ti

Chisel

to

5

co

Conser

so

di

Contou

op

va

th

some terms a more specific definition is given when discussed in other chapters.

Alfisols: Alfisols are one of ten orders used to classify world soils. In the United States corn belt region, soils of this order are those which developed under native forest vegetation and on loess or glacial till parent material.

Back-sloped terrace: A type of terrace used on erosive soils to direct runoff and reduce soil loss. The ridge of the terrace is constructed by pushing the dirt up the slope and leaving a steep slope on the downward side. The steep slope is placed in permanent vegetation. This type of construction leaves a relatively flat surface on the upward side which may be cultivated.

Chisel plowing: A soil tillage which breaks and loosens the top four to fifteen inches of soil without inversion. The practice leaves 50 to 90 percent of preceding crop residues on the surface to help control erosion.

Conservation tillage: Any tillage system specifically used to reduce soil erosion. It includes chisel plowing, strip tillage and discing when used as a substitute for moldboard plowing.

Contour farming: The practice of performing all tillage and planting operations across the slope or along contour lines of equal elevation. The direction of row crops is around the hillside rather than straight rows which may go up or down the hill.

Cost-s

or

ad

se

pe

Crop r

re

th

se

Erosic

th

ph

ph

Grasse

wi

pu

fo

Moldbo

to

re

Mollis

so

ar

gl

Cost-share: An economic incentive program provided by federal, state or local governments to encourage certain activities such as the adoption of soil conservation systems. For specific soil conservation practices, land owners are reimbursed for a certain percentage of the cost they incur in adopting the practice.

Crop rotation: A planned sequence of crops growing in a regular recurring succession on the same field. For example, a C-O-M three-year rotation consists of corn the first year, oats the second year and meadow the third year and then the sequence repeats.

Erosion phase: The mixture of A and B soil horizons which occur within the normal plow layer. Phase I consists of only A horizon soils, phase II consists of a mixture of A and B horizon soils and phase III consists of B horizon soil.

Grassed waterway: A constructed outlet, shaped, graded and established with permanent vegetation for safe disposal of runoff. Their purpose is to provide an outlet for runoff and prevent gully formation.

Moldboard plowing: A tillage technique which inverts the top four to twelve inches of soil. The technique incorporates all surface residues into the soil profile and exposes bare soil.

Mollisols: Mollisols are one of the ten orders used to classify world soils. In the United States corn belt region, soils of this order are those developed under native prairie vegetation and from glacial till parent material.

Mulch tillage: A form of conservation tillage which leaves a part of the preceding crop residue on the surface. Chisel plowing is a common form of mulch tillage.

No-till: Planting a crop in previously unprepared soil by opening a narrow slot or trench of only sufficient width and depth for proper seed placement. No other soil preparation is done to prepare the seedbed.

Rill erosion: The removal of soil by runoff which causes small but well-defined channels. If these channels do not interfere with normal tillage, these channels are called rills.

Runoff: That part of rainfall which flows over the ground surface and through channels to larger streams.

Sheet erosion: The removal of a fairly uniform layer of soil from the land surface by runoff water.

Slope gradient: A measure of the steepness of a land surface. It is expressed as the ratio or percentage of the vertical distance to the horizontal distance. For example, a 10 percent slope implies a 10 feet rise for every 100 feet of horizontal distance.

Slope length: The distance from the point of origin of runoff to the point where runoff enters a well-defined channel.

Strip cropping: Growing crops in a systematic arrangement of strips or bands to reduce soil erosion. The crops are arranged along a slope so that strips of soil conserving crops alternate with strips of row crops.

soil lc

native

consist

sions.

a parti

element

researc

study.

topogra

This ir

intern

pests a

other l

into wa

inter a

habitat

CHAPTER II

A CONCEPTUAL FRAMEWORK FOR ASSESSING SOIL LOSS AND NON-POINT SOURCE POLLUTION PROBLEMS ON AGRICULTURAL LAND

Introduction

A holistic perspective is necessary to adequately define the soil loss and non-point source pollution problem and to evaluate alternative abatement measures. As with any natural resource problem, it consists of physical-biological, economic, and institutional dimensions. Neglecting any one of these dimensions would result in only a partial analysis of the total problem.

The physical-biological dimension includes the many interacting elements which cause soil to erode and impact on the environment. The research in this dimension can be broadly divided into two areas of study. One area includes the on-site effects of weather, vegetation, topography, and the soil erosion and sedimentation control practices. This includes soil loss effects on soil fertility, water infiltration, internal drainage, soil microbial activity related to plant disease and pests as well as other factors that may affect crop productivity. The other broad area deals with sediment movement on the other land and into water courses. The off-site physical-biological effects include, *inter alia*, water quality, health, aesthetics, fish and wildlife habitats, and flooding.

of be

tices

be di

benef

chang

of pr

inclu

tion

produ

numer

value

and h

costs

and n

measu

is an

manag

land

econo

the i

land

loss

The economic dimension to this problem consists of an assessment of benefits from control practices, the cost of applying control practices, and the timing of these costs and benefits. It, likewise, can be divided into on-site and off-site effects. The on-site economic benefits basically include increased value of production through changes in crop yields or land use and potential reductions in cost of production inputs. The on-site costs of erosion control practices include investments for land treatments, reduction in value of production from reduced crop yields or change in land use and increase in production input cost. The off-site costs and benefits are much more numerous and difficult to identify and empirically measure. Economic values cannot be easily placed on non-market goods such as aesthetic and human health which may be affected. Its economic impacts on social costs for flood protection, water treatment, electric power generation, and navigation are among the major economic variables that are measurable in the market economy.

The institutional dimension addresses the question of what is and what is not an acceptable land use. It performs an overall management function of allocating beneficial and adverse effects from land use activities not only between private and public sectors of the economy but also between present and future generations. Included in the institutional dimension is the role of governments in directing land use activities toward socially desired goals.

The focus of this study is limited to on-site effects of soil loss and non-point source pollution abatement practices and the impact cr

cr

a

th

fr

in

no

so

so

wha

foc

pol

dis

con

the

Pro

to u

righ

Clif

of different governmental activities to increase the adoption of practices on private lands. Further, the study is limited to a short-run analysis including only the life span of practices and the short-run economic goals of farmers. Consequently, this conceptual framework is also limited to on-site and short-run physical and economic impacts and governmental activities directed to abate the soil loss and non-point source pollution problem on private land.

Institutional Parameters

The institutional dimension to the soil loss and non-point source pollution problem involves many interacting elements from social, political, economic, and religious activities which dictate what are and what are not acceptable land uses.[1] This discussion will focus on governmental activities to implement programs and formulate policy to increase the farmer's adoption of control measures. Before discussing government's activities, it is important to introduce the concept of property rights in land and discuss the relationships of these rights to governmental activity.

Property Rights in Land

From a legal point of view, property consists of man's right to use and control the object.[2] Property consists of interests or rights which an individual may acquire in an object but not the

---

[1]Raleigh Barlowe, Land Resource Economics, 2nd ed. (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1972), p. 355.

[2]Ibid., p. 374.

phys

excl

cont

the

of

act

and

ind

to

tha

ord

wha

som

rul

fee

can

Or
els
is
Or
oth

Pra

physical object itself. The concept usually implies an element of exclusion.[1] A right gives one individual the opportunity to use and control but excludes someone else from having the opportunity to have the same use or control.

Schmid has described property rights as "the relationship of one person to another with respect to a resource or any line of action."[2] Any line of action can involve interpersonal relations and includes one's right to impose cost or inflict harm on another individual or group of individuals. For example, a smoker's right to impose discomfort on a non-smoker or vice versa. Schmid also states that "rights are the instrumentality by which any society controls and orders human interdependence and resolves the question of who gets what."[3] This implies that rights are synonymous with rules and that some sovereign power will recognize and enforce those rules. The rules evolve to resolve conflicts between two or more persons who feel they have some right to an object or line of action.

Rights in land have been described as a bundle of rights which can be held separately or in combination. In the United States, the

---

[1]The element of exclusion depends on the nature of the object or good. The use of some goods by one person does not exclude someone else from making the same use of the good. An example of such a good is a TV signal. Another example is the aesthetics of landscape. Two or more persons can enjoy it simultaneously and neither can prevent the other from its enjoyment.

[2]A. Allen Schmid, Property, Power and Public Choice (New York: Praeger Publishing Co., 1978).

[3]Ibid., p. 5.

most complete set of rights in land is when it is held in fee simple ownership. Barlowe lists the following rights often associated with fee simple ownership:

> The fee simple owner has the right to possess, use, and within reason to exploit, abuse, and even destroy his land resource. He can sell his land with or without deed restrictions that affect its future use. He can give it away, trade it for other things, or devise it in any of a number of ways to his heirs. He can lease his use rights to others. He can mortgage his property or permit liens to be established against it. He can subdivide his land holding or grant easements for particular uses. He can enter into contractual arrangements involving the use of disposition of his resource holdings.[1]

As individuals make use of these rights, they impact on other individuals. The impact on other individuals, pollution for example, may prevent individuals from exercising certain rights and may conflict with societal goals. When an individual's use conflicts with society's goals, governments have certain reserved powers to control rights in property. These powers include spending, taxation, police, eminent domain and proprietory.[2] These rights are shared by different levels of governments and their various activities to establish rules or implement programs use one or more of these powers.

Soil loss and non-point source pollution from private lands used for agricultural production may affect the activities and costs of other persons. The residuals from the agricultural production systems may inflict cost on downstream water users or upon future generations who inherit a depleted soil resource. Property rights

---

[1]Barlowe, p. 378.

[2]Ibid., p. 575.

adi

Doe.

or

use

on

pol

pro

His
Co

pro

int

sus

and

in

19

ho

na

be

exe

Dep
44

Men

address the question of who has the right to inflict cost on others. Does the farmer have a right to inflict costs on downstream water users or on future generations or do future generations and downstream water users have the right to impose specific production cost or land uses on the farmer? The implementation of soil loss and non-point source pollution abatement programs and policies establish whose rights in property prevail.

Historic Development of Soil Conservation Policy

Soil erosion was recognized in the early 1930s as a national problem requiring government intervention to protect the public interests. Although the need to preserve soil and its fertility for sustained agricultural production had been obvious to some reformers and leaders since colonial days,[1] it was regarded as a problem for the individual farmer and not a problem of society. Hugh H. Bennett in 1928 pointed out the broader effects of soil erosion.[2] He emphasized how the continued loss of productivity on agricultural land would limit national growth and affect almost every aspect of American life.

To achieve the public benefit from soil conservation, it would be necessary for government to become involved in land use decisions by exercising some of their reserved rights. Congressman James Buchanan

---

[1]Angus McDonald, "Early American Soil Conservationists," U.S. Department of Agriculture, Soil Conservation Service, Misc. Pub. No. 449, October 1941.

[2]Hugh H. Bennett and W. R. Chapman, "Soil Erosion, A National Menace," U.S. Department of Agriculture, Circular No. 33, April 1928.

in 19

befor

a pol

off,

purpo

it fo

venti

1929

and t

towa

the

Serv

dire

the

priv

prov

assi

Cent
Agri
Gove

Wate
D.C.

in 1928 stated the need for national soil and water conservation policy before the House of Representatives Appropriation Committee. He said a policy is needed for the purpose of "keeping this water from running off, conserving it for the immediate benefit of the farmer, for the purpose of keeping it from washing away soil and depleting and ruining it forever, and thereby conserving it and having the effect of preventing the overflow into streams and rivers."[1] Congress responded in 1929 by appropriating $160,000 in funds for soil erosion investigations and the establishment of soil erosion experiment stations.[2]

Although such a research and education program was a step toward conserving the nation's soil resources, it could never accomplish the level of control Bennett felt necessary. In 1933, the Soil Erosion Service was established in the Department of Interior with Bennett as director. Soon after its formation, Bennett found strong objection to the Department's policy of curtailing efforts to control erosion on private lands. He felt that it was private lands, not public, that provided the greatest threat to national welfare and that direct assistance to farmers was necessary.[3] In 1934, Bennett began to

---

[1]Gladys Baker, Wayne Rasmussen, Vivian Wiser and Jane Porter, Century of Service, The First 100 Years of the U.S. Department of Agriculture, U.S. Department of Agriculture (Washington, D.C.: Government Printing Office, February 1963), p. 138.

[2]U.S. Department of Agriculture, Appraisal 1980, Soil and Water Resources Conservation Act (Review draft, Part I) (Washington, D.C.: Government Printing Office, 1979), pp. 11-15.

[3]Baker and others.

gather support for a transfer of the Soil Erosion Service from the Department of Interior to the Department of Agriculture. This transfer was made in 1935 and the agency was renamed the Soil Conservation Service.

Bennett saw soil erosion as a widespread problem requiring comprehensive and cooperative action by many land owners. "Erosion and its accompanying evils do not stop at fence lines or farm boundaries. Neither do they stop at state lines. They are, in general, watershed or regional problems and must be treated on that basis."[1] An effective conservation plan requires the participation of all farmers within a watershed. Realizing that 100 percent participation could not be achieved in any type of voluntary program, mandatory regulation would have to be enforced by some governmental unit.

> From the standpoint of national adequacy, effective soil conservation requires the intensive and coordinated treatment of all lands in every natural region of similar soil, slope, climatic, and type of farming characteristics in accordance with their needs and adaptabilities. This cannot be achieved, naturally, by intensive application of conservation measures to the land of a small group of farmers within boundaries of demonstration projects and camp areas.[2]

The New Deal Administration emphasized the need for strong national policy. Secretary of Agriculture Wallace, however, had a strong conviction that democracy could not succeed "unless the mass of the people participate in the affairs of government."[3] In the

---

[1]Robert Parks, Soil Conservation Districts in Action (Ames: Iowa State University Press, 1952), p. 2.

[2]Ibid.

[3]Baker and others, p. 196.

lon

unl

Lan

cou

loc

to

vid

nat

be

sis

for

le,

"St

be

ac

di

co

an

ac

as

—

wa
a
co

long run, a soil conservation program could not succeed, he believed, unless farmers were responsible for its planning and management. Land use regulations to prevent soil from washing and blowing away could not be imposed from Washington. They must be adopted by the local people working together to meet a common problem.

Given these views, two governmental units were conceptualized to implement soil conservation policies. A federal agency would provide technical assistance in planning, organizing and carrying out national soil conservation policies. A local government unit would be responsible for deveoping a comprehensive conservation plan consistent with national policy. The local unit would also be responsible for enforcing any land use controls.

It was envisioned that state governments would pass enabling legislation to create a new local government unit as set forth in the "Standard State Soil Conservation District Law."[1] This new unit would be endowed with certain reserved powers according to this model act to achieve specified conservation goals. The model act proposed that districts be organized along watershed boundaries. An elected board consisting of mostly farmers in the district could conduct research and demonstrations, disseminate information and carry out other activities to further soil conservation. The board with technical assistance would formulate a conservation plan including tentative

---

[1]The U.S. Department of Agriculture prepared a model law which was presented to state legislatures by the President for enactment to authorize federal, state, and local cooperation in implementing soil conservation policies.

re

on

po

va

se

ap

Con

fac

gui

in

ser

mon

to

ref

for

add

had

Cons

of t

regu

acti

regulation of land use. Public hearings and referendums would be held on the plan. Upon acceptance of the plans, districts would have the power to make contracts with land owners which stipulated and required various practices. The districts would also have the power to buy and sell land and equipment, hire personnel, receive and administer state appropriations.

As a part of the federal-local cooperative agreement, the Soil Conservation Service would provide professionally trained personnel and facilities to the local district. Their purpose would be to provide guidance in the development of district plans and technical assistance in designing and implementing practices on private land. The Soil Conservation Service would also carry out certain education, research and monitoring activities in the district.

In 1937, President Roosevelt sent copies of this model law to state governors with the recommendation that they adopt legislation reflecting its concepts. Twenty-two states passed enabling legislation for creation of soil conservation districts that same year and nineteen additional states had passed similar legislation by 1941. All states had passed some type of legislation allowing the creation of Soil Conservation Districts as a subunit of state government by 1950.[1]

Significant variations from the model law were made in most of the states' legislation. Many states did not provide land use regulation powers to districts and most made the adoption of mandatory activities difficult. In 1952, only six states allowed the adoption

---

[1]Parks, p. 8.

of land use regulations following a referendum in which 51 percent of the farmers favored the controls.[1] Most states required at least a two-thirds majority with several states requiring an 80 percent or 90 percent majority. Sixteen states did not authorize districts to adopt any land use regulations. Because of the difficulty of obtaining enforcement powers, only 10 out of 3,000 districts in 1952 had land use regulations in effect. Another variation in the establishment of districts was their creation along political boundaries rather than watersheds. In 1949, nearly 60 percent of the districts coincided with county boundaries. A large part of the remaining were subdivisions of counties or combinations of counties.

The soil conservation activities were conceptualized to create a blend of power and responsibility--not wholly centralized or decentralized. This blend of powers and authority, however, did not develop as originally planned. Because no regulatory powers were provided to either the Soil Conservation Service or Soil Conservation Districts, it was necessary to shift emphasis from a compulsory to a voluntary program. The role of the Soil Conservation Service and Soil Conservation Districts became that of education and gaining voluntary support for conservation practices.

Recent Legislation for Program Planning and Implementation

Federal Water Pollution Control Act amendments. Until adoption of the Federal Water Pollution Control Act (FWPCA) amendments in 1972,

---

[1] Ibid.

soil and water conservation policies did not specifically address water pollution aspects of soil erosion. The stated objective of the FWPCA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[1] To achieve this objective, Section 208 of this act specifies that states in cooperation with the Environmental Protection Agency do comprehensive area-wide planning which identify "agriculturally and silviculturally related non-point source of pollution including runoff from land used for crop production."[2] It also states that the plans set forth procedures and methods to control such sources. The Act has no provisions for federal regulation of these pollution sources.

The 208 planning activity in Minnesota has examined the non-point sources and their effects on water quality.[3] Agricultural activity is one of the study topics of the 208 planning effort. They emphasize the state-of-the-arts in determining water quality as rudimentary and a number of limiting factors are inherent in their assessment. They, however, generally conclude that "many agricultural activities have the potential to generate and deliver potential pollutants to surface waters."[4] They state that the magnitude of that

---

[1]U.S. Congress, Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500, Sec. 101-a, Washington, D.C.

[2]Ibid., Sec. 208f.

[3]Minnesota Pollution Control Agency, "Agriculture Package I of 208 Water Quality Management Plan," St. Paul, Minnesota, May 1979.

[4]Ibid., p. vi.

effect is largely unknown and "is probably insignificant in some waters and highly significant in others."[1]

Resource Conservation Act. The Resource Conservation Act of 1977 declares that the policy and purpose of the Act is "to further the conservation of soil, water and related resources" and that conservation programs of the U.S. Department of Agriculture "be responsive to the long-term needs of the Nation."[2] The Act calls for an appraisal on quantity and quality of soil, water and related resources and a program setting forth directions for future soil and water conservation efforts to meet long- and short-run needs of the Nation. The appraisal is to include data on "the cost and benefits of alternative soil and water conservation practices" and on "federal and state laws, policies, programs, rights, regulations, ownership and their trends relating to the use, development and conservation of soil, water and related resources." The program calls for an "evaluation of effectiveness of soil and water conservation ongoing programs and the overall progress being achieved by Federal, state and local programs." It also asks for an analysis of alternative methods for "conservation, protection, environmental improvement and enhancement" of soil and water resources and the "costs and benefits of alternative soil and water conservation practices."

---

[1] Ibid.

[2] U.S. Congress, Soil and Water Resources Conservation Act of 1977, P.L. 95-192, 18 November 1977.

State legislation. The first state-wide law passed to regulate agricultural activity to prevent soil erosion and control non-point source pollution was passed in Iowa in 1971. The Iowa law made it the duty of farmers to establish and maintain erosion control practices to maintain specified soil loss limits. The soil loss limit is established by soil conservation district commissioners at levels acceptable to meet the statute's erosion control and water quality goals. The commissioners only specify the soil loss limits and may not specify how the landowner meets those limits. Failure to meet the soil loss limits are subject to a court injunction. However, before legal action may be taken, cost-share assistance must be available to cover 75 percent of the cost of installing any permanent practice. The Iowa Supreme Court recently upheld that those aspects of the law relating to soil loss limits were reasonable exercise of the police power.

A bill patterned after the Iowa legislation was introduced in the Minnesota legislature in 1979.[1] It provides power to the soil conservation district supervisor to establish soil loss limit as deemed necessary "to insure applications of wind and water erosion control systems, gully erosion control systems and sediment control systems to reduce soil losses to acceptable limits." Like the Iowa legislation, the proposed bill stipulates that 75 percent cost-share assistance must be made available before legal action can be taken against the landowner.

---

[1]Introduced by Redalen, Munger, Searle, Mann, and Valan, 15 April 1979 in the Minnesota House of Representatives, H.F. No. 1211.

Major Soil and Water Conservation Programs

Agricultural Conservation Program. Financial assistance from the Federal government has been available to farmers who voluntarily adopt soil and water conservation practices through the Agricultural Conservation Program. This Program uses the spending power of the Federal government to provide economic incentives to landowners. For farmers who are willing to adopt certain practices, the program will either pay a certain percentage of its installation cost or make a fixed subsidy payment to the farmer. Cost share payments are made for enduring practices such as terraces and subsidy payments are made for other practices such as contouring and conservation tillage.

In 1936, Congress passed the Soil Conservation and Domestic Allotment Program which offered farmers payments for shifting acreage from surplus, soil depleting crops to soil conserving crops of legumes and grasses.[1] This program had both farm income and soil conservation objectives. The farm income objective of this program was dropped in 1943. In the following years of this program, the emphasis was on furnishing lime and fertilizer materials. These were provided to encourage the growing of soil conserving legume crops, while at the same time they improved soil productivity. Additional practices which reduce soil loss were made eligible for cost-sharing through the years. These have included such practices as establishment of permanent cover, drainage, stripcropping, terracing, grassed waterways, farm ponds, and conservation tillage.

---

[1]Baker and others, p. 166.

In 1971, and again in 1974, the Program was renamed and called the Rural Environmental Assistance Program and Rural Environmental Conservation Program, respectively. As these titles imply, the emphasis shifted to include broader environmental objectives. The list of eligible practices was changed to include pollution abatement measures such as sediment retention structures and livestock waste facilities. The production oriented practices of lime and fertilizer was provided under more restricted situations and drainage and weed control practices were deleted.[1]

Annual appropriations for the program are made by Congress and funds are distributed to states and counties according to administrative and Congressional directives. Allocations are to be based on the most recent conservation needs data available. County committees then determine the practices from a Federal and state list of authorized practices and set the cost-share or subsidy they will offer to farmers in their county. Current national guidelines specify that cost-share rates may not exceed 80 percent of the installation cost.[2] The number of farmers participating in the program has ranged from 4.4 million in 1943 to 302,000 in 1977.[3] Federal appropriations were

---

[1]U.S. Department of Agriculture, "Appraisal 1980, Soil and Water Resources Conservation Act," pp. 8-15.

[2]U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, <u>State Handbook on Minnesota Agricultural Conservation Program</u>, 1-Mn, ACP, 1979, St. Paul, Minnesota.

[3]U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, <u>1977 Agricultural Conservation Program Accomplishments</u> (Washington, D.C.: Government Printing Office, August 1978), Table 15.

highest in 1939, when nearly $500 million of assistance was provided. From 1955 to 1972, the assistance was slightly over $200 million each year. Since 1972, total gross assistance provided under this program has been less than $200 million annually.

Rural clean water program. Section 208 of the Federal Water Pollution Control Act was amended in 1977 to establish a rural clean water program.[1] The program is authorized to provide financial and technical assistance to rural land owners who install and maintain practices that abate non-point source water pollution. The Act authorizes the Secretary of Agriculture with the concurrence of the Environmental Protection Agency Administrator to make five to ten year contracts with landowners. The landowner must install practices consistent with the 208 area-wide treatment plan. Practices which control soil erosion and nutrient runoff are expected to be important aspects of the plan. Although $200 million was authorized for fiscal 1979, no appropriations were made.[2]

Minnesota cost-share program. Minnesota passed legislation in 1977 to authorize soil and water conservation districts to make contracts with landowners for cost-sharing on practices. Cost-sharing is available for "implementing any system or practice for erosion control and water quality improvement which are designed to protect

---

[1]Beatrice Homes, Institutional Bases for Control of Non-Point Source Pollution Under the Clean Water Act, U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service and Environmental Protection Agency, WH-554, November 1979, p. 17.

[2]Ibid.

protect and improve the state's soil and water resources.[1] The practice or system must be consistent with the soil and water conservation district plan, meet the U.S. Department of Agriculture standards and specifications under their program and be properly maintained for ten years. To initiate the program, $3 million was appropriated for 1980 and 1981.

Economic Parameters

Soil erosion represents an additional constraint on the agricultural production system. It impairs the productivity of a major resource for future use in the system and, as a residual, it impairs the production and consumption of other natural resource systems. Only part of these undesirable side effects or costs are dealt with through prices in the market. Many of the cost accrue to widespread groups of individuals outside the market system and to future generations who are unable to make their bids known. To reduce the effects of these market failures, or externalities, rule changes emanating from the institutional dimension are made to reflect these social desires. These actions result in a redistribution of rights and consequently shift costs and benefits. Shifts occur not only between on-site producers and off-site water users but also between present and future generations.

Although considerable research is needed and being conducted to evaluate off-site economic effects, no attempt will be made here

---

[1]Minnesota Code of Agency Rules, "Soil and Water Conservation Board Cost Share Program," Chapter 40, Sec. 2 (St. Paul: Minnesota Soil and Water Conservation Board, 1978), p. 581.

to review or expand upon this information. This review will focus on the on-site benefits and cost associated with soil loss and application of control practices. Land is discussed as a factor of production and the effects of control practices are measured as changes in the economic return to land.

Soil as a Factor of Production

Soil resources have been described as a combination of fund and flow resources. Ciriacy-Wantrup views soil as a flow resource with the future rate of flow affected by man's use and subject to a critical zone or tolerance level.[1] The flow character of soil refers to its availability as a factor in agricultural production year after year. The moisture supply, sunlight, nutrient content, microbial populations, and other properties needed for agricultural production are renewed each year. Although the availability of these properties may vary from year to year, their use in one year does not preclude their use in following years. The critical zone refers to a level of use which results in a diminished future rate of flow. Once that critical zone is reached, the reversal of a diminished rate of flow is not economically possible. Bennett viewed soil where erosion occurs as a fund resource. "Once this valuable asset leaves a field, it is as irretrievably lost as if consumed by fire, as far as that particular field is concerned."[2]

---

[1] S. V. Ciriacy-Wantrup, Resource Conservation Economics and Policies (Berkeley: University of California Press, 1963).

[2] Hugh Hammond Bennett, Soil Conservation (New York: McGraw-Hill Book Co., Inc., 1939), p. 8.

The economic return from the use which man makes of either the flow or fund resource is called land rent. Land rent is the return that accrues to land or should accrue to it for its use in production. Land rent is calculated as the residual of total value of production that remains after all labor and capital cost are subtracted.[1] When land is viewed as a flow resource, perpetual land rents from a certain quality of land may be assumed. However, if the use exceeds the critial level, the land rents will diminish at some point in the future.

Economics of Soil Loss Control Practices

It has long been argued by conservationists that the loss of top soil will reduce crop yields and lead to substantial loss in income from reduced productivity. Yet, farmers are unwilling to adopt control measures. The need for immediate income and failure to see the economic need for erosion control have been identified as obstacles.[2] According to one author,[3] farmers are aware of potential yield reductions; however, they have also observed substantial yield increases on their lands over the last fifteen years. Any yield impact from soil loss has been masked by effects of increased fertilizer and technology.

---

[1]Barlowe, p. 157.

[2]Melvin G. Blase and John Timmons, "Soil Erosion in Western Iowa: Progress and Problems," Research Bulletin 498 (Ames: Iowa State University Agricultural Experiment Station, October 1971).

[3]Paul Rosenberry and N. C. Moldenhauer, "Economic Implications of Soil Conservation," Journal of Soil and Water Conservation 26 (November-December 1971): 221.

Other objections have been timeliness of operation and uncertainty of profitable returns within their planning horizon.[1]

The nutrients lost through soil erosion represent a cost to the farmer. Beasley estimates that the loss of nutrients in one ton of eroded top soil had a value of $1.70 in 1972.[2] Others[3] have estimated that the amount of nitrogen released for plants from one ton of top soil may be no more than 0.1 lb. each year which is an insignificant loss even at high rates of erosion. Beasley points out that soil loss affects many other variables than plant nutrients. It reduces infiltration rate and water holding capacity which may have far greater yield reduction impacts than the loss of nutrients.

Studies[4] conducted in Iowa fifteen to twenty years ago showed farm incomes could be increased with the adoption of soil conservation systems. The increase in incomes, however, would not be immediate and losses would occur in the first years of the system. They also indicated a need to expand livestock enterprises to get the highest returns

---

[1]Ibid., p. 221.

[2]R. P. Beasley, Erosion and Sediment Pollution Control (Ames: Iowa State University Press, 1972), p. 15.

[3]Rosenberry and Moldenhauer.

[4]Studies conducted by the Agricultural Experiment Station, Iowa State University, Ames, Iowa, include "Cost and Returns for Soil Conserving Systems of Farming on Ida-Monona Soils in Iowa," by Ross Baumann, E. O. Heady, and Andrew Aandahl (Research Bulletin 429, June 1955) and "Profit Maximizing Plan for Soil Conserving Farming in Spring Creek Watershed," by Jay Anderson, E. O. Heady, and W. D. Shrader (Research Bulletin 519, July 1963).

from the conservation systems. Landgren and Anderson[1] concluded in 1962 that annual soil loss of 5 ton per acre was consistent with a profit maximizing solution. Heady and Smith[2] using recursive linear programming were unable to reach any conclusion as to the profitability of conservation systems. Carkner[3] in 1972 found no significant cost difference in the use of conservation tillage over conventional tillage to control soil loss on an Illinois dairy farm.

An erosion study in Southern Iowa considered increased energy use, higher fertilization rates, and reduced crop yields as variables associated with soil loss.[4] The study estimated that current erosion rates cost farmers $4.75 per acre each year. Lower yields account for most of this loss. The study also investigated the least cost erosion control method. They found that use of crop rotation, contouring and residue tillage was least costly while relying on use of rotation and terracing was the most expensive. Other combinations of crop rotation, contouring, terracing and residue tillage were evaluated.

---

[1]Norman Landgren and Jay Anderson, "A Method for Evaluating Erosion Control in Farm Planning," in Agricultural Economics Research USDA XIV(2) (Washington, D.C.: U.S. Department of Agriculture, April 1962).

[2]Wesley Smith and E. O. Heady, "Use of Dynamic Model on Programming Optimum Conservation Farm Plans on Ida-Monona Soils," Research Bulletin 475, Agricultural and Home Economics Experiment Station, Iowa State University, February 1960.

[3]Richard Carkner, "A Case Study of the Economic Impacts of Farm Soil Loss Controls" (Ph.D. dissertation, Michigan State University, 1974).

[4]"Erosion Costs You More Than Soil," Wallaces Farmer, 24 February 1979.

Physical Parameters

Soil erosion is a natural and continuous process. In a natural ecologic system there are forces resulting in soil formation as well as soil loss. Soil formation results from the weathering of parent materials and the breakdown of vegetation into soil constituents. Loss of soil constituents occur from wind and water erosion, and leaching. Without the influence of man's production and consumption activities, the soil formation has generally exceeded soil losses. Over eons of time and a thick mantle of soil has developed which constitutes the physical basis for today's agricultural production.

Soil Loss Tolerance

Soil conservationists have been concerned with cropping practices which maintain a long-run equilibrium between soil formation and soil loss. Based on sustained land rents, soil loss tolerance levels have been established for most soils. Soil loss tolerance is "the maximum level of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely."[1] Factors considered in the establishment of these limits included soil depth, physical properties and other characteristics affecting root development, gully prevention, field sediment problems, seeding losses, soil organic matter and plant nutrient losses.

---

[1]U.S. Department of Agriculture, Science and Education Administration, "Predicting Rainfall Erosion Losses," Agricultural Handbook 537, December 1978, p. 2.

These tolerance levels are designed for sustained cropland productivity and do not address water pollution aspects of soil loss.[1] These limits may or may not be sufficient to meet the water quality objectives. Water pollutants include not only sediments and the nutrients or chemicals adhering to soil particles but also those materials which are water soluble and leave the land in water runoff. Although research is being conducted to relate soil erosion rates to water quality,[2] no conclusive results were found in the studies reviewed.

Soil loss tolerance levels range from two to five tons per acre per year for soils in the United States.[3] These limits were established by a team of soil scientists, agronomists, geologists and soil conservationists at regional workshops in 1961 and 1962. A deep, medium textured soil that has a subsoil favorable for plant production has a greater tolerance level than shallow soils with unproductive subsoils. According to some authors, some soils are capable of sustained productivity with soil loss in excess of the five-ton maximum limit.[4]

---

[1]Ibid., p. 3.

[2]Studies are being conducted by the Science and Education Administration, Soil Research Laboratory in Morris, Minnesota by C. A. Onstadt, and by Economics, Statistics, and Cooperative Service and University of Iowa, by David Carvey.

[3]"Predicting Rainfall Erosion Losses," p. 3.

[4]Ibid., p. 3.

When average annual soil loss exceeds soil formation, a portion of top soil resource is lost as far as future agricultural production is concerned. Erosion phases have been used to describe soil conditions and their productivity.[1] Erosion phases are defined by the mixture of A and B soil horizons which occur within the normal plow layer. Soils with a deep top soil which has little mixing of the B horizon in the plow layer are Phase I. Phase II conditions exist on soils with a mixture of A and B horizons in the plow layer and Phase III includes those severely eroded conditions in which the plow layer consists mostly of B horizon soil constituents.

The Soil Conservation Service and Economics, Statistics and Cooperatives Service conducted a soil depletion study in southern Iowa to predict changes in erosion phases. One objective was to predict a future date when specific soils would shift from one erosion phase to another under current practices. It was estimated in that study by year 2020, that 26 percent of land currently in Phase I will deplete to Phase II or Phase III and 20 percent currently in Phase II will deplete to Phase III.[2] As a consequence, Phase III conditions will increase from 9 percent to 39 percent of the harvested cropland in the area unless changes in cropping practices or land treatments are made.

---

[1]Paul Rosenberry, Lacy Harmon and Russell Knutson, "Soil Depletion Study Reference Report, Southern Iowa Rivers Basin," U.S. Department of Agriculture, Soil Conservation Service and Economics, Statistics and Cooperatives Service, Des Moines, Iowa, February 1980.

[2]Ibid.

Soil Loss Measurements

Since 1930, controlled studies on field plots and watersheds have been made to identify and measure the physical variables which cause soil to erode. Zingg, in 1940, published an equation relating soil loss to slope lengths and gradients.[1] Others[2] conducted studies to relate soil loss rates to growing crops, conservation practices, soils, and rainfall events. In 1946, all of this information was assimilated by a national committee on soil loss to develop a formula for predicting soil loss. This formula became known as the Musgrave equation.[3] With further studies and more refined measurements, a new soil loss equation was developed in the late 1950s by a team of scientists led by W. H. Wischmeir. The equation has become known as the Universal Soil Loss Equation.[4] It is adaptable to uses by planners and researchers and can incorporate improved measurements from on-going research. The impact of various factors and the specific formulation of this equation is discussed in Chapter IV.

---

[1]A. W. Zingg, "Degree and Length of Land Slope as It Affects Soil Loss and Runoff," Agricultural Engineering 21 (1940): 59-64.

[2]D. D. Smith, J. H. Neal, D. M. Witt, C. M. Woodruff, C. L. Parish and John Gloss also made significant contribution in identifying these relationships.

[3]G. W. Musgrave, "The Quantitative Evaluation of Factors in Water Erosion, A First Approximation," Journal of Soil and Water Conservation 2 (1947): 133-138.

[4]U.S. Department of Agriculture, Agricultural Research Service and Purdue Agricultural Experiment Station, "Predicting Rainfall-Erosion Losses from Cropland East of the Rocky Mountains," Agricultural Handbook 282, May 1965.

The initial purpose for the equation was to facilitate on-site planning for soil conservation practices. The simple equation, a product of six factors, was capable of providing farmers and conservationists with various combinations of crop rotation, tillage systems and land treatments that would be within soil loss tolerance levels. Site specific factors could easily be fitted into the equation and a farmer could select those alternatives best suited to his unique situation. The Universal Soil Loss Equation has also been used in a much broader application to estimate impacts of watershed projects, comprehensive river basin development plans, and commercial, industrial development activities.

This equation was applied in the Southeast Minnesota Tributaries Basin to estimate soil loss from cropland.[1] Over 13.5 million ton of soil loss was estimated from cropland under 1975 cropping practices and land treatments applied at that time. A land treatment plan for the basin which increased adequately treated cropland from 42.5 percent in 1975 to 70 percent in 2000 was estimated to reduce total soil loss in the basin to 8.4 million tons.

Naturally Occurring Factors Which Affect Soil Loss Rates

Climate and land are factors which affect soil loss rates over which man has little control. Rainfall and runoff provide the energy and transport mechanism for soil loss and non-point source pollution. The energy to dislodge and move soil particles varies

---

[1]U.S. Department of Agriculture, Soil Conservation Service, "Southeast Minnesota Rivers Basin Report" (draft), St. Paul, Minnesota, January 1980.

according to rainfall intensity and amount of runoff. Rainfall intensity is a function of raindrop size, velocity of free falling rain drops, and rainfall rate.[1] Runoff is not always directly related to rainfall. Soils become dryer, vegetation lusher, temperatures higher and evaporation and transportation losses greater as summer progresses. These factors reduce runoff from storm events which means reduced soil loss and lower transport capabilities in later crop production stages.

Land factors which affect soil loss include properties of the soil and its topography. Soil texture, structure, organic matter content and water permeability are important factors affecting soil erodibility and quantity of runoff.[2] Organic matter content increases the adhesiveness between soil particles and its resistance to dislodge. Soil textures high in clay also have strong adhesive forces. In general, soil tendencies to erode are directly related to percent of finer soil particles, except clay, and are inversely related to percent of organic matter content.[3] Soils high in silt, low in organic matter and clay, are usually most erodible.

Soil properties also affect runoff. Soil porosity and permeability affect infiltration and runoff rates and consequently soil

---

[1]U.S. Department of Agriculture, Science and Education Administration, "Predicting Rainfall Erosion Losses," Agricultural Handbook 537, December 1978, p. 5.

[2]Ibid., p. 8.

[3]G. S. Johnson and J. A. Moore, "The Effects of Conservation Practices on Nutrient Loss," University of Minnesota, Agricultural Engineering Department, St. Paul, Minnesota, 1978.

erodibility. Soils with low runoff potential include deep silts of loess parent material.[1] These soils have large soil aggregates and have less expansion when wet than soils higher in clay content or lower in organic matter. Shallow soils or soils with high clay content impede downward movement of water and consequently result in higher runoff rates.[2]

Slope steepness is an obvious factor affecting quantity and velocity of runoff. Velocities are generally proportional to slope grade. Because of the velocity occurring on steep grades, there is less opportunity for infiltration. Quantities of runoff increase also with slope length and consequently the greatest erosion hazards occur at the base of a slope.

Affects of Farm Production Systems

Crops, tillage systems, and conservation practices specifically adapted to control soil loss are interrelated with the natural factors and impact on soil loss rates and non-point source pollution. They affect the intensity of rainfall striking a soil surface; the resistance of soil components to detachment and the quantity and velocity of runoff. In addition, they introduce materials into the natural system which may enter waterways through runoff and sediment delivery. This section will identify some of the variables in a farm production system that affect soil loss and non-point source pollution.

---

[1]Minnesota Pollution Control Agency, "Agriculture Package I of 208 Water Quality Management Plan," St. Paul, Minnesota, May 1979, p. 27.

[2]Ibid., p. 27.

The effect of individual crops on runoff and erosion is related to the canopy and the time of the year when the protective cover is present. Other affects of crops are related to the root system of the plant and the residues they produce. Susceptibility to erosion hazard is greatest for those crops which provide little or no protective canopy during high rainfall seasons. These crops include corn and soybeans which have no canopy to intercept rainfall for a significant time period before and after spring planting. Because corn has a fibrous root system, once established it can stabilize soil and control erosion better than soybeans.[1] Hay crops once established provide some continuous protective cover and erode much less than row crops. Permanent establishment of grasses with fibrous roots and continuous canopy provide excellent protection and soil loss is nearly negligible.[2]

Soil loss from row crops is affected by tillage systems and residue management. In general, soil loss is directly related to the time bare soil is exposed to rainfall and inversely related to the amount of crop residue remaining on the surface. Tillage systems using fall moldboard plow which incorporates all crop residues has the greatest hazard by leaving soil exposed for the longest time prior to planting. Crop residue left on the surface can decrease the energy

---

[1]J. V. Mannering and C. R. Fenster, "Vegetative Water Erosion Control for Agricultural Area," in Proceedings of the National Symposium on Soil Erosion and Sedimentation (St. Joseph, Mich.: American Society of Agricultural Engineers, 1977), pp. 91-106.

[2]Ibid.

[3]G. R. Foster and L. D. Meyer, "Soil Erosion and Sedimentation by Water," in Proceedings of the National Symposium on Soil Erosion and Sedimentation by Water (St. Joseph, Mich.: American Society of Agricultural Engineers, 1977), pp. 1-13.

intensity of rainfall as well as entrap soil particles. Secondary tillage following moldboard plowing smooths the surface. This removes micro depressions on the surface and reduces water infiltration. As a consequence such secondary tillage increase runoff and soil loss rates.

It also needs to be mentioned that tillage practices affect plant growth. When left rough, fall moldboard plowing has high water infiltration which increases water availability to the crop in the following growing season.[1] Secondary tillage provides better soil-seed contact for good germination and early plant growth.[2] Moldboard plowing also distributes applied fertilizer throughout the plow layer and does not allow them to accumulate at the surface where they may be lost through runoff or evaporation.[3]

A number of alternatives to moldboard plowing have resulted. In general, these systems are designed to leave crop residues on the surface for soil loss control and still provide good water infiltration and a seedbed for good plant germination and growth. Crop residues left on the surface prevent raindrops from directly striking the soil and thus reduce its energy intensity. The residues also provide small depressions which increase water infiltration and entrap soil. Soil

---

[1]James Swan and John True, "Management Considerations in Primary Tillage for Corn and Soybeans," Special Report 64 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1977).

[2]Ibid.

[3]J. W. Bauder, C. F. Halsey and W. E. Jokela, "Tillage: Its Role in Controlling Soil Erosion by Water," Extension Folder 479 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979).

aggregates are not pulverized as much with conservation tillage systems which leaves them larger in size and less easily transported by runoff.

Tillage practices also affect the loss of nutrients from fields into watercourses. Nitrogen and phosphorus are a major non-point source pollutants affected by tillage systems. Nitrogen is lost from fields either as sediment-associated nitrogen or soluble nitrogen in runoff.[1] Conservation tillage which does not incorporate applied fertilizer in the soil is subject to a greater loss through runoff. One researcher found that soluble nitrogen losses on no-till corn roughly doubled when applied as a broadcast over that which was incorporated into the soil.[2] However, this loss is more than offset according to Johnson and Moore[3] from lower losses of sediment associated nitrogen. Because phosphorus attaches to soil particles, its loss to watercourse is directly related to sediment. There is some evidence that the lack of fertilizer incorporation associated with conservation tillage increases the phosphorus concentration on the soil surface and on the soil that does erode. The reduction in quantity eroded more than offsets the increase in concentration.[4]

---

[1]Minnesota Pollution Control Agency, "Agriculture Package of the 208 Water Quality Management Plan," St. Paul, Minnesota, May 1979, p. 89.

[2]F. D. Witaker, H. G. Heineman and R. E. Burwell, "Fertilizing Corn Adequately With Less Nitrogen," Journal of Soil and Water Conservation, January-February 1978, p. 32.

[3]G. S. Johnson and J. A. Moore, "The Effects of Conservation Practices on Nutrient Loss," University of Minnesota, Agricultural Engineering Department, 1978.

[4]Ibid.

Crop Yield Impacts From Tillage System

According to one farm management extension specialist,[1] many farmers are reluctant to adopt conservation tillage systems. They are aware of the relationships of yield to soil moisture, spring soil temperature, fertilizer placement and weed and pest control from moldboard plowing. The unknowns related to crop yields with various conservation tillage systems is an added risk which the farmers are reluctant to assume. Farmers are interested in crop yield impacts from conservation tillage research and from farmers who have adopted these systems.

A number of studies have been conducted throughout the cornbelt to measure corn and soybean yields using mulch tillage or no-till systems. Cosper[2] surveyed recent site specific research in four cornbelt states to determine what crop yields could be expected from various conservation tillage systems. In general, he found lower corn yields were reported in Ohio, Indiana and Illinois when no-till systems were used on fine textured, poorly drained soils. The yield reduction, however, was less significant on better drained soils. There was little difference between mulch tillage and conventional tillage systems in Iowa.

---

[1]Personal interview with Mervin Freeman, Area Farm Management Specialist, University of Minnesota Extension Service, Rochester, Minnesota.

[2]Harold Cosper, "The Influence of Tillage Systems on Corn Yields and Soil Loss in Ohio, Indiana, Illinois and Iowa," Working Paper No. 54 (Washington, D.C.: Economic Research Service, Natural Resource Economics Division, July 1978).

The studies to measure effects of tillage systems on crop yields in Minnesota are inconclusive. In a four-year study on Webster soils in south central Minnesota, tillage practices significantly affected corn yields.[1] The highest yields were obtained with moldboard plowing. Average yields with chisel plow were significantly lower and no-till systems consistently resulted in the lowest average yield. The average yield for fall moldboard chisel plow and no-till systems for corn were 130, 117, and 108 bushel per acre, respectively.

Studies jointly conducted by the University of Wisconsin and the University of Minnesota at Lancaster, Wisconsin[2] do not show as significant yield reduction as those in south central Minnesota. In these studies, no difference was found between spring moldboard and chisel plowing. In two out of three years, corn yield using a no-till system was seven and fifteen bushels less.[3] On the third year, however, it was nine bushels higher.

---

[1]J. W. Bauder et al., "Tillage Practices in South Central Minnesota," Extension Folder 492 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979).

[2]J. B. Swan and J. A. True, "Tillage for Corn and Soybeans," in Soils, Soil Management and Fertilizer Monographs, Special Report 24 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1978), pp. 35-57.

[3]W. Paulson, A. E. Peterson, J. B. Swan and R. Hoggs, "Tillage Summary, 1976-78," in A Report on Field Research in Soils, Soil Series 105 (St. Paul, Minn.: Department of Soil Science, University of Minnesota, March 1979), pp. 179-181.

CHAPTER III

ANALYTIC FRAMEWORK

Policy Simulation

The analytic approach of this study is an application of a mathematical model to predict physical and economic effects of soil conservation practices and policies and to compare these effects between different production systems. A mathematical model is a technique which allows the researcher to build a representation of a real world system in which he can conduct controlled experiments and observe changes.[1] The representation consists of a set of simplifying assumptions which capture sufficient essence of reality to predict real world outcomes from changes in the system.

In this system the model represents the agricultural production systems on farms representative of southeastern Minnesota. The independent variables of this model are the alternative soil conservation practices and alternative policy options. The dependent variables include net farm income, soil loss, crop production and the farmer's choice of production technology applied on each representative farm. Since policy-makers can change the independent variables in the real world production system through use of government powers, their interest

---

[1]Daniel E. Chappelle, "Economic Model Building and Computers in Forestry Research," Journal of Forestry, May 1966, p. 329.

in such a model is its prediction of impacts measured by the dependent variable from a policy change.

The validity of a model's prediction depends on limitations of the simplifying assumptions to reflect real world relationships and the precision of data measurements used in the model. This model assumes that representative farms have a profit maximization goal. It assumes that profit constraints are unique between farms because of their size, soil composition and enterprise combination and such constraints can be reflected in the representative farm definitions. It is further assumed that the physical and economic data sets can be estimated to reflect production processes, management, institutional effects and the technology applied on each of the farms. The remainder of this chapter as well as the next two chapters deal with the assumptions used to formulate this model and the estimated data inputs required for its application.

Representative Farms

This analysis is conducted using a representative farm concept. There has been a wide application of this concept to provide guidance to farmers as well as policy makers.[1] Plaxico and Tweeten[2] suggested such an approach could be useful for programs which require incentive payments in order to achieve certain national interest objectives. A

---

[1]E. O. Heady et al., Agricultural Supply Functions (Ames: Iowa State University Press, 1961).

[2]James S. Plaxico and Luther Tweeten, Representative Farms for Policy and Projection Research," Journal of Farm Economics, December 1963, p. 1460.

representative farm approach has been used to measure economies of scale for different farm sizes[1] as well as variation from farm programs due to farm types.[2] Iowa farms representative of the Ida-Monona soil association were used to measure economic impacts of conservation farm plans.[3] Although representative farms may never be duplicated on individual real farms, they do provide a means of measuring relative effects from institutional changes.

Within a general farm region, farms may be stratified according to different characteristics. Representative farms may be developed for several target populations such as dairy farms, cash grain farms, small farms, farms with high erosion hazard soils, etc. It was earlier hypothesized that soil conservation policies could have differential effects on farm income because of soils composition, enterprise combination and size. To test this hypothesis, the following target populations were selected:

- Farms with roughage consuming livestock enterprise;
- Farms without roughage consuming livestock enterprises;

---

[1]G. E. Frick, I. F. Fellows and S. B. Weeks, Economies of Scale in Dairying--An Exploration in Farm Management Research Methodology, Research Bulletin 285 (Storrs: Connecticut Agricultural Experiment Station, 1952).

[2]Warren Bailey and Ronald Aines, How Wheat Farmers Would Adjust to Different Programs, Research Report No. 52 (Washington, D.C.: U.S. Department of Agriculture, 1961).

[3]Wesley G. Smith and E. O. Heady, Use of a Dynamic Model in Programming Optimum Conservation Farm Plans on Ida-Monona Soils, Research Bulletin 475 (Ames, Iowa: Agricultural and Home Economics Experiment Station, February 1960).

- Farms with high erosion hazard soils;
- Farms with moderate erosion hazard soils;
- Commercial size farms; and
- Small farms.

The concept of representative farms was selected for this study as a method of analysis over other techniques such as per acre budgeting, case studies or average farm conditions. The representative farm approach has been criticized because of aggregation bias and its static nature.[1] While limitations exist they are not unique to this model but are common to alternative models. Per acre approaches do not allow for measurement of effects from a total conservation plan. The adverse effects of one practice may be partially offset by beneficial effects of another practice.[2] Case studies involve unique production functions which cannot be generalized to a broader population. The average farm approach is biased by extreme observations. These weaknesses as well as the availability of data and personnel and time constraints of the study are reasons for selecting this approach.

---

[1]Jerry A. Sharples, "The Representative Farm Approach to Estimation of Supply Response," American Journal of Agricultural Economics 51 (May 1969).

[2]The Rural Clean Water Program authorized by the Culver Amendment to PL 95-500 stipulates that non-point pollution be implemented on a total farm basis.

The Mathematical Model of Representative Farms

The mathematical model for each representative farm consists of a set of crop enterprise budgets and selection of the most profitable combination of cropping systems (activities) with alternative soil conservation practices and policies. Budgets for each activity are developed for each field on representative farms and includes costs and returns for alternative crops, crop rotation, tillage systems and applied conservation practices. The budgets include quantity and cost of production input estimates and estimates of quantity and value of crop production. Also included in the budgets are soil conservation practice cost, subsidies for specific practices and an estimate of soil loss.

The selection of the most profitable combination of activities on each farm is made by integer linear programming on livestock farms and a computerized sorting and ranking routine on grain farms. On livestock farms the selection of the maximum profit cropping system is constrained by minimum levels of hay and silage production in addition to the soil conservation policy options. To simultaneously consider these constraints and maximize profits, integer linear programming is used to select the optimum set of activities. On grain farms the selection of activities is constrained only by the soil conservation policy option. Consequently on grain farms, the sorting of activities by different policy options and ranking by profit is sufficient to determine the maximum profit combination of activities.

A budget generator is used to estimate a budget for each crop enterprise activity. This estimating procedure was developed by the U.S. Department of Agriculture's Economic, Statistics and Cooperatives Service for use in river basin studies.[1] The budget generator has been used in the north central region to develop budgets and matrices for linear programming and production simulation models. When data input are specified, the generator estimates capital input cost, interest on capital inputs, machine operation costs, fuel consumption, labor requirements, and other production costs. The advantage in using such a generator is that it facilitates the numerous calculations needed to reflect differences in inputs for alternative soil conditions, tillage systems, crop sequence in rotation and applied soil conservation practices.

In this application, budgets were developed for five soil types on each farm, four tillage systems, five crops within fifteen rotations and three applied soil conservation practices. The input items for each budget include capital inputs, machine operations, labor, and other specified expenses. The capital inputs include seed, fertilizer and chemical pesticides which change by expected yields and tillage systems. The machine operation costs include all fuel, depreciation,interest, storage and maintenance cost for all tillage, planting and harvesting operations. The labor costs are based on time requirements to accomplish machine operations given the equipment size,

---

[1]U.S. Department of Agriculture, Economic Research Service, Natual Resource Economics Division, "Multiple Objective Resource Evaluation System," East Lansing, Michigan, January 1973.

speed and field efficiency. Representative farm capital and labor constraints were considered in specifying machine size and type. Other production input costs include amortized average annual cost of soil conservation practices, drying cost for corn and custom harvest cost on small farms. The specific data inputs used to generate budgets for this study are reported in Chapter V.

Integer programming is an optimizing technique which selects from a set of feasible processes that process which maximizes a linear objective function. In this application, the objective function is to maximize net farm income from alternative crop production and soil and water conservation activities. The production activities include grain and forage crops produced according to specified crop rotations, tillage systems and applied conservation practices. The maximization procedure is subject to land and forage production constraints assumed for each of the representative farms. Various sets of activities are added to or deleted from the models to reflect adoption of soil conservation plans or to simulate alternative policy options.

The mathematical formulation of the model can be presented in the following general form:

Maximize:
$$Z = \sum_{j=1}^{n} C_j X_j \tag{3.1}$$

Subject to:
$$\begin{aligned} &\sum_{j=1}^{n} a_{1j} X_j \le (\text{or} \ge)\ b_1 \\ &\quad\vdots \\ &\sum_{j=1}^{n} a_{mj} X_j \le (\text{or} \ge)\ b_m \end{aligned} \tag{3.2}$$

and: $$X_j = 0 \text{ or } 1 \qquad (3.3)$$

The objective function is expressed by equation 3.1 where Z represents net farm income, X_j is the level of crop production activity and application of soil conservation practice and C_j is the net profit associated with each activity. The technical coefficients and model constraints are represented by the inequalities in 3.2. The b_1 to b_m are the land resource constraints and minimum levels of roughage production. A less than or equal to inequality applies to the land constraint and a greater than or equal to inequality applies to the minimum levels of roughage production. The a_{ij} represent the resource requirement or roughage production for activity j. The final equation, 3.3, is the non-negative and integer constraint which requires the model to either include or exclude an activity.

In this application, the production activities are defined as crops grown in a specific sequence in a rotation and using specific tillage system and conservation practice. For example, corn may be grown in a continuous corn rotation (c-c) or in rotation following an alfalfa hay crop (c-c-o-m-m-m). The crop activities are also defined according to the different tillage systems. For example, either conventional fall moldboard plowing or minimum tillage system may be used to grow corn. Likewise, the farming practice may be straight rows across the field, contour rows or contour strips. In addition to the crop activities, the model also includes activities to reflect the adoption of such enduring practices as terracing and grassed waterways.

The net return for each activity represents the annual return to land and labor. It is calculated as the total value of production less expenses for seed, fertilizer, herbicide, fuels, machinery depreciation, hired labor, custom work, etc. The cost of enduring conservation practices is amortized over the expected life span of the practice. In this application, no allowance for land taxes, mortgage payments, interest expense, or cash rent is made.

The level of activity in this model is the farm field. Any alternative crop production activity is assumed to be applied on the entire field and not some portion of the field. In other words, a field is not considered a divisible unit in which different combinations of activities may occur. This assumption is not consistent with the infinitely divisibility assumption of non-integar programming.[1] Integer programming restricts the level of any activity, X_j, to an integer and is consistent with the indivisibility assumption. In this application, the activity level is either zero or one.

Policy Options

The preceding chapter discussed policy options to reduce soil loss and abate non-point source pollution. Each option uses one or more of the reserved powers of government to increase the adoption of soil conservation practices. The policy options in this study involve financial subsidy through government spending power, regulation through the police power and a soil loss tax. The mathematical model

---

[1]William Baumol, Economic Theory and Operations Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 149.

for each of the eight representative farms is used to simulate the impact of such policy options.

The following policy options are addressed to this study:

1. Base line (no government programs);
2. Cost share subsidy for practices;
3. Subsidy for conservation tillage systems;
4. Combined cost-share subsidy for practices and use of mulch or zero tillage systems;
5. A maximum soil loss limit at the per acre tolerance level;
6. A soil loss tax on estimated tons of soil loss; and
7. A cross compliance minimum conservation plan.

The base line option assumes no government programs exist to provide economic incentives for adopting practices nor regulation to control soil erosion rates. The model considers only conventional fall or spring moldboard tillage systems in selecting the most profitable cropping system on farms. No cropping system having erosion rates exceeding 50 tons per acre however were considered in any model applications. The cost-share subsidy for practices include full payment of all technical assistance and cost-share payments to farmers and operators who install practices. The subsidy for mulch or no-till is reflected in the model as a per acre payment for crops grown with these tillage systems. The soil loss maximum at the tolerance level assumes no cropping system is used which results in soil loss greater than five ton per acre per year. The soil loss tax policy option assumes the farmer must pay a tax on each ton of estimated soil loss but is otherwise free to select the most profitable cropping system. The cross compliance minimum conservation option assumes the adoption of a minimum conservation plan which includes contour farming with grassed waterways.

soil

are

for

rese

well

and

decu

and

the

havi

non-

(1)

Soil

farm

is th

and

lives

CHAPTER IV

THE PHYSICAL DATA SET

The physical relationships between crop production activities, soil loss and soil loss control practices, while extensively researched, are extremely complex and not well documented. The physical data set for this model relies on a number of information sources including research publication, soil surveys, technical handbooks and guides as well as personal discussions with researchers, farm managers, advisors and conservationists. Some of the physical relationships are well documented with substantial research while others are only assumptions and judgments. The purpose of this chapter is to document and quantify the most important independent variables of the model.

Representative Farms

Three elements were identified in Chapter I, as potentially having different economic effects from the adoption of soil loss and non-point source pollution control practices. These elements were: (1) soil composition, (2) enterprise combination, and (3) farm size. Soil composition compares farms with severe erosion hazard soils to farms with only moderate erosion hazard soils. Enterprise combination is the comparison between farms that grow primarily cash grain crops and those which also grow forage crops in support of roughage consuming livestock enterprises. Farm size compares farms that have different land, labor and capital limitations. Using these three elements, eight representative farms are identified for this study. They are as follows:

- Fayette and Associated Soils
  - Grain Farm
    - 160 Acre Farm
    - 480 Acre Farm
  - Roughage Consuming Livestock Farm
    - 160 Acre Farm
    - 480 Acre Farm

- Downs and Associated Soils
  - Grain Farm
    - 160 Acre Farm
    - 480 Acre Farm
  - Roughage Consuming Livestock Farm
    - 160 Acre Farm
    - 480 Acre Farm

Soil composition varies widely among farms in southeast Minnesota. Farms in the thin loess and til uplands, consisting mostly of alfisols often have severe erosion hazards when used for crop production. Farms in the deeper loess uplands consisting of a mixture of mollisols and alfisols have moderate erosion hazards under row crop production. In the Southeast Minnesota Tributaries Basin, these hazard areas were identified and correlated with several soil associations.[1] Fayette-Dubuque-Chaseburg was a prevalent soil association in areas of severe erosion hazards. Tama-Downs-Chaseburg was identified as a predominate soil association with moderate erosion hazards.

---

[1]U.S. Department of Agriculture, The Southeast Minnesota Tributaries Basin Report (draft) (St. Paul, Minn.: Soil Conservation Service, Economics, Statistics, and Cooperative Service, 1980).

A wide variety of enterprise combinations occur in the area. The 1974 Agricultural Census reports some combination of crop, livestock and poultry enterprises occur on 85 percent of the farms.[1] Forty percent of the farms had beef cows and the average herd size was 40 head. Forty-four percent of the farms had milk cows with an average herd size of 32 head. Other confined livestock enterprises include fed beef, swine and poultry. For this study, minimum roughage requirements on livestock farms is an estimate of hay and silage needs for a beef cow-calf enterprise. This minimum requirement is estimated from feed rations for beef cows. The herd size is estimated from the number of cows which could be supported during the growing season by permanent pasture or grazed forest on representative farms.

The farm sizes considered in this study are 160 acres and 480 acres. In 1977, the average farm size in the ten-county area of southeast Minnesota was 217 acres.[2] The 1974 Agricultural Census reports that 48 percent of the farms in the area are less than 180 acres in size and only 8 percent are larger than 500 acres. The farms larger than 500 acres, however, account for over 30 percent of all farmland while those under 180 acres account for 19 percent.

Small farms as applied in this model have limited capital while larger farms have limited labor, especially during critical spring planting. The 480 acre farms are assumed to have all machine

---

[1]U.S. Department of Commerce, Bureau of Census, 1974 Agricultural Census, Minnesota State and County Data (Washington, D.C.: Government Printing Office, 1974).

[2]Ibid.

complements necessary for tillage, planting and harvesting activities while the 160 acre farms custom hire certain activities. The machinery on the 480 acre farms is of sufficient size to allow the operator to complete all operations with only limited hired labor. Machinery size on each representative farm was determined using a maximum of fifteen field operation days to complete spring planting operations[1] and the acreage per hour covered by different sizes of farm machinery.[2]

The natural resource base, including topography, soils, and crop yield potential, are assumed identical between the grain farms and farms including roughage consuming livestock. Difference in use, however, are assumed between these two farm classes. The field layout on grain farms is designed to make the best use of all land suitable for cultivation and row crop production.[3] Land unsuitable for tillage is assumed to remain idle when it occurs as a small acreage within a field. Larger acreages of land unsuited for cultivation are assumed to be in permanent pasture and cash rented to surrounding livestock farms. On farms with a roughage consuming livestock enterprise, marginal land for tillage is left in permanent pasture. Consequently, the representative farms with roughage consuming livestock have a

---

[1]Fifteen days of field operation days was suggested by Mervin Freeman, Area Extension Farm Management Specialist, University of Minnesota, Rochester, Minnesota.

[2]Fred Benson and Bruce Hatteberg, "Minnesota Farm Machinery Economic Cost Estimates," FM 609 (St. Paul, Minn.: University of Minnesota Agricultural Experiment Station, February 1979), Table 5.

[3]Land in capability class VI is defined to have limitations that make them generally unsuited for cultivation and limit their use to pasture, woodland and wildlife food and cover.

larger acreage of pasture and smaller acreage of cropland than representative grain farms, even though they have an identical natural resource base.

A maximum profit objective is assumed for all representative farms. The model selects that combination of activities on cropland subject to certain specified soil loss and control practice constraints. Production activities on representative farms with roughage consuming livestock are constrained to minimum levels of hay and silage production for winter livestock rations. Silage is produced only on roughage consuming livestock farms. Hay may be produced on representative grain farms when necessary to meet soil loss objectives. When hay is produced on a grain farm, however, it is assumed to be 50-50 share cropped with a surrounding livestock farm. The return includes only half the value of hay produced. The grain farmer establishes the hay crop and applies fertilizer while the share farmer provides all labor and machinery for harvesting. No difference between the grain production activities are specified between grain and roughage consuming livestock farms.

On livestock farms a minimum level of hay and silage is assumed to be produced in support of the livestock enterprises. These minimum levels of hay and silage production are based on the winter roughage requirements for a beef cow-calf enterprise. The size of the enterprise was estimated from the number of animal units which could be supported during the growing season from pasture. The roughage needs are estimated from winter feed fation for a beef cow and the size of the enterprise on each representative farm. These roughage needs are reported in Appendix A.[1]

Land Base

To measure crop production and soil loss, specific topographic and soils information is needed. This information for the representative farms was constructed from county soil survey maps,[2] farm plans[3] and information and descriptions provided by the Soil Conservation Service district conservationists. Maps for each of the representative farms were constructed to indicate natural drainage patterns typical of the soil association and the location of specific soil mapping units relative to the constructed landscape. Farm fields were imposed on the maps with consideration given to topographic conditions, soils and potential uses by either the grain farms or the roughage-consuming livestock farms. The land in ditches, forest, fence rows and farm lanes was calculated and subtracted from the land base of each field. Each field was then planimetered to determine the acreage by soil available for crop production in each field.

Tables 4-1 and 4-2 show major land use for representative farms in the Fayette and Downs Soil Associations, respectively. Land use in the Fayette soils consists of larger acreages of pasture and

---

[1]Sydney James, Midwest Farm Planning Manual, 3d ed. (Ames: Iowa State University Press, 1974), p. 60.

[2]Soil survey maps from Fillmore, Wabasha, Goodhue, Dodge and Rice Counties were used to construct typical drainage patterns and the general location of soil types relative to a drainage pattern.

[3]Farm plans were reviewed in the Soil Conservation Service District offices in Houston and Olmstead County, Minnesota.

Table 4-1. Major land uses assumed for representative farms with Fayette and associated soils, southeast Minnesota study area

Land Use	160 Acre Farms		480 Acre Farms	
	Grain Farms	Livestock Farms	Grain Farms	Livestock Farms
	Acres			
Cropland pasture	126.4	93.0	348.6	236.3
Pasture	7.0	42.3	55.8	177.8
Forest	14.8	14.8	51.2	5.2
Farm buildings and lots	4.0	4.0	4.0	4.0
Miscellaneous	7.8	5.9	20.4	10.7
Total	160.0	160.0	480.0	480.0

Table 4-2. Major land uses assumed for representative farms with Downs and associated soils, southeast Minnesota study area

Land Use	160 Acre Farms		480 Acre Farms	
	Grain Farms	Livestock Farms	Grain Farms	Livestock Farms
	Acres			
Cropland	149.5	120.4	456.3	388.5
Pasture	0.0	32.0	0.0	72.0
Forest	0.0	0.0	0.0	0.0
Farm buildings and lots	3.0	3.0	4.0	4.0
Miscellaneous	7.5	4.6	19.7	15.5
Total	160.0	160.0	480.0	480.0

forest. Even on grain farms, the pasture, forest and miscellaneous acreage comprise over 20 percent of the farm. On the livestock farms, these uses are assumed to be 42 percent on the 160 acre farm and 51 percent on the 480 acre farm. In the Downs association, no forest land occurs and pasture is found only on the livestock farms. Representative farms in the Downs association consist of only cropland and miscellaneous uses. On the 160 acre grain farm, 93 percent is assumed in cropland and on the 480 acre grain farm, 95 percent is in cropland.

Fayette and Associated Soils

Fayette soils occur on upland areas and on a wide variety of slopes. They generally occur on ridge tops and side slopes with a slope gradient ranging from 2 to 24 percent. Fayette soils are developed from deep silty loess parent material and under a native vegetation of mixed hardwood forest. Forested areas remain on the steeper slopes and along natural drainage ways. These silty loam textured soils have medium internal drainage and permeability. They are free of stones and easy to till. The soils are moderately acidic with moderately high natural fertility. Soil acreage on representative farms with Fayette and associated soils are shown in Table 4-3.

Fayette silt loams with slopes gradients of 2 to 6 percent and slope lengths of 200 to 300 ft. are generally classified as IIe land capability. They currently have lost 2 to 6 inches of top soil and have a slight hazard for further erosion. The plow layer incorporates some of the B soil horizon. This soil is highly productive under

Table 4-3. Soil acreage by soil mapping unit and land capability on representative farms with Fayette and associated soils, southeast Minnesota study area

Soil Mapping Unit	Land Capability	160 Acre Farm	480 Acre Farm
		-------- Acres	--------
Fayette silt loam, 4% slope moderately eroded	IIe	26.6	65.3
Fayette silt loam, 9% slope moderately eroded	IIIe	65.7	197.0
Fayette silt loam, 14% slope moderately eroded	IVe	52.4	133.0
Dubuque silt loam, 14% slope	VIe	6.5	53.1
Chaseburg silt loam, 17% slope	IIw	8.8	17.8
Steep, stony and rock land form, 22% slope	VIIe	0.0	13.8

good management and suited to growing corn, soybeans, small grains, and hay. On the 480 acre farm, this soil comprises 13.5 percent of the land base and on the 160 acre farm it comprises 16.6 percent.

Fayette soils with slope gradient of 6 to 12 percent and slope length of 200 to 300 feet are the most prevalent soil on representative farms. This soil has a moderate erosion hazard and has lost up to eight inches of the surface layer. As a result, the plow layer is less friable and more difficult to keep in good tilth than the preceding soil. It is classified as IIIe land capability. The soil has less natural fertility and lower available water than IIe, Fayette soil. However, under good management, it is suitable for row crop production.

These soils comprise 41 percent of the land base on both the 480 acre and 160 acre farms.

Fayette soils having slope gradients of 12 to 18 percent occur on side slopes of natural drainage systems. These soils have a much thinner soil layer and are subject to moderately severe erosion hazard. The organic content, natural fertility and available moisture capacity is low. With proper management, however, these soils can be used for growing row crops. Soybeans are not recommended for this soil. This soil has a IVe land capability. It comprises 28 percent and 33 percent of the land base on the 480 acre and 160 acre representative farms, respectively.

Dubuque soils often occur in association with Fayette and are found on the steeper ridge tops and valley slopes. These soils are formed from a thin mantle of loess parent material and under hardwood forest vegetation. The soils are acidic and moderate in natural fertility. The soils have a silt loam texture and are moderately permeable; however, because of the steep slopes, they often have a hazard of drought. These soils on representative farms occur on slopes of 12 to 18 percent and have a land capability of VIe. Because of their erosion and drought hazard, these soils are not recommended for cultivated crops. They are generally used for permanent pasture. They account for 11 percent of the land base on the 480 acre farms and 4 percent on the 160 acre farms.

Chaseburg soils also occur in association with Fayette soils. These soils are formed along upland drainage ways in silty materials that washed down from higher areas. They occur in narrow strips at the upper ends of deep narrow valleys in which no stream channel has developed. They usually have less than 2 percent slope and no erosion hazards. These soils are slightly acid and have moderately high natural fertility. The soils have moderate permeability and available water capacity but are often subject to flooding hazards. Also, because of the low area where these soils occur, late maturing crops may occasionally be damaged by frost. The soil is considered to be highly productive and suited to most all crops grown in southeastern Minnesota. With good management practices, corn and soybeans can be grown intensively on these soils, but with some hazard of flooding or frost damage. Lodging is a problem on these soils for oats. These soils are most often used for hay or pasture. Chaseburg soils account for only 5 percent of the land base.

Downs and Associated Soils

Representative farms with the less erosive conditions are assumed to have mostly Downs soils. Downs soils occupy a transitional zone between Fayette soils developed under forest vegetation and Tama soils developed under prairie grasses. Downs soils have a darker and thicker surface layer than Fayette but not as dark or thick as Tama. Like Fayette soils, they were developed from loess parent material and have a very silty texture. Downs soils generally occur on uplands but on more gentle slopes than Fayette soils. The soils are slightly to moderately acidic, well drained and moderately permeable. Their water holding capacity is high and they have moderately high natural fertility.

Soil acreage on representative farms with Downs and associated soils are shown in Table 4-4.

Upland Downs soils with 2 to 6 percent slope and approximate slope length of 200 feet have a capability classification of IIe. The surface soils are from 6 to 8 inches thick and very productive. These are excellent agricultural soils and used almost entirely for crops of corn and soybeans. The erosion hazard of these IIe Downs soils is slight and the practices necessary for control are easily applied.

Table 4-4. Soil acreage by soil mapping unit and land capability on representative farms with Downs and associated soils, southeast Minnesota study area

Soil Mapping Unit	Land Capability	160 Acre Farm	480 Acre Farm
		--------Acres--------	
Downs silt loam, 2% slope	IIe	28.9	87.4
Downs silt loam, 4% slope moderately eroded	IIe	49.5	188.2
Downs silt loam, 9% slope moderately	IIIe	52.8	170.0
Downs silt loam, 14% slope moderately eroded	IVe	10.7	10.4
Chaseburg silt loam, 1% slope	IIw	18.1	24.0

The eroded phase of Downs soils with 2 to 6 percent slopes is also classified IIe. These soils differ from the previously described uneroded phase in having a thinner surface layer and greater sheet erosion hazard. In some places, tillage has mixed the subsoil with the surface layer. Because of erosion and the tillage practices on these soils, the organic matter, natural fertility and available moisture capacity have been reduced. With care taken to control erosion, however, these soils can be very productive for most crops grown in southeaster Minnesota.

The Downs silt loam with 7 to 11 percent slope gradient and slope lengths of about 250 feet are classified as IIIe. This eroded phase has lost 5 to 9 inches of surface soil and a moderate hazard of further erosion exists. The plow layer often contains some subsoil making them less easy to work and more difficult to keep in good tilth. These steeper soils, however, with good management and conservation practices are generally suited to all crops grown locally.

The Downs silt loam with slope gradient of 12 to 17 percent and slope lengths of 250 feet are classified as IVe. Much of the surface layer has been lost through erosion. Because of the strong slopes and past erosion, these soils are generally not recommended for corn or soy beans and are best suited for hay and pasture.

Chaseburg soils also occur in association with Downs soils and are formed from the silty materials washed down from higher areas occupied by Downs soils. These are the same soils that also occur in association with Fayette. Chaseburg soils occupy narrow valleys and drainageways and are subject to periodic flooding. Because they occur in long narrow strips adjacent to steep hills, their use is often limited to pasture and waterways. However, where it is feasible to grow crops and the flood and frost hazard is slight, Chaseburg soils are highly productive for corn or soybeans.

In association with the steeper Fayette soils, are small areas of very steep, stoney and rocky land types. This land form generally occurs between ridge tops and the lower valley slope. Frequent outcrops of bedrock occur and only a thin layer of silt covers most of this land. Most of the areas are forested, however, some south and west facing slopes will not support good timber stands. Those soils have either a VIIe or VIIIe land capability classification and are not suited for crop cultivation.

Crop Yields

Crop yield is the result of the interaction on many natural environmental factors as well as many technology and management factors which man applies. Man has little control over crop productivity as it relates to soils, climate or topography. However, he can and does control many management factors which interact with the natural environment to affect crop yields.

In the short-run, crop rotations, tillage practices, fertilizer application, hybrid seeds, chemical pesticides and many other factors have been shown to affect crop yield. In this model, however, yield differences occur only between soils with different slope and erosion phase and tillage system used to produce the crop. This model does not address any long-run yield changes that might occur because of soil depletion or new technology.

Crop yields used in this model were developed from the crop yield estimates reported in soil survey reports in southeast Minnesota. Yields for major crops are estimated for each soil by its slope range and erosion phase. The estimated yields are based on experimental plots within the county at or about the time the survey is published. To apply these yields, it was necessary to update the published data to present expectations from current types of management and technology. Yield data for the proposed Olmsted County Soil Survey scheduled for publication in 1980 provided yields for many soils on different slopes and erosion phases. For soil conditions not in Olmsted County, a crop equivalent rating guide[1] was used to correlate soils between counties and to adjust crop yields to be consistent with those proposed for Olmsted County. The crop yields for soils, slopes and erosion condition are given in Table 4-5.

The results of a number of cornbelt studies was reviewed to determine the yield variation caused by alternative tillage systems. The studies indicate that tillage practices need to be tailored to specific crop, soil, environmental and management conditions. Minnesota and Wisconsin studies[2] have indicated that reduced tillage practices

---

[1]R. H. Rust and L. D. Hanson, "Crop Equivalent Rating Guide for Soils of Minnesota," Miscellaneous Report (St. Paul, Minn.: University of Minnesota Agricultural Experiment Station, 1975).

[2]J. B. Swan and T. A. True, "Tillage for Corn and Soybeans," in <u>Soils, Soil Management and Fertilizer Monographs, Special Report 24</u> (St. Paul, Minn.: University of Minnesota Agricultural Extension Service, 1978).

Table 4-5. Selected crop yields by soil mapping unit assumed for the southeast Minnesota study area

Soil Mapping Unit	Corn	Silage	Soybeans	Oats	Alfalfa Hay	Pasture
Fayette and associated soils:						
Fayette silt loam, 4% slope, mod. eroded	110	15.0	33	77	4.4	99
Fayette silt loam, 9% slope, mod. eroded	95	14.0	28	75	3.8	90
Fayette silt loam, 14% slope, mod. eroded	85	12.0	26	70	3.6	90
Dubuque silt loam, 14% slope, mod. eroded	56	8.0	17	46	3.4	60
Chaseburg silt loam, 1% slope	99	14.0	29	75	4.5	105
Downs and associated soils:						
Downs silt loam, 2% slope	135	20	42	86	5.1	123
Downs silt loam, 4% slope, mod. eroded	130	19	41	83	5.1	108
Downs silt loam, 9% slope, mod. eroded	110	16	32	72	4.2	99
Downs silt loam, 14% slope, mod. eroded	95	14	28	63	3.6	95
Chaseburg silt loam, 1% slope	99	14	29	75	4.5	105

can be applied to well-drained, medium textured, erosive soils such as those contained in this model. Soil scientists, however, warn that better than average management is essential for successful conservation tillage systems. The effect of conservation tillage on crop yields remains inconclusive. On test plots in southeastern Wisconsin on Fayette silt loam soils, corn yields on continuous no-till averaged about ten bushels below conventional tillage.[2] Other tests in Minnesota show no conclusive evidence that no-till will result in reduced yields if the system is properly applied.[2] Other tests in Minnesota show no conclusive evidence that no-till will result in reduced yields if the system is properly applied.[3] Other tests in Minnesota show no difference between moldboard and chisel plowing.[4] Conservation tillage systems has not had a significant effect on soybean yields.[5]

For purposes of this study, all crop yields except corn were set equal for the alternative tillage options considered. Corn yields for no-till systems were set 5 percent below alternative tillage systems.

---

[1]Ibid., p. 58.

[2]J. W. Bauder et al., "Tillage Practices in South Central Minnesota," Special Report 24 (St. Paul, Minn.: University of Minnesota Agricultural Extension Service, 1978).

[3]Ibid.

[4]Swan and True.

[5]Ibid.

Soil Loss Estimation

The universal Soil Loss Equation is used to calculate soil loss on representative farms with alternative practices for controlling soil loss and non-point source pollution. The equation is expressed as the product of the following six factors:

$$A = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

where:

A = Tons of soil loss per acre per year;

R = Rainfall factor;

K = Soil erodability factor;

L = Slope length factor;

S = Slope gradient factor;

C = Crop management factor; and

P = Conservation practice factor.

The first four factors reflect natural environmental relationships of rainfall intensity, soil erodibility, slope length and slope gradient. Crop management and control practices, except terracing, are reflected in the remaining factors. Because terracing divides drainage acres on natural occurring slopes, their effect on soil loss is reflected in the slope length and slope gradient factors.

The equation predicts average annual soil loss from sheet and rill erosion. It does not predict soil loss from gully or stream bank erosion. Sheet and rill erosion is distinguished from sediment yield in that sheet and rill erosion refers to the gross movement of soil off the slope segment under study. Much of this soil is deposited at the base of the slope from which it eroded or in grassed waterways, field depressions, sod strips from stripcropping and fence rows. Sediment yield refers to that portion of gross soil loss that enters water courses.

The soil loss as predicted by the equation is the average annual loss expressed in tons per acre. It is the long-run average that would occur with typical rainfall and storm events for the area. The soil loss which occurs in any given year may deviate significantly from the average if storm events are abnormal.

The R factor is an index of the erosive force of normal rainfall and storms for the study area. The erosion index considers the amount of rain, the rate at which it falls, the size of rain drops and its terminal velocity when it impacts the surface. The factor is based upon approximately thirty years of measurements. The R factor for southeastern Minnesota and applied in this study is 150.[1]

The K factor is an index of the erodibility of soils based on the physical properties of the soil itself. The index is experimentally determined for each soil and is the ratio of soil loss on a specific soil to the soil loss from a "unit"[2] plot under otherwise identical conditions. The index is affected by such physical properties as soil

---

[1]U.S. Department of Agriculture, Science and Education Administration, "Predicting Rainfall Erosion Losses, A Guide to Conservation Planning," Agricultural Handbook 537, December 1978, Figure 1.

[2]The unit plot is defined as 72.6 feet long, with uniform lengthwise slope of 9 percent, in continuous fallow, tilled up and down the slope.

texture and organic matter content. The K factors as applied in this model were obtained from the Soil Conservation Service Technical Guide for Minnesota.[1] The K values for soils on representative farms is given in Table 4-6.

Both steepness and length of slopes are important factors in predicting soil loss from water. Long, steep slopes have greater soil loss than short, gentle slopes. The velocity of rainfall from steep slopes is greater. With greater velocity, there is less infiltration and a larger volume of runoff occurs. This in combination with longer slopes results in greater soil loss per unit of area, especially at the lower end of a slope. Like the K factor, the L and S factors are based on experimental data comparing soil loss from a sample plot to the "unit" plot. The L and S factors as used in this model were obtained from the Soil Conservation Service Technical Guide.[2]

The L and S factors are presented in a later section and shown relative to their values when terracing is applied. The crop management (C factor) and erosion practice (P factor), values are presented in the following discussion of conservation systems.

Conservation Systems

The soil loss and non-point source pollution control practices considered in this study include sod in rotation, contouring and grassed waterways, contour strip cropping, steep back-slope terracing and conservation tillage. These practices may be adopted singly or in

[1]Soil Conservation Service, Technical Guide, Section III-1-A, St. Paul, Minnesota, May 1976.

[2]Ibid., p. 8.

Table 4-6. Soil erodibility factors assumed for Fayette and associated soils and Downs and associated soils, southeast Minnesota study area

Soil Mapping Unit	Soil Erodibility Factor
Fayette and associated soils:	
Fayette silt loam, 4% slope, moderately eroded	.37
Fayette silt loam, 9% slope, moderately eroded	.37
Fayette silt loam, 14% slope, moderately eroded	.37
Dubuque silt loam, 14% slope, moderately eroded	.37
Chaseburg silt loam, 1% slope	.37
Downs and associated soils:	
Downs silt loam, 2% slope	.32
Downs silt loam, 4% slope, moderately eroded	.32
Downs silt loam, 9% slope, moderately eroded	.32
Downs silt loam, 14% slope, moderately eroded	.32
Chaseburg silt loam, 1% slope	.37

Source: Soil Conservation Service Technical Guide for Minnesota, Section III-1-A, St. Paul, Minnesota, May 1976.

combinations to achieve the soil loss constraints imposed on the model. Each practice affects soil loss as measured by the Universal Soil Loss Equation. These practices affect the value in the Universal Soil Loss Equation assigned to the L, S, C, and P factors. This section briefly describes each practice and gives the L • S, C and P factors used to calculate its affect on erosion.

Contouring and Grassed Waterways

In designing a farm conservation plan, the establishment of contouring and grassed waterways is the first basic step. All other practices considered in this study will be in addition to contour farming with grassed waterways. Contouring is the practice of performing tillage and planting operations across the slope rather than straight rows which may go up and down the slope. Furrows, wheel tracks and crop rows, when on the contour, act as miniature terraces which detain water and direct runoff. As a consequence, the practice increases water infiltration and reduces runoff velocity.

Grassed waterways are surface channels constructed at intervals down the slope where runoff concentrates. Their purpose is to replace gullies and prevent their formation. They are usually constructed in natural depressions where runoff occurs and have a design depth and width to carry peak runoff. Once constructed, permanent vegetative cover of grasses is established to provide soil protection.

Contouring affects are measured in the Universal Soil Loss Equation by the erosion control practice, P factor. Table 4-7 provides the P factors used in this model.

The establishment of grassed waterways removes land from production. The width and length of waterways depend on the drainage area from which they receive runoff. Steeper and larger drainage areas require wider and more frequent waterways. Table 4-8 indicates the acreage requirements estimated to establish grassed waterways by soils. It was assumed that waterway widths of 30, 40 and 60 feet were needed on soils with land capabilities IIe, IIIe, and IVe, respectively.

Table 4-7. P factors by soil mapping units assumed for the Universal Soil Loss Equation when contouring is applied, southeast Minnesota study area

Soil Mapping Unit	P Factor
Fayette and associated soils:	
Fayette silt loam, 4% slope, moderately eroded	.50
Fayette silt loam, 9% slope, moderately eroded	.60
Fayette silt loam, 14% slope, moderately eroded	.80
Fayette silt loam, 14% slope, moderately eroded	.80
Chaseburg silt loam, 1% slope	1.00
Downs and associated soils:	
Downs silt loam, 2% slope	.60
Downs silt loam, 4% slope, moderately eroded	.50
Downs silt loam, 9% slope, moderately eroded	.60
Downs silt loam, 14% slope, moderately eroded	.80
Chaseburg silt loam, 1% slope	1.00

Source: Soil Conservation Service Technical Guide, Section III-1-A, St. Paul, Minnesota, December 1975, p. 6.

Contour Strip-Cropping

In this practice, row crops, oats and alfalfa hay crops are planted in alternate strips across the slope. Crop rotation also occurs on the strips. The runoff from the row crop is retarded by either the oat or hay crop down slope. It results in greater infiltration and reduces runoff velocity. This practice is more effective in controlling erosion than contouring and may be used on highly erosive soils.

Contour strip cropping effects are measured in the Universal Soil Loss Equation by both the erosion control practice and the crop management practice factors. In this application, row crops could

Table 4-8. Assumed waterway length and land requirement by soil mapping unit to establish grassed waterways, southeast Minnesota study area

Soil Mapping Unit	Length (Ft./Acre)	Land Requirement (Percent of Field Acreage)
Fayette and associated soils:		
Fayette silt loam, 4% slope, moderately eroded	30	2.1
Fayette silt loam, 9% slope, moderately eroded	40	2.8
Fayette silt loam, 14% slope, moderately eroded	60	4.1
Dubuque silt loam, 14% slope, moderately eroded	60	4.1
Chaseburg silt loam, 1% slope	0	0
Downs and associated soils:		
Downs silt loam, 2% slope	0	0
Downs silt loam, 4% slope, moderately eroded	30	2.1
Downs silt loam, 9% slope, moderately eroded	40	2.8
Downs silt loam, 14% slope, moderately eroded	60	4.1
Chaseburg silt loam, 1% slope	0	0

Source: Clifton Halsey and Kathryn Bolin, "Grassed Waterways--Construction and Maintenance," Extension Folder 480 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979).

account for either 44 percent or 33 percent of the field acreage. When 44 percent of the land is in row crop, the strip crop C factor is the same as a crop rotation of three years row crop, oats and three years of hay. When 33 percent of the land is in row crop, the C factor is the same as the above rotation except one year of row crop is dropped. A following section will provide these C factors under alternative tillage practices. The P factors associated with ccntour strip-cropping are given in Table 4-9. It was assumed the contour strip-cropping is not used on soils with less than 4 percent average slope.

Table 4-9. P factors by soil mapping units assumed for the Universal Soil Loss Equation when strip-cropping is applied, southeast Minnesota study area

Soil Mapping Unit	P Factor
Fayette and associated soils:	
Fayette silt loam, 4% slope, moderately eroded	.25
Fayette silt loam, 9% slope, moderately eroded	.30
Fayette silt loam, 14% slope, moderately eroded	.40
Dubuque silt loam, 14% slope, moderately eroded	.40
Chaseburg silt loam, 1% slope	1.00
Downs and associated soils:	
Downs silt loam, 2% slope	1.00
Downs silt loam, 4% slope, moderately eroded	.25
Downs silt loam, 9% slope, moderately eroded	.30
Downs silt loam, 14% slope, moderately eroded	.40
Chaseburg silt loam, 1% slope	1.00

Source: Soil Conservation Service Technical Guide, Section III-1-A, St. Paul, Minnesota, December 1975, p. 6.

Steep Back-Sloped Terraces

Terraces can be an effective soil and water conservation practice on farms with intensive row crop production. Terraces reduce volume of runoff by dividing a field into separate drainage areas and reduce velocity of runoff by reductions in both slope length and gradient. As a consequence, they not only increase water infiltration and decrease soil loss, but they direct water off bottom lands which reduces flood and sediment damages. Their parallel construction avoids odd shaped areas which impose problems for operation of large machinery. The reduction in slope gradient between terraces also makes it easier and safer to operate farm machinery on steep slopes.

Steep, back-sloped terraces affect soil loss estimates measured by the Universal Soil Loss Equation by the slope length and slope gradient. The slope length is decreased to the distance between terraces. Steep, back-sloped terraces also decrease slope gradient because the earth to build the ridge comes from the lower side of the terrace and the grade from the bottom of the upper terrace to the top of the lower terraces is slightly reduced. The following table indicates the length and slope factor for soils in the model with and without terracing.

Crop Rotation and Tillage Systems

All production activities in this model are associated with a specific crop rotation and tillage system. Reductions in soil loss may occur by either adoption of a rotation that includes additional oat or hay crops or by adopting a soil conserving tillage practice.

Table 4-10. Slope length and gradient factors by soil mapping units assumed for the Universal Soil Loss Equation on fields without terracing and with grassed, back-sloped terracing, southeast Minnesota study area

	L • S Factor	
Soil Mapping Unit	Without Terracing	With Terracing
Fayette and associated soils:		
Fayette silt loam, 4% slope, moderately eroded	.57	.43
Fayette silt loam, 9% slope, moderately eroded	1.70	.99
Fayette silt loam, 14% slope, moderately eroded	2.80	1.80
Dubuque silt loam, 14% slope, moderately eroded	2.80	1.80
Chaseburg silt loam, 1% slope	.15	.15
Downs and associated soils:		
Downs silt loam, 2% slope	.32	.32
Downs silt loam, 4% slope, moderately eroded	.53	.37
Downs silt loam, 9% slope, moderately eroded	1.30	.89
Downs silt loam, 14% slope, moderately eroded	2.80	1.80
Chaseburg silt loam, 1% slope	.15	.15

Source: Soil Conservation Service Technical Guide, Section III-1-A, St. Paul, Minnesota, p. 8.

The interaction of crop rotation and tillage practices is reflected by the C factor in the Universal Soil Loss Equation. Table 4-11 identifies the C factors for each crop rotation and tillage practice option.

Conventional tillage either with spring or fall moldboard plowing is the predominant practice currently employed in the basin. It includes moldboard plowing for corn, silage or soybean crops either in the fall following harvest or in the spring as soon as field operations can occur. These practices leave the ground without any vegetative or plant residue protective cover for certain periods of time. Often this exposure is during the spring of the year when the greatest number of storms occur. The mulch tillage makes use of a chisel plow which leaves approximately two-thirds of the preceding year's crop residue on the surface. The no-till planting assumes no tillage operations are performed prior to planting and that 90 percent of the previous year's residue remains on the surface following planting. The effectiveness of these different tillage systems in controlling soil loss is reflected in the C factors in Table 4-11.

Table 4-11. C factors for Universal Soil Loss Equation by crop rotation and tillage system, southeast Minnesota study area

	Fall Moldboard Plowing	Spring Moldboard Plowing	Mulch Tillage	No-Till Planting
C-C	.39	.37	.19	.10
C-S	.45	.43	.24	.19
C-Si	.44	.41	.30	.26
C-C-C-O-M-M-M	.17	.16	.11	.07
C-S-C-O-M-M-M	.17	.16	.12	.08
C-Si-C-O-M-M-M	.17	.16	.14	.11
C-C-C-M-M-M-M	.16	.15	.11	.07
C-S-C-M-M-M-M	.16	.15	.11	.07
C-Si-C-M-M-M-M	.16	.15	.11	.07
C-C-O-M-M-M	.13	.12	.09	.06
C-S-O-M-M-M	.14	.13	.09	.06
C-Si-O-M-M-M	.13	.12	.10	.08
C-C-M-M-M-M	.12	.12	.09	.06
C-S-M-M-M-M	.13	.13	.09	.07
C-Si-M-M-M-M	.12	.12	.10	.07

Source: Soil Conservation Service Technical Guide, Section III-1-A, St. Paul, Minnesota, pp. 9-10.

CHAPTER V

ECONOMIC DATA SET FOR MEASURING NET INCOME EFFECTS FROM ADOPTION OF SOIL LOSS CONTROL PRACTICES ON REPRESENTATIVE FARMS

The preceding chapter documents crop production alternatives that may be employed on representative farms. It included combinations of five crops, fifteen rotations, four tillages, and four soil loss control practices. The data requirements used to measure the effect of each production alternative on the land base, crop yield and soil loss was documented. This chapter provides the economic data used to estimate net returns for each of these activities. It includes the prices assumed to estimate the value of production and the procedure and data used to estimate cost of crop production inputs and installation of soil loss control practices.

Activities

The crop production activities are defined in the model by a sequence of crops in a rotation and by a tillage system. The crops grown in the rotation include corn for grain (C), corn silage (Si), soybeans (S), oats (O), and alfalfa hay (H). Each crop, except alfalfa hay, represents one year in a rotation. Alfalfa is a perennial plant and once established, it is harvested for three or more years.

Some difference occurs between rotations on the grain farms and the farms with roughage consuming livestock. Rotations including corn silage do not occur on grain farms. Alfalfa hay crops, however, are considered on the grain farms. Even with the establishment of good conservation practices and tillage systems, continuous row crop culture would still have excessive erosion rates on Fayette and associated soils. Table 5-1 presents the crop rotations on representative grain farms and farms with roughage consuming livestock enterprises which are included in this model.

Not all rotations, however, apply to all fields. Continuous row crops were not simulated to be grown on those fields with severe erosion hazard soils. Any rotations which would result in erosion rates exceeding 50 tons per acre were deleted from the model.

Four alternative tillage practices are used with these rotations. They are:

- conventional fall moldboard plowing;
- conventional spring moldboard plowing;
- mulch tillage with chisel plowing; and
- no-till planting.

For conventional fall moldboard plowing, the seedbed preparation for all row crops and oats consist of moldboard plowing in the fall. This practice incorporates all crop residue and leaves the soil totally exposed until the crop is established the following spring. The practice also includes several secondary tillage operations which will be specifically defined in a later section on farm machinery operation cost.

Table 5-1. Assumed crop rotations on representative grain and livestock farms, southeast Minnesota study area

Rotation	Grain Farms	Roughage Consuming Livestock Farms
Continuous corn (C-C)	x	x
Corn-soybean (C-S)	x	x
Corn-silage (C-Si)	..	X
Corn-corn-corn-oat-hay-hay-hay (C-C-C-O-H-H-H)	x	x
Corn-soybean-corn-oat-hay-hay-hay (C-S-C-O-H-H-H)	x	x
Corn-silage-corn-oat-hay-hay-hay (C-Si-C-O-H-H-H)	..	x
Corn-corn-oat-hay-hay-hay (C-C-O-H-H-H)	x	x
Corn-soybean-oat-hay-hay-hay (C-S-O-H-H-H)	x	x
Corn-silage-oat-hay-hay-hay (C-Si-O-H-H-H)	..	x
Corn-corn-corn-hay-hay-hay-hay (C-C-C-H-H-H-H)	x	x
Corn-soybean-corn-hay-hay-hay-hay (C-S-C-H-H-H-H)	x	x
Corn-silage-corn-hay-hay-hay-hay (C-Si-C-H-H-H-H)	..	x
Corn-corn-hay-hay-hay-hay (C-C-H-H-H-H)	x	x
Corn-soybean-hay-hay-hay-hay (C-S-H-H-H-H)	x	x
Corn-silage-hay-hay-hay-hay (C-Si-H-H-H-H)	..	x

Conventional spring moldboard plowing as a tillage system delays all pre-plant tillage operations until a short time prior to planting the row crop. The bare soil is exposed for a shorter time period, especially during early spring when large runoffs causing erosion is most likely to occur. The spring moldboard tillage system as assumed in this model also involves fewer secondary tillage operations.

Mulch tillage with chisel plowing incorporates only about one-third of the preceding crop residue. The practice loosens the soils with narrow points or sweepshovels leaving most of the residue at or near the surface. This residue acts as a protective cover for the soil by reducing energy intensity of rainfall and slowing runoff. The secondary tillage operations associated with chisel plowing are similar to spring moldboard plowing.

The no-till system for row crops assumed for this study involves no tillage prior to planting. At planting time, the only soil manipulation is that required for good seed, fertilizer and herbicide placement. The practice leaves approximately 90 percent of preceding crop residue on the surface. Weed control is exclusively by chemical herbicides.

In addition to the crop rotation-tillage system combinations, the activities are also defined according to the conservation practice applied to the field. When no conservation practices are applied, all tillage and planting operations are assumed to be straight rows without regard to field topography. Three alternative soil loss control practices may be applied to the field with a technical assistance, installation and maintenance cost. These practices as defined in the preceding chapter are contour farming with grassed waterways, stripcropping and steep, back-sloped terracing.

Prices and Value of Production

Current normalized prices as developed by the National Water Resources Council are used in this study to evaluate production activities.[1] These prices remove short-run fluctuations that occur because of abnormal supply or demand conditions. They are also developed to remove the influence of price control programs and government subsidies to agricultural producers.

They represent a nationally consistent set of prices which the National Water Resources Council requires for evaluation of all federally funded land and water resource development projects.[2] Such an evaluation allows policy makers to compare alternative projects without built-in distortions from government programs, abnormal supply and demand conditions, or regional price differences.

---

[1]U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Natural Resource Economics Division, "Current Normalized Prices" (draft), September 1979.

[2]"Water and Related Land Resources, Establishment of Principles and Standards for Planning," Federal Register 38 (10 September 1973).

The prices are developed using long-run trend analysis.[1] They are weighted to reflect the recent price changes considered permanent. They are normalized from the standpoint that the relative differences between commodities is an average over time. Relationships between local, state and national prices are developed to reflect transportation costs and other variables which cause regional price differences. The adjusted normalized prices for Minnesota which are used in this model are reported in Table 5-2.

Seed, Fertilizer, and Chemical Pesticide Inputs

Seed. All seeding rates are constant with regard to soil, tillage system or erosion control practice for all crops except corn. The specific application rates, price, and per acre cost for each rotation component is given in Table 5-3.

Corn seeding rates are based on achieving a final plant population sufficient to produce the estimated yield for each field. To achieve a corn yield in the range of 90 to 130 bushels as occurs on most fields in this model, a target final population of 20,000 plants per acre is adequate. Under conventional tillage, a mortality rate of 15 percent is assumed and on mulch and no-till tillage systems, a mortality rate of 25 percent is assumed. Hybrid seedcorn is generally sold by the bag with a count ranging from 75,000 to 90,000 kernals. The price in Table 5-3 reflects that of an 80,000 count bag.

---

[1]Robert D. Niehaus, "Data and Procedures for Calculating 1975 Normalized Agricultural Prices for the U.S. Water Resources Council," Working Paper No. 22, Economic Research Service, U.S. Department of Agriculture, January 1977.

Table 5-2. Adjusted normalized prices for commodities grown on representative farms, southeast Minnesota study area

Commodity	Unit	Adjusted Normalized Price ($)
Corn	bushel	2.17
Silage[a]	ton	15.00
Soybeans	bushel	5.80
Oats	bushel	1.21
Hay	ton	46.84

Source: U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Natural Resource Economics Division, "Current Normalized Prices" (draft), September 1979.

[a]Because markets are not well established for silage, no price was reported. Based on judgments of its relative feed value, a market price of $15.00 per ton was derived.

Table 5-3. Seed planting rates, prices and cost per acre by crop and tillage system, southeast Minnesota study area

Crop	Tillage System	Seeding Rate	Price ($)	Cost per Acre ($)
Corn	Conventiona, spring or fall	.30 bag	45.00	13.50
Corn	Mulch or no-till	.325 bag	45.00	14.63
Silage	Conventional, spring or fall	.30 bag	45.00	13.50
Silage	Mulch or no-till	.325 bag	45.00	14.63
Soybeans	All tillages	1.0 bu.	9.50	9.50
Oats	All tillages	2.0 bu.	3.50	7.00
Hay establishment	All tillages	12 lbs.	2.20	26.50

[a]Prices and seeding rates reported in "What Should I Grow in 1979 in Southeast Minnesota?" Farm management Extension Service Publication FM 418.7, University of Minnesota, Agricultural Experiment Station, January 1979.

Fertilizer. The fertilizer application rates for corn and silage vary with expected yields, tillage systems and sequence in crop rotation. The application rates for all other crops are constant. The application rates of nitrogen, phosphorous, potassium and lime on crops are presented in Tables 5-4, 5-5, 5-6, and 5-7, respectively.

The nitrogen applications include different combinations of granular fertilizer applied as a broadcast or a starter and anhydrous ammonia applied only to corn as a side-dress. The phosphorus and potassium are applied as a combination of broadcast and starter fertilizers. Lime is applied prior to the establishment of alfalfa hay. If alfalfa hay does not occur in the rotation, then one application every eight to ten years is necessary to counteract the acidic build-up from nitrogen fertilizer. The following prices were used in the budget generator to estimate fertilizer input costs:

	($)
Granular nitrogen	0.18/lb
Anhydrous ammonia	0.17/lb
Potassium	0.08/lb
Lime	3.50/ton

The fertilizer rates are based on recommended applications to account for natural fertility of the soil, nutrient loss from preceding crops and needs of the current crop, nitrogen fixation by legumes, and conservation tillage systems. Organic matter is slightly higher in Downs soils than Fayette and consequently, more nitrogen. Corn removes nearly 1.0 lb. of nitrogen, 0.4 of phosphate and 0.3 lb. of potash.[1] Oats remove about the same amount of nitrogen and phosphorus per bushel as corn but much higher quantities of potash. Soybeans remove nearly as many nutrients as corn or oats but provides most of its nitrogen needs through fixation of atmosphere nitrogen. Alfalfa hay is considered a nitrogen building crop and can provide 85 to 100 lbs. of nitrogen for succeeding crops.[2]

Conventional tillage systems incorporate broadcast fertilizers into the plow layer. This provides excellent placement for efficient plant utilization and prevents nutrient loss either as a gas to the atmosphere or from rainfall runoff. The conservation tillage practices of mulch or no tillage do not allow as optimum of fertilizer placement. Broadcast fertilizers remain near the surface and are less available to growing plants. A larger proportion of the total fertilizer need to be applied as a starter during the planting operation or as a side dress. The amount which can be applied as a starter, however, is limited. As a result of the poorer fertilizer placement, slightly higher application rates are recommended for corn with mulch or no-till systems.

---

[1]C. J. Overdahl and G. E. Ham, "Fertilizing Soybeans," in Soils, Soil Management and Fertilizer Monographs, Special Report 24, University of Minnesota, Agricultural Extension Service, 1978, p. 79.

[2]W. E. Fenster and C. J. Overdahl, "Predicting Nitrogen Needs," in Soils, Soil Management and Fertilizer Monographs, Special Report 24, University of Minnesota, Agricultural Extension Service, 1978, p. 10.

Table 5-4. Assumed nitrogen fertilizer application rates for rotation components and selected crop yields under alternative tillage systems, southeast Minnesota study area

Rotation Components	Selected Yield[a]	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
		Lbs. per Acre			
Corn preceded by corn,[b] silage or soybeans	90	119	119	128	153
	115	147	147	165	193
	130	164	164	189	217
Corn preceded by alfalfa hay	90	15	15	20	25
	115	43	43	55	62
	130	76	76	86	95
Soybeans	All	10	10	10	10
Oats with hay establishment	All	65	65	65	65
Hay establishment preceded by corn or silage	All	0	0	0	0
Hay establishment preceded by soybeans	All	15	15	15	15
Established hay	All	0	0	0	0

[a]These represent the range of corn yields that occur on representative farms.

[b]These rates also apply to silage.

Table 5-5. Assumed potassium fertilizer application rates for rotation components and selected crop yields under alternative tillage systems, southeast Minnesota study area

Rotation Components	Selected Yield[a]	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
		Lbs. per Acre			
Corn preceded by corn, silage or soybeans	90	35	35	40	45
	115	45	45	50	60
	130	50	50	55	68
Corn preceded by alfalfa hay	90	35	35	40	45
	115	45	45	50	60
	130	50	50	55	68
Soybeans	All	30	30	30	30
Oats with hay establishment	All	120	120	120	120
Hay establishment preceded by corn or silage	All	60	60	60	60
Hay establishment preceded by soybeans	All	60	60	60	60
Established hay	All	60	60	60	60

[a]These represent the range of corn yields that occur on representative farms.

Table 5-6. Assumed phosphorus fertilizer application rates for rotation components and selected crop yields under alternative tillage systems, southeast Minnesota study area

Rotation Component	Selected[A] Yield	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
		Lbs. per Acre			
Corn preceded by corn, silage or soybeans	90	40	40	55	64
	115	60	60	65	78
	130	65	65	70	86
Corn preceded by alfalfa hay	90	50	50	55	64
	115	60	60	65	78
	130	65	65	70	86
Soybeans	All	20	20	20	20
Oats with hay establishment	All	20	20	20	20
Hay establishment preceded by corn or silage	All	30	30	30	30
Hay establishment preceded by soybeans	All	30	30	30	30
Established hay	All	30	30	30	30

[a] These represent the range of corn yields that occur on representative farms.

Table 5-7. Assumed lime application rates for rotation components under alternative tillage systems, southeast Minnesota study area

Rotation Component	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	Tons per Acre			
Corn preceded by corn, silage or soybeans[a]	0.16	0.16	0.16	0.16
Corn preceded by alfalfa hay	0	0	0	0
Soybeans	0	0	0	0
Oats with hay establishment	4.0	4.0	4.0	4.0
Hay establishment preceded by corn or silage	4.0	4.0	4.0	4.0
Hay establishment preceded by soybeans	4.0	4.0	4.0	4.0
Established hay	0	0	0	0

[a]Lime is applied to continuous row crops once every eight to ten years. The rate reported is what the average annual rate would be.

Herbicides. Weed control for both mulch and no-till systems is accomplished totally by chemical herbicides. It includes a combination of pre-emergence and post-emergence herbicide applications. Conventional tillage systems use a combination of chemical herbicide and field cultivations.

For corn, all tillage systems assume some use of 2-4-D to control problem weed areas after the crop is well established. Conventional spring tillage assumes the use of a post-emergence herbicide (atrazine) to replace on field cultivation. The conservation tillage system uses a mixture of pre-emergence (atrazine and alachlor) herbicides. When soybeans follow in the rotation, a different combination of chemicals is required to prevent carry-over damage.[1] The application rates used in developing these budgets were taken from Agricultural Extension Service recommendations and the prices used in Table 5-8 are those quoted by local herbicide retailers in southeast Minnesota.

Farm Machinery Operation Cost

The farm machinery operation cost in this model not only reflects the different kinds of operations for each crop and tillage system but also reflects different sizes of machines between representative farms. The small farms with limited capital and excess labor use a smaller size of equipment than the larger farms. In this application, the 160 acre farm uses the smallest size of equipment

---

[1]Soybeans are sensitive to atrazine carry-over and other chemicals have to be substituted. In these budgets, cyanazine is assumed as a substitute.

Table 5-8. Herbicide costs for rotation components under alternative tillage systems, southeast Minnesota study area

Rotation Component	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	$ per Acre			
Corn preceded by corn or silage	1.99	5.99	12.28	18.27
Corn preceded by soybeans	1.99	15.02	18.98	18.98
Corn preceded by hay	5.99	5.99	21.26	21.26
Soybeans	0	9.43	11.15	11.15
Oats preceded by corn, silage or soybeans	0	0	0	0
Hay establishment preceded by corn or silage	0	0	9.13	9.13
Silage preceded by corn	1.99	5.99	12.28	18.27
Established hay	0	0	0	0

used in the area. For example, the 160 acre farm has tractors no larger than 75 horsepower and use only 4-row equipment. The 480 acre farm uses equipment of sufficient size to complete all spring tillage operations with no more than 150 labor hours.

Because of the large investment per hour of operation for harvesting equipment, small farms with limited capital are assumed to rely on custom harvest. The number of acres harvested on these farms cannot justify the large investment in harvesting equipment. The interest charge alone for a new small combine exceeds the custom rate a farmer would have to pay for harvesting the small number of row crops on a 160 acre farm.[1] In this model, a custom rate for harvesting corn, soybeans and oats is assumed. Small farms with roughage consuming livestock are assumed to have equipment to harvest hay or silage. The following custom rates were used:[2]

	$/Acre
corn harvest	23.00
soybean harvest	14.39
oat harvest	12.31

The data inputs for the budget generator to estimate machine operation costs include:

---

[1]The interest charge for a new combine costing $39,000 exceeds the custom rate of $23.00 per acre for the number of acres harvested on small farms.

[2]These are the suggested rates in "Minnesota Farm Machinery Cost Estimates for 1979" by Fred Benson and Bruce Hatteberg, Agricultural Extension Service, University of Minnesota (FM 609), St. Paul, Minnesota, February 1979, Table 11.

- machine cost per hour of operation;
- power unit cost per hour of operation;
- fuel consumption by power unit;
- labor hours per machine hour;
- machine width;
- field operation speed;
- field efficiency; and
- number of times over the field.

These data are presented in Tables 5-10 through 5-17. Table 5-10 presents the kind and size of farm machinery on representative farms. Table 5-11 and 5-12 gives the operation cost per hour of power units and machine components. Tables 5-13 through 5-17 indicate the number of times over a field by each machine for the various crop and tillage system combinations.

The cost per hour of operation includes depreciation, interest, insurance, repair and shelter for each machine and power unit.[1] Field operation costs include the machine component, a power unit, fuel consumption and operator labor. The number of hours per acre in Table 5-11 are estimated using machine width, field operation speed and field efficiency components. Table 5-11 also indicates the number of labor hours to be associated with each hour of machine operation. The labor cost for machine operation assumes a wage of $3.50 per hour. Diesel and gasoline fuel consumption by power units is given in Table 5-12.

---

[1]These costs were developed from "Minnesota Farm Machinery Economic Cost Estimates for 1979" by Fred Benson and Bruce Hatteberg, Agricultural Extension Service, University of Minnesota (FM 609), St. Paul, Minnesota, February 1979.

Table 5-9. Assumed farm machinery on representative farms, southeast Minnesota study area

Machine	160 Acre Farm		480 Acre Farm	
	Grain	Livestock	Grain	Livestock
Tractor, 40 H.P.	x	x	x	x
Tractor, 75 H.P.	x	x	.	.
Tractor, 100 H.P.	.	.	x	x
Tractor, 140 H.P.	.	.	x	x
Combine power unit, small	.	.	x	.
Combine power unit, medium	.	.	.	x
Swather power unit	.	x	.	x
Pick-up, 3/4 ton	x	x	x	x
Truck, 2 ton	.	.	x	x
Grain wagon	x	x	x	x
Forage wagon	.	x	.	x
Hay wagon/fork	.	x	.	x
Stalk shredder	x	x	x	x
Fertilizer spreader	x	x	x	x
Anhydrous applicator	x	x	x	x
Sprayer	x	x	x	x
Moldboard plow, 4-16[a]	x	x	x	.
Moldboard plow, 5-16[a]	.	.	.	x
Moldboard plow, 7-16[a]	.	.	x	x
Chisel plow, 15 ft.[b]	x	x	.	.
Chisel plow, 17 ft.[b]	.	.	x	x
Springtooth drag, 30 ft.	x	x	.	.
Springtooth drag 48 ft.	.	.	x	x
Disc, 16 ft.	x	x	.	.
Disc, 24 ft.	.	.	x	x
Cultivator, 4 row[a]	x	x	.	.
Cultivator, 6 row[a]	.	.	x	x
Rotary hoe[a]	x	x	x	x
Planter, 4 row	x	x	.	.
Planter, 6 row	.	.	x	x
No-till planter, 4 row[c]	x	x	x	x
Grain drill	x	x	x	x
Grain head, 13 ft.	.	.	.	x
Grain head, 15 ft.	.	.	x	.
Corn head, 2 row	.	.	.	x
Corn head, 3 row	.	.	x	.
Swather, 12 ft.	.	x	.	.
Swather, 14 ft.	.	.	.	x
Forage harvester, 1 row	.	x	.	.
Forage harvester, 2 row	.	.	.	x
Round baler, 1 ton	.	x	.	x
Forage blower	.	x	.	x

[a]Not included on farms using either mulch tillage or no-till systems.

[b]Used only on farms with mulch and no-till systems.

[c]Used only on farms with no-till systems.

Table 5-10. Machine operation use rate, power source, labor requirement and cost, southeast Minnesota study area

Machine	Use Rate (hr./acre)	Power Source[a]	Labor Requirement (hr./m. hr.)[b]	Cost[c] ($)
Moldboard plow, 4-16	0.43	A,B	1.02	5.82
Moldboard plow, 5-16	0.34	C	1.02	8.54
Moldboard plow, 7-16	0.25	D	1.02	11.34
Chisel plow, 15 ft.	0.15	B	1.02	5.41
Chisel plow, 17 ft.	0.13	D	1.02	7.36
Springtooth drag, 30 ft.	0.06	B,C	1.08	15.47
Springtooth drag, 48 ft.	0.03	C	1.08	25.01
Disc, 16 ft.	0.13	B	1.02	8.72
Disc, 24 ft.	0.09	D	1.02	19.18
Cultivator, 4 row	0.20	A	1.04	3.83
Cultivator, 6 row	0.14	C	1.04	5.01
Rotary hoe	0.09	A	1.00	9.55
Planter, 4 row	0.21	A	1.16	16.57
Planter, 6 row	0.14	C	1.16	24.77
No-till planter, 4 row	0.29	A,C	1.16	17.83
Grain drill	0.16	A,B	1.11	20.53
Grain head, 13 ft.	0.24	E	1.11	3.05
Grain head, 15 ft.	0.21	F	1.11	3.69
Corn head, 2 row	0.67	E	1.11	4.84
Corn head, 3 row	0.45	F	1.11	7.94
Swather, 12 ft.	0.17	G	1.00	22.35
Swather, 14 ft.	0.14	G	1.00	22.85
Forage harvester	1.06	B,C	1.11	13.55
Round baler, 1 ton	0.22	B,C	1.11	7.82
Forage blower	1.06	B	..	5.91
Grain wagon	0.24	A	1.00	1.66
Forage wagon	1.06	A	1.00	6.10
Hay wagon/fork	0.75	A	1.00	1.66
Stalk shredder	0.23	A	1.00	6.53
Fertilizer spreader	0.03	A,B	1.33	17.93
Anhydrous applicator	0.11	C,D	1.33	16.46
Sprayer	0.07	A	1.25	5.51

Source: Fred Benson and Bruce Hatteberg, "Economic Cost of Machinery in 1979," Agricultural Extension Service, University of Minnesota, FM 609, St. Paul, Minnesota, February 1979.

[a] Power source codes are identified in Table 5-11.

[b] Hours per machine hour.

[c] Includes depreciation, interest, insurance, repair and shelter cost, but does not include operation costs of power units.

Table 5-11. Fuel type, fuel consumption and operation cost of power units, southeast Minnesota study area

Power Unit	Code	Fuel Type	Fuel Consumption (gal./hr.)	Operation Cost[a] ($/hr.)
Tractor, 40 H.P.	A	Gasoline	2.4 (G)	3.45
Tractor, 75 H.P.	B	Diesel	4.5 (D)	6.07
Tractor, 100 H.P.	C	Diesel	6.0 (D)	8.32
Tractor, 140 H.P.	D	Diesel	8.4 (D)	10.23
Combine power unit, small	E	Gasoline	6.0 (G)	28.94
Combine power unit, medium	F	Diesel	7.7 (D)	36.36
Swather power unit	G	Diesel	3.1 (D)	..[b]
Pick-up, 3/4 ton	H	Gasoline	2.64 (G)	9.01
Truck, 2 ton	I	Gasoline	3.96 (G)	15.02

Source: Fred Benson and Bruce Hatteberg, "Economic Cost of Machinery in 1979," Agricultural Extension Service, University of Minnesota, FM 609, St. Paul, Minnesota, February 1979.

[a]Includes depreciation, interest, insurance, repair and shelter cost, but does not include operation costs of power units.

[b]Power unit costs are included with the Swather operation component.

Table 5-12. Machine operation by tillage system for corn,[a] southeast Minnesota study area

Machine	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	---- Times Over the Field ----			
Stalk shredder[b]	1.0	0	0	0
Broadcast fertilizer	1.0	1.0	1.0	1.0
Moldboard plow	1.0	1.0	0	0
Chisel plow	0	0	1.0	0
Disc	2.0	1.0	1.0	0
Springtooth drag	1.0	1.0	0	0
Sprayer	1.2	1.2	2.2	2.2
Corn planter	1.0	1.0	1.0	0
Rotary hoe	1.0	0	0	0
Anhydrous applicator	1.0	1.0	1.0	1.0
Field cultivator	2.0	1.0	0	0
No-till planter	0	0	0	1.0
Corn picker[c]	1.0	1.0	1.0	1.0

[a]The same operations occur for silage except the forage harvester replaces the corn picker.

[b]This operation is not included when corn is preceded by silage or soybeans.

[c]This machine operation occurs only on 480 acre size farms. Small farms custom harvest corn.

A price of $0.90 and $0.80 per gallon of gasoline and diesel are used in the budget generating process to estimate fuel charges. In addition, a lubrication charge of 15 percent of fuel consumption was used.

The number of times over each field by each machine is given in Tables 5-13 to 5-17 for the four tillage systems and crop component of a rotation. The data in the preceding tables are used to estimate the per acre costs for each machine operation. The data in these tables are used to calculate the per acre cost for all machine operations for specific crops and tillage systems.

Other Input Costs

Other input costs include interest on operating capital, drying charges for corn, and a cost for motor vehicle operation. Interest on operating capital was calculated on the cost of seed, fertilizer, and chemical inputs. An 11 percent rate for eight months was used in this calculation. A charge of $0.14 per bushel to dry corn was assumed. On small farms, a cost of $3.83 per acre was assumed for a pick-up use associated with crop production. On the 480 acre farms, a charge of $3.77 per acre for pick-up and $6.16 per acre for truck which was associated with crop production was assumed.

Costs of Soil Loss Control Practices

Limited data were available on practice cost, and what was available indicated a broad range of cost. The data developed for the practices considered in this study rely on the technical specifications for practices contained in the Soil Conservation Service

Table 5-13. Machine operation by tillage system for soybeans, southeast Minnesota study area

Machine	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	Times Over the Field			
Stalk shredder	1.0	1.0	1.0	1.0
Broadcast fertilizer	1.0	1.0	1.0	1.0
Moldboard plow	1.0	1.0	0	0
Chisel plow	0	0	1.0	0
Disc	2.0	1.0	1.0	0
Springtooth drag	1.0	1.0	0	0
Planter	1.0	1.0	1.0	1.0
Sprayer	0	0	1.2	1.2
Cultivator	2.0	2.0	0	0
Combine[a]	1.0	1.0	1.0	1.0
No-till planter	0	0	0	1.0

[a]This operation occurs only on 480 acre size farms; small farms custom harvest soybeans.

Table 5-14. Machine operation by tillage for oats and alfalfa hay establishment, southeast Minnesota study area

Machine	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	---------- Times Over the Field ----------			
Stalk shredder[a]	1.0	1.0	1.0	1.0
Broadcast fertilizer	1.0	1.0	1.0	1.0
Moldboard plow	1.0	1.0	0	0
Disc	1.0	1.0	0	0
Springtooth drag	0	0	1.0	1.0
Grain drill	1.0	1.0	1.0	1.0
Swather[b]	1.0	1.0	1.0	1.0
Baler[b]	1.0	1.0	1.0	1.0
Combine[c]	1.0	1.0	1.0	1.0

[a]This machine operation is not included when oats are preceded by soybeans or silage.

[b]This operation occurs only on farms with roughage consuming livestock. Hay is 50-50 share cropped on grain farms.

[c]This operation occurs only on 480 acre size farms; small farms custom harvest oats.

Table 5-15. Machine operations by tillage for establishment of alfalfa hay without oat cover crop, southeast Minnesota study area

Machine	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	---------- Times Over the Field ----------			
Stalk shredder[a]	1.0	1.0	1.0	1.0
Broadcast fertilizer	1.0	1.0	1.0	1.0
Moldboard plow	1.0	1.0	0	0
Chisel plow	0	0	1.0	0
Disc	2.0	1.0	1.0	1.0
Springtooth drag	1.0	1.0	0	0
Grain drill	1.0	1.0	1.0	1.0
Swather[b]	1.0	1.0	1.0	1.0
Baler[b]	1.0	1.0	1.0	1.0

[a]The stalk shredder operation is not included if hay establishment follows silage or soybeans.

[b]This operation occurs only on farms with roughage consuming livestock. Hay is 50-50 share cropped on grain farms.

Table 5-16. Machine operation by tillage for established alfalfa hay, southeast Minnesota study area

Machine	Conventional Fall Tillage	Conventional Spring Tillage	Mulch Tillage	No-Till
	--- Times Over the Field ---			
Broadcast fertilizer	1.0	1.0	1.0	1.0
Swather[a]	3.0	3.0	3.0	3.0
Baler[a]	3.0	3.0	3.0	3.0

[a]This operation occurs only on farms with roughage consuming livestock. Hay is 50-50 share cropped on grain farms.

standards for practices and other publications[1] as well as rough cost estimates provided by district conservationists in the area. Much of the cost information is developed from judgments related to the adoption of specific practices. This section identifies the assumptions made to estimate costs for technical assistance, installation, and operation and maintenance of soil loss control practices.

The technical assistance cost is assumed to be that provided by Soil Conservation Districts and Soil Conservation Service. A cost of $140.00 per day is assumed for technical assistance. This is based on the hourly wage of an engineer, an engineering aid and their overhead costs.

The installation of grassed waterways and steep back-sloped terraces require the use of earth-moving equipment as well as farm machinery, seed, and fertilizer to establish a permanent vegetative cover. A $75.00/hr. charge[2] was assumed for earth-moving equipment operations. Farm machinery costs are the same as those estimated by the budget generator process. The seed and fertilizer are based on the Soil Conservation Service standards and specifications. The fertilizer prices are the same as those used in the crop budget

---

[1]R. P. Beasley, Erosion and Sediment Pollution Control (Ames: Iowa State University Press, 1972); Clifton Halsey and Kathryn Bolin, "Grassed Waterways-Construction and Maintenance," Extension Folder 480 (St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979); and USDA, Soil Conservation Service, "Grassed Backsloped Terraces," St. Paul, Minnesota, March 1977.

[2]This cost is based on local contractor price quote of $70.00/hr. plus a $75.00 transportation charge for a D-7 caterpillar bulldozer.

generator. The seed cost for bromegrass, Kentucky bluegrass, and ryegrass used to establish grassed waterways and steep back-slope terraces are those reported in 1978 Agricultural Statistics.

The technical assistance and installation costs were amortized over the expected life span of the practice to estimate an average annual cost. An 11 percent interest rate was used to estimate annual cost. The life span for contouring, stripcropping and terracing practices was assumed to be 10 years. Grassed waterways have a 20-year life span.

Tables 5-18 and 5-19 indicate the constructed cost for soil erosion control practices on Fayette and associated soils and Downs and associated soils, respectively.

Table 5-17. Estimated cost of soil loss control practices by soil type and slope gradient for Fayette and associated soils, southeast Minnesota study area

Practice	Fayette Silt Loam 4% Slope	Fayette Silt Loam 9% Slope	Fayette Silt Loam 15% Slope	Dubuque Silt Loam 15% Slope	Chaseburg Silt Loam 1% Slope
	Average Annual Dollars per Acre				
Contouring:					
Technical assistance	0.59	0.59	0.59	0.59	0
Installation	1.62	2.16	3.24	3.24	0
Maintenance	0.17	0.22	0.33	0.33	0
Strip-Cropping:					
Technical assistance	0.59	0.59	0.59	0.59	0
Installation	1.62	2.16	3.24	3.24	0
Maintenance	0.17	0.22	0.33	0.33	0
Steep, back-sloped terraces:					
Technical assistance	1.20	1.20	1.20	1.20	0
Installation	27.72	31.19	31.19	31.19	0
Maintenance	0.74	0.83	0.83	0.83	0

Table 5-18. Estimated cost of soil loss control practices by soil type and slope gradient for Downs and associated soils, southeast Minnesota study area

Practice	Downs Silt Loam 2% Slope	Downs Silt Loam 4% Slope	Downs Silt Loam 9% Slope	Downs Silt Loam 14% Slope	Chaseburg Silt Loam 1% Slope
	---------------- Average Annual Dollars per Acre ----------------				
Contouring:					
Technical assistance	0	0.59	0.59	0.59	0
Installation	0	1.62	2.16	3.24	0
Maintenance	0	0.17	0.22	0.33	0
Strip-Cropping:					
Technical assistance	0	0.59	0.59	0.59	0
Installation	0	1.62	2.16	3.24	0
Maintenance	0	0.17	0.22	0.33	0
Steep, back-sloped terraces:					
Technical assistance	0	1.20	1.20	1.20	0
Installation	0	27.72	31.19	31.19	0
Maintenance	0	0.74	0.83	0.83	0

CHAPTER VI

ON-FARM IMPACTS FROM POLICY OPTIONS

The representative farm models outlined in the preceding chapters are used to estimate impacts of alternative soil conservation and non-point source pollution abatement policies. The empirical results from policy simulations are reported for each of the representative farms in this chapter. Greater detail of impacts for each policy simulation is included in Appendix C.

Analysis of Policy Simulations

Seven policy simulations are made for each of the eight representative farms. Net incomes from crop production are maximized in each simulation given specific policy constraints and other assumptions in the model previously addressed. The first simulation is a baseline and assumes no policy constraints on the model. The remaining simulations include various constraints on the model to reflect potential government activities to reduce soil loss and abate non-point source pollution.

The results reported here include impacts of alternative policies on net income, soil loss and choice of conservation technology. Net income is the residual of total value of crop production plus any cost-share or subsidy payments after subtracting all production input cost, soil conservation practice cost and soil loss tax. Net income estimates do not include returns from pasture or forest production, livestock enterprises or other income-producing activities that may occur on the farms. Neither does it include a land charge. Soil loss is tons of sheet and rill erosion as estimated by the Universal Soil Loss Equation. The choice of conservation technology includes the acreage treated by contouring, strip cropping, terracing and use of conservation tillage systems.

Baseline

The baseline simulation assumes no government programs exist to provide economic incentives, technical assistance or regulation of crop production technology. No conservation practices are included in the model and only conventional fall and spring moldboard tillage systems are considered. However, cropping systems having erosion rates exceeding 50 tons per acre are not included in any model application. Consequently, continuous row crop production is not considered as an option on the high erosive soils. On livestock farms, the choice of crop rotations and tillage systems is constrained by minimum production levels of hay and silage.

Cost-Share on Practice

The cost-share on practice option assumes government subsidy payments to partially offset the cost of applying contouring, contour strip cropping, and back-sloped terracing. This policy option approximates the incentives provided under the current Agricultural Conservation Program. In this simulation, farmers are assumed to receive payments for 75 percent of the practice installation cost. Technical assistance for planning, land surveys, staking, and engineering inspection is provided in this option without charge to the farmer. The farmer, however, must assume all maintenance cost for the practices. As with all policy options considered in this study, the farmer receives no reimbursement for land removed from production as a result of the practice.

Tillage Subsidy

The tillage subsidy option assumes that payments are made to farmers who adopt conservation tillage systems for growing row crops. A annual cash subsidy of $6.00 is provided for each acre of corn, soybean, or silage which is grown under mulch or no-till and also uses contouring, strip cropping or terracing. Farms which use conservation tillage systems with straight row planting are not eligible for the subsidy. In this simulation, all costs for contouring, strip cropping and terracing are subtracted from net farm income.

Soil Loss Maximum

The soil loss maximum option assumes implementation of a mandatory soil conservation or non-point source pollution abatement policy. The policy requires that no crop production system be used which results in soil loss rates greater than the established tolerance level for that soil. The tolerance level for all soils considered in these models is 5.0 tons per acre per year. In these simulations, the farmer must pay the full cost of any practice including technical assistance. The farmer, however, can select any conservation technology to reduce soil loss to tolerance and maximize net income.

Soil Loss Tax

The soil loss tax option estimates the impacts of imposing a tax on each ton of soil loss. This option assumes that a state or local unit of government could use their taxation power to levy a tax on soil loss to achieve soil conservation or non-point source pollution abatement goals. The Universal Soil Loss Equation could provide a basis for estimating the tax. This procedure would provide farmers with prior knowledge of the tax under various crop and production technologies and farmers could choose the production system most beneficial to their unique situation. In this application, a soil loss tax of $0.50 per ton is used. This tax is added to production costs in calculating net income. In these simulations, no cost-sharing on practice or tillage subsidies is assumed. Since the model does not address general market equilibrium, it is assumed there is no shifting of the tax burden. Consequently, the impact of the tax does not affect farm product prices.

Combined Policy

The combined policy option includes a mandatory soil loss restriction but also assumes the availability of cost sharing on practices and tillage subsidies. The soil loss restrictions and subsidies are the same as those discussed in the preceding policy options. This policy option is the same general nature as that contained in the Iowa Conservancy Law and the soil erosion control bill introduced in the 1979 Minnesota Legislature. Under this legislation, farmers must restrict soil loss to specified limits when 75 percent cost-share funds are available for needed practices. Tillage subsidies, however, are not specifically mentioned in this legislation. All counties do not include tillage subsidies in their list of eligible practices under the Federal Agricultural Conservation Program. Also when they are included, tillage subsidy payments are generally restricted to the year the system is adopted and not available in following years. Other than the continued availability of tillage subsidies, this policy option parallels the policy contained in this legislation.

Minimum Conservation Plan

The minimum conservation plan option assumes a policy which bans the use of straight row planting on erosive soils. In this simulation, grassed waterways are established in all fields and the practices of contouring, strip cropping or terracing are used when producing corn, soybeans or silage. In this option, no cost-sharing on practice or tillage subsidy is assumed. Consequently, the farmer pays the full cost of adopting any one of the practices.

One of the Resource Conservation Act strategies receiving special attention is called cross compliance. Under this strategy only those farmers who maintain minimum conservation practices are eligible for government aid programs including price support and disaster loans. The objective of this option is to replicate the impacts of maintaining necessary conservation practices to be eligible for other programs under a cross-compliance type of policy.

Empirical Results on Representative Farms

The impacts of alternative policy options on each representative farm are reported in Tables 6-1 through 6-8. It should be noted that in the following discussion, impacts of policy options are compared to baseline estimates. Although the baseline resulted in the most erosive condition, it was not always the most profitable alternative. A number of crop production activities using straight row conservation tillage systems have higher per acre profits than straight row conventional tillage systems. Under other simulations, the optimum combination of activities sometimes resulted in net incomes higher than the baseline. Because conservation tillage is a relatively new technology and not widely used, conventional straight row tillage systems were selected as a reference point even though a higher income alternative might exist.

On the 480 acre grain farm with Fayette and associated soils, Table 6-1, the policy options which result in the greatest reduction in soil loss are the soil loss maximum and combined policy. In attaining tolerance levels on all fields, total soil loss is reduced by 81 percent from the baseline. Both options result in identical crop rotations, tillage systems and practice combinations. The loss in net income is $1,609 or 7.6 percent of the baseline under the soil loss maximum option. When subsidies were provided under the combined policy option, net income was almost identical to the baseline while government subsidies amounted to $1,720.

Table 6-1. Net income, subsidy, soil loss and applied conservation technology on the 480 acre grain farm with Fayette and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	21,039	0	6,752	0	0	0
Cost-share on practice	21,981	0	4,228	0	0	171
Tillage subsidy	22,014	221	3,954	37	0	170
Soil loss maximum	19,430	0	1,272	0	338	143
Soil loss tax	19,867	[2,114]	4,228	0	0	170
Combined policy	21,066	1,720	1,272	0	338	143
Minimum conservation plan	20,249	0	1,584	37	301	166

The soil-loss tax and cost-share on practice options have no impact on the adoption of soil conservation technology on the 480 acre grain farm with Fayette and associated soils. The tax, however, reduces income by $2,114. Soil loss is estimated to be reduced by 36 percent under these policy options. This reduction is not caused by the policies but rather because straight row mulch tillage systems are more profitable as well as less erosive than the straight row system included in the baseline analysis.

The policy option on this farm resulting in the highest net income is tillage subsidy. In this simulation, 170 acres of row crops were grown under mulch or no-till systems. Only 37 acres, however, have the necessary applied practices to be eligible for $221 of tillage subsidy. Under the tillage subsidy option, soil loss is reduced 41 percent from the baseline.

The minimum conservation plan option is nearly as effective in reducing soil loss as the options with soil loss constraints. Soil loss is reduced by 76 percent and the 480 acre grain farm with Fayette and associated soils foregoes only 4 percent of the baseline income.

When livestock enterprises are included on the 480 acre farm with Fayette and associated soils, Table 6-2, the policy options have the same general impacts. The baseline soil loss on livestock farms is less than on grain farms. This is because the more erosive soils are in permanent pasture and because soil conserving hay crops are forced into the crop rotations. As a consequence, the impacts are of less magnitude than on grain farms.

Table 6-2. Net income, subsidy, soil loss and applied conservation technology on the 480 acre livestock farm with Fayette and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	18,282	0	3,307	0	0	0
Cost-share on practice	18,782	0	2,386	0	0	87
Tillage subsidy	18,789	86	2,369	14	0	94
Soil loss maximum	17,556	0	743	0	229	83
Soil loss tax	17,758	[1,048]	2,097	0	0	79
Combined policy	18,508	1,029	774	0	229	86
Minimum conservation plan	17,533	0	773	0	229	84

On the 480 acre livestock farm with Fayette and associated soils, the soil loss maximum policy results in the greatest reduction of soil loss. Strip cropping and mulch tillage systems were the applied technology. A 77.5 percent reduction in soil loss is achieved with a 4 percent reduction of income. The combined policy was nearly as effective in reducing soil loss and resulted in little change in income but required $1,048 in government subsidies. The minimum conservation plan option selected the same production and conservation technology as the combined policy, but without subsidies the net income is 5 percent less.

The impacts on the 160 acre grain farm with Fayette and associated soils is reported in Table 6-3. The combined policy results in an 86 percent reduction in soil loss. This is a reduction from 25.5 tons per cropland acre to 4.4 tons per cropland acre. The practices include mulch and no-till systems in combination with strip cropping. This option also results in a net income reduction of 12.5 percent and requires $726 in government subsidy. The soil loss maximum policy without subsidy payments results in an 83 percent reduction in soil loss and nearly an 18 percent loss of income.

Neither the cost-share on practice nor soil loss tax options are effective in getting practices applied to the fields on the 160 acre grain farms with Fayette and associated soils. No soil loss, income, or applied conservation technology changes occur in the simulation with cost-sharing on practices. The soil loss tax option results in a shift from straight row conventional tillage to straight row

Table 6-3. Net income, subsidy, soil loss and applied conservation technology on the 160 acre grain farm with Fayette and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	8,925	0	3,226	0	0	0
Cost-share on practice	8,925	0	3,226	0	0	0
Tillage subsidy	8,926	166	2,543	28	0	28
Soil loss maximum	7,370	0	546	0	76	45
Soil loss tax	8,089	[726]	1,451	0	0	74
Combined policy	7,809	635	446	0	123	52
Minimum conservation plan	8,276	0	1,615	46	33	0

conservation tillage. This shift reduces soil loss 55 percent and income 9.5 percent. The minimum conservation plan is nearly as effective as the tax option in reducing soil loss and income is reduced by only 7.5 percent.

On the 160 acre livestock farms with Fayette and associated soils, Table 6-4, soil loss reductions occur only under mandatory and tax options. No change in crop production technology or soil loss resulted from either the cost-share on practice or tillage subsidy option. Only straight row mulch tillage is selected when a soil loss tax is assessed. Strip cropping in combination with mulch tillage is the required technology to reduce soil loss to tolerance levels on several fields. The options requiring soil loss to be less than or equal to tolerance results in a 2 percent income reduction when $437 in government subsidies are paid to farmers and a 7 percent reduction when the farmer paid full practice costs.

Table 6-5 reports the model results of policy options on the 480 acre grain farm with Downs and associated soils. In the baseline analysis, average soil loss is 17 tons per cropland acre and net farm income is $58,759. A corn-soybean rotation is used on all fields with straight row conventional fall moldboard plowing. On policy options, which include conservation tillage systems, higher net income is obtained by shifting to straight row mulch tillage. As a result, income is increased approximately 1 percent while soil loss is reduced by 45 percent. The tillage subsidy option further reduces soil loss as contouring is also applied to all fields. In this option, soil

Table 6-4. Net income, subsidy, soil loss and applied conservation technology on the 160 acre livestock farm with Fayette and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	7,723	0	1,803	0	0	0
Cost-share on practice	7,723	0	1,803	0	0	0
Tillage subsidy	7,723	0	1,803	0	0	0
Soil loss maximum	7,178	0	368	0	90	19
Soil loss tax	7,192	[437]	873	0	0	36
Combined policy	7,575	433	311	0	90	39
Minimum conservation plan	7,212	0	411	0	90	0

Table 6-5. Net income, subsidy, soil loss and applied conservation technology on the 480 acre grain farm with Downs and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	58,760	0	7,954	0	0	0
Cost-share on practice	59,337	0	4,242	0	0	456
Tillage subsidy	59,961	2,686	2,451	448	0	448
Soil loss maximum	52,372	0	1,991	337	18	421
Soil loss tax	57,216	[2,121]	4,242	0	0	456
Combined policy	55,240	3,292	1,797	412	36	427
Minimum conservation plan	57,275	0	2,451	448	0	448

loss is reduced 68 percent and income is higher than in any other simulation. The minimum conservation plan results in an identical combination of rotations, tillages and practices as the tillage subsidy option.

The soil loss maximum policy without any cost-share or subsidy payments reduces soil loss 74 percent while net income falls 11 percent. When $3,292 in subsidies is provided, additional practices are adopted and erosion is reduced an additional 11 percent while net income is only 6 percent under the baseline. The soil loss tax option reduces soil loss 45 percent and results in a tax of $2,121.

When livestock enterprises are included on the 480 acre farms with Downs and associated soils, Table 6-6, the impact of policy options closely parallels the grain farms. Both policy options restricting soil loss to tolerance reduces soil loss more than 70 percent. The reduction in income is about 4 percent without subsidy payments and only 1.5 percent with subsidies. The cost-share on practice and soil loss tax options have no impact on the adoption of soil conserving rotations, tillages or practices. Under the tillage subsidy option, 306 acres receive a subsidy payment of $1,959. The minimum soil conservation plan results in a $1,574 loss in income but reduces soil loss 47 percent.

The impacts of policy options on 160 acre grain farms with Downs and associated soils is reported in Table 6-7. Soil loss restrictions are needed to reduce soil loss to tolerance level or below. The soil loss tax reduces average soil loss from 18.9 to

Table 6-6. Net income, subsidy, soil loss, and applied conservation technology on the 480 acre livestock farm with Downs and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	50,140	0	5,540	0	0	0
Cost-share on practice	50,314	0	5,413	0	0	13
Tillage subsidy	50,685	1,959	1,844	306	0	331
Soil loss maximum	48,352	0	1,554	154	0	231
Soil loss tax	48,714	[1,511]	3,021	0	0	363
Combined policy	49,512	1,406	1,580	193	0	257
Minimum conservation plan	48,566	0	2,957	307	72	24

Table 6-7. Net income, subsidy, soil loss and applied conservation technology on 160 acre grain farm with Downs and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	19,148	0	2,830	0	0	0
Cost-share on practice	19,148	0	2,830	0	0	0
Tillage subsidy	19,236	570	1,733	95	0	95
Soil loss maximum	16,682	0	577	128	0	148
Soil loss tax	18,204	[755]	1,510	0	0	149
Combined policy	17,720	1,098	548	147	0	147
Minimum conservation plan	18,520	0	1,742	147	0	0

10.1 tons per acre. The $755 tax results in an income reduction of about 5 percent. The tax policy is more effective than the minimum conservation plan options in maintaining income and reducing soil loss on this farm. An 80 percent reduction in soil loss occurs when maximum soil loss constraints are included in the model. Net incomes are 13 percent lower without the subsidy payments and 7.5 percent lower with payments. The cost-share on practice option causes no change in the model estimates.

On 160 acre livestock farms with Downs and associated soils, Table 6-8, the maximum soil loss and combined policy options reduce soil loss 66 percent and 70 percent, respectively. The tax option is estimated to reduce soil loss 40 percent and the minimum conservation plan 44 percent. Under the tillage subsidy option, soil loss is reduced by one-third and no reduction occurs under the cost-share on practice option. No policy option causes more than a 4 percent reduction in net income on this farm.

Generalizations From Results

The impacts of the simulations which restricted soil loss to no more than 5.0 tons per acre are of particular interest. They replicate the proposed Minnesota law to enforce soil loss restrictions. With 75 percent cost sharing for practices and $6.00 tillage subsidies, income reductions occur on three of the four grain farms. The reductions are 12.5 and 7.5 percent on the 160 acre farms and 6 percent on the 480 acre farm. This policy option has negligible income impact on the livestock farms and the one grain farm. Income changes are less than 2 percent on these five farms.

Table 6-8. Net income, subsidy, soil loss and applied conservation technology on 160 acre livestock farm with Downs and associated soils under alternative policies, southeast Minnesota study area

Policy Option	Net Return ($)	Subsidy [Tax] ($)	Soil Loss (tons)	Contoured Acreage (acres)	Strip-Crop Acreage (acres)	Conservation Tillage Acreage (acres)
Baseline	15,921	0	1,530	0	0	0
Cost-share on practice	15,921	0	1,530	0	0	0
Tillage subsidy	15,979	415	1,013	58	0	58
Soil loss maximum	15,346	0	522	39	19	76
Soil loss tax	15,335	[455]	911	0	0	92
Combined policy	15,814	729	453	74	19	93
Minimum conservation plan	15,365	0	824	77	41	0

When no subsidies are offered, the soil loss restriction policy reduces income on all farms but results in greater reductions on grain farms than livestock farms. On the 160 acre grain farms, a 17 and 13 percent reduction occurs on the farms with Fayette and Downs soils, respectively. On the 480 acre grain farms, the reduction was 7 and 11 percent, respectively, on farms with Fayette and Downs soils. The income reductions on all livestock farms except one was less than 4 percent and only a 6 percent reduction occurs on the 160 acre farm with Fayette soils.

Also of special interest is the impact from the minimum conservation plan option which simulates the restrictions under a cross compliance type of strategy. The minimum conservation practice of grassed waterways with contouring, strip cropping or terracing is shown to effectively reduce soil loss on representative farms. On farms with Fayette soils, strip cropping was often applied and resulted in average annual soil loss less than tolerance on all farms except the 160 acre grain farm. The soil loss rates were higher on farms with Downs soils because many fields are in continuous row crop in which strip cropping cannot be applied. Soil loss on farms with Downs soils range from 5.5 to 12 tons per acre.

Incomes are estimated to be reduced as a result of implementing a minimum conservation plan. The income reduction is greatest for the 160 acre farms with Fayette and associated soils. For the grain farm, income is 7.3 percent lower and for the livestock farm, it is 6.6 percent lower. On all other farms, net income is reduced by less than 4 percent under the minimum conservation plan option.

The tillage subsidy option offered economic incentive for adopting conservation tillage in combination with contouring, strip cropping or terracing. This option substantially increases the number of acres with treatments on representative farms with Downs and associated soils but was less effective in treating the Fayette and associated soils. On the 480 acre grain farm with Downs and associated soils, all 447 acres of row crops received the $6.00 subsidy. On other representative farms with Downs soils, at least 58 percent of all row crops had both conservation tillage and contouring applied. On representative farms with Fayette soils, at most only 35 percent of the row crops receive the subsidy. On the 160 acre livestock farm with these soils, the policy had no impact on the adoption of conservation technology.

The cost sharing rate on practices assumed in this application was shown not to have sufficient economic incentive to get practices applied. Under the cost-share on practice option, there is no change from the baseline acreage of applied contouring, strip cropping or terracing on any farm. The only change in production technology which occurred with this option was increased straight row conservation tillage.

The soil loss tax of $0.50 per ton of estimated soil loss was shown not to be effective in getting practices applied on representative farms. No contouring, strip cropping nor terracing are applied as a result of the tax. Additional acreage of straight row conservation tillage, however, occurs as a result of the tax on all 160 acre farms and on the 480 acre livestock farm with Downs and associated soils. The increase in acreage using conservation tillage as a result of the soil loss tax ranged from 36 acres on the 160 acre livestock farm with Fayette soil to 350 acres on the 480 acre livestock farm. The tax did not cause soil loss to be reduced to its tolerance level.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary and Conclusions

The purpose of this study is to measure on-farm impacts of alternative soil conservation and non-point source pollution abatement policies. The on-farm impacts include net income from crop production, soil loss, and choice of production technology. It is hypothesized that specific practices or policies have different economic impacts on farms because of their size, soil composition and enterprise combination. It was also hypothesized that different policy options have different on-farm impacts because of farm size, soil composition and enterprise combinations.

These hypotheses were tested using eight representative farm models. The representative farms included two farm sizes, two major soil types and farms with and without roughage consuming livestock enterprises. Farm sizes included 160 acre and 480 acre farms. Soil types included highly erosive conditions represented by Fayette and associated soils and moderately erosive conditions with Downs and associated soils. The target population for this analysis was southeastern Minnesota.

Seven model simulations were made to test alternative policy options. The policy options included cost sharing on practices, subsidies for conservation tillage systems, restrictions which limit soil loss to tolerance rate, a tax on soil loss, and adoption of a minimum conservation plan. The cost-share on practice option is similar to the currently administered Agricultural Conservation Program. The restriction on soil loss approximates the proposed restrictions contained in a soil erosion bill introduced in the 1979 Minnesota legislature. The minimum conservation plan is similar to requirements necessary to participate in other programs under a potential cross compliance type of policy.

The mathematical model for each representative farm includes a set of crop enterprise budgets reflecting alternative production technologies applicable to each farm and the selection of the most profitable combination of production technologies. On farms with livestock enterprises the most profitable combination is constrained by minimum levels of hay and silage production. Integer linear programming was the optimizing technique on livestock farms. On grain farms all constraints including land, labor and capital are implied in the budgets. As a consequence, the most profitable combination of production technologies for grain farms was selected by ranking potential budgets and selecting the most profitable production technology for each field. Alternative policy options were analyzed by adding or deleting different activity sets in the model.

The results from these analyses show that alternative practices and policy options impact on farm incomes, soil loss and applied production technology. It is further shown that representative farms of different sizes, soil compositions and enterprise combinations are unequally impacted by different policy options.

The policy options resulted in very slight increases in net incomes to reductions as great as 17.5 percent. In general, the largest income reductions occurred on all eight representative farms when production technologies were constrained to achieve soil loss at or below tolerance levels and when no cost sharing on practices or tillage subsidies was available to offset practice cost. Policy options including tillage subsidies, soil loss tax, and minimum conservation plan resulted in an increase of applied conservation technology, however, soil loss rates generally continued to exceed tolerance levels. The cost-share on practice was not effective in getting soil conservation technology applied on representative farms.

The impact of policy options on net incomes from livestock farms was less than the impacts on grain farms. On all policy options resulting in lower net incomes, the percentage reduction in income was greater on the grain farms. The impact of most policy options on net incomes was greater on representative farms with severe erosion hazard soils than with moderate erosion hazard soils. The largest reduction in incomes occurred on farms with Fayette soils when soil loss rates were forced to tolerance level. Small farms were less responsive in changing production technology under subsidy policy options than larger farms. Under soil loss restriction or tax policies, the percentage reduction of income for 160 acre farms was greater than for 480 acre farms.

Limitations and Needs for Future Study

The findings from this study apply only to situations similar to the modeled representative farms. Although efforts were made to define the model farms to reflect impacts on broad target population, the generalizations which can be made remain a question. A number of references and data sources were used in developing the model and its data base. An attempt was made to select those sources that most accurately apply to a broader population. However, no probability statements can be made regarding either the data inputs or findings from this study.

The target populations in this study are limited to soils and farm types in southeast Minnesota. Soil conservation policies have statewide and national applications. Additional studies are needed in other areas of the state and nation under different soil, climate and farming conditions before broad policy decisions are made.

Administrative and enforcement cost of implementing the various policy options was not considered in this research. Continuation of current policies of voluntary programs and economic incentives could have a much different administrative and enforcement cost than a regulatory or tax program. The institutional structure for implementing cost share and subsidy programs is already established and its cost and performance can be assessed from past experience. Regulatory or tax programs, however, will require a different institutional structure. Research is needed to assess the necessary institutional changes including the cost and performance of regulatory and tax options.

Although this study measures economic impacts of policy options on farm incomes, it does not necessarily indicate farmer preference. The farmer preference for various policy options is important in gaining political support to initiate a policy as well as its eventual performance. The current activities being conducted under the Resource Conservation Act[1] are addressing the question of land user preference for specific implementation strategies.

This study was limited to on-site, physical and economic impacts of alternative policy options. Obviously, the objective of non-point source pollution abatement practices is to improve off-site environments, especially water quality. Further research is needed to relate on-site practices to changes in water quality and other off-site environments impacted. Although a great deal of research is being conducted to measure both the physical and economic impacts, no conclusive evidence is available to directly link on-site practices to water quality.

The research findings do not consider long-run implications from soil loss. Continued soil loss rates in excess of tolerance can be expected to result in soil depletion and reduced productivity at some time in the future. Studies are needed to assess potential long-run physical and economic impacts of soil depletion. A

---

[1]Land users are currently being asked to review alternative strategies for implementing soil and water conservation programs and report their preferences. This activity is being carried out by the U.S. Department of Agriculture as mandated in the Soil and Water Resources Conservation Act of 1977.

study.[1] was conducted on southern Iowa soils to predict soil depletion stages and changes in crop production inputs and yields from continuation of current soil loss rates. Similar studies need to be conducted for soils in southeast Minnesota and other geographic areas to measure future costs and benefits from reductions in soil loss rates.

This research did not address the long-run impacts on conservation tillage on crop production inputs or yields. Mulch and no-till tillage is relatively new technology and longitudinal studies are not available. Bauder and others[2] have suggested that tillage practices affect the distribution and availability of plant nutrients. Limited research has shown that continuous no-till systems resulted in an accumulation of certain plant nutrients near the surface. These nutrients are less available, especially in dry years for crop production. Further research is needed to address fertilizer needs over time and the long-run limitations to conservation tillage systems.

The land and capital requirements needed to adopt soil conservation practices which include grassed waterways, back-sloped terraces and other enduring practices has wide variations between soil types, topography and farms. The estimates used in this study were developed

---

[1]Paul Rosenberry, Lacy Harmon, and Russell Knutson, Soil Depletion Study Reference Report: Southern Iowa Rivers Basin (Des Moines, Ia: U.S. Department of Agriculture, Soil Conservation Service and Economics Statistics and Cooperatives Service, February 1980).

[2]J. W. Bauder, G. W. Randall, J. B. Swan, J. A. True and C. F. Halsey, "Proposed Fact Sheet--Tillage Practices in South Central Minnesota" (St. Paul, Minn.: University of Minnesota, Agricultural Experiment Station).

from limited data from the 1978 Agricultural Conservation Program Evaluation, estimates provided by the Minnesota Soil Conservation Service and judgments of Soil Conservation Service district conservationists in southeast Minnesota. Further research is needed to develop a consistent data base for estimating installation cost. This base needs to include: technical assistance; actual construction inputs including earth movement and materials; land acreage removed from production; seed, fertilizer and machine operations to establish permanent vegetative cover and maintenance of the practice. The data base should reflect differences in inputs by soil types and topographic features.

APPENDIX A

MINIMUM LEVELS OF ALFALFA HAY AND CORN SILAGE PRODUCTION ON REPRESENTATIVE FARMS

APPENDIX A

MINIMUM LEVELS OF ALFALFA HAY AND CORN SILAGE PRODUCTION ON REPRESENTATIVE FARMS[1]

Representative Farm	Corn Silage (tons)	Alfalfa Hay (tons)
160 Acre, Fayette and associated soils	72	120
480 Acre, Fayette and associated soils	270	450
160 Acre, Downs and associated soils	45	75
480 Acre, Downs and associated soils	108	180

[1]These estimates represent the winter roughage requirements of a beef cow-calf enterprise which utilizes the pasture production on representative farms.

APPENDIX B

SAMPLE BUDGETS FOR CROP ROTATION COMPONENTS BY TILLAGE SYSTEM

APPENDIX B

SAMPLE BUDGETS FOR CROP ROTATION COMPONENTS BY TILLAGE SYSTEM

The following tables are samples of budgets used in the model to estimate net return per acre. The sample budgets included are for eight crop rotation components and two tillage systems on 480 acre grain farm with Fayette and associated soils. The rotation component is identified by the crop which the budget is developed and also the preceding crop. For example, corn-corn indicates a budget for a corn activity when the preceding crop is also corn. The oats, hay-corn activity is the oat budget with hay establishment when preceded by corn. This identification allows the budgets to be added to form a total rotation budget.

The sample budgets include conventional fall tillage and no-till. The level of inputs and cost in these sample budgets are for three potential yields. The actual data included in the model varies from this according to the yield assumed for the particular field.

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS — 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
CORN-CORN — CONVENTIONAL FALL TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	90.0	115.0	130.0	BUS /ACRE		90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3000	.3000	.3000	BAGS/ACRE	45.00	13.50	13.50	13.50
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.18	2.70	2.70	2.70
NITROGEN ANHYDROUS	104.1	132.1	148.9	LBS. /ACRE	.10	10.41	13.21	14.89
PHOSPHORUS PHOSPHORUS	50.1	59.6	65.3	LBS. /ACRE	.17	8.52	10.13	11.10
POTASSIUM POTASSIUM	35.1	44.6	50.3	LBS. /ACRE	.08	2.81	3.57	4.02
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00	4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04	1.99	1.99	1.99
LIME	.2	.2	.2	TONS/ACRE	3.50	.56	.56	.56
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	2.86	3.19	3.39
SUBTOTAL						47.35	52.84	56.14
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34	2.79	2.79	2.79
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18	3.30	3.30	3.30
30FT SPRAYER	.08	.08	.08	HOURS/ACRE	5.51	.47	.47	.47
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
CORN PLANTER 6ROW 38IN	.14	.14	.14	HOURS/ACRE	24.77	3.41	3.41	3.41
ROTARY HOE	.09	.09	.09	HOURS/ACRE	9.55	.88	.88	.88
CULTIVATOR 6ROW 38IN	.27	.27	.27	HOURS/ACRE	5.01	1.36	1.36	1.36
ANHYDROUS APPLICATOR	.11	.11	.11	HOURS/ACRE	16.46	1.85	1.85	1.85
SML CORN HEAD 3ROW 38IN	.45	.45	.45	HOURS/ACRE	7.94	3.54	3.54	3.54
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.67	.67	.67	HOURS/ACRE	5.66	3.79	3.79	3.79
100HP TRACTOR	.47	.47	.47	HOURS/ACRE	13.83	6.56	6.56	6.56
240HP TRACTOR	.53	.53	.53	HOURS/ACRE	17.95	9.51	9.51	9.51
SML BASIC COMBINE	.45	.45	.45	HOURS/ACRE	34.45	15.34	15.34	15.34
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66	6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14	12.60	16.10	18.20
LABOR	3.34	3.34	3.34	HOURS/ACRE	3.50	11.67	11.67	11.67
SUBTOTAL						137.71	146.71	152.11
TOTAL YEARLY PER ACRE COST						137.71	146.71	152.11
TOTAL YEARLY PER ACRE VALUE						195.30	249.55	282.10
NET RETURN PER ACRE						57.59	102.84	129.99
COST PER BUS						1.53	1.28	1.17
VALUE PER BUS						2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	13.75	13.75	13.75	GALS./ACRE	.80	10.99	10.99	10.99
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.65	1.65	1.65

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
CORN-CORN NO TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	90.0	115.0	130.0	BUS /ACRE		90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3250	.3250	.3250	BAGS/ACRE	45.00	14.63	14.63	14.63
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	25.0	25.0	25.0	LBS. /ACRE	.18	4.50	4.50	4.50
NITROGEN ANHYDROUS	127.9	168.0	192.1	LBS. /ACRE	.10	12.79	16.80	19.21
PHOSPHORUS PHOSPHORUS	64.1	78.0	86.3	LBS. /ACRE	.17	10.89	13.25	14.67
POTASSIUM POTASSIUM	45.5	59.9	68.5	LBS. /ACRE	.08	3.64	4.79	5.48
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00	4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04	1.99	1.99	1.99
HERBICIDE ATRAZINE	2.0	2.0	2.0	LBS. /ACRE	2.00	4.00	4.00	4.00
HERBICIDE ALOCHOR	2.3	2.3	2.3	LBS. /ACRE	3.43	7.72	7.72	7.72
LIME	.2	.2	.2	TONS/ACRE	3.50	.56	.56	.56
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	4.15	4.64	4.93
SUBTOTAL						68.87	76.88	81.69
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
30FT SPRAYER	.16	.16	.16	HOURS/ACRE	5.51	.85	.85	.85
NO-TIL PLANTER 4ROW 38	.31	.31	.31	HOURS/ACRE	17.83	5.52	5.52	5.52
ANHYDROUS APPLICATOR	.11	.11	.11	HOURS/ACRE	16.46	1.85	1.85	1.85
SML CORN HEAD 2ROW 38IN	.67	.67	.67	HOURS/ACRE	4.84	3.25	3.25	3.25
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.42	.42	.42	HOURS/ACRE	5.66	2.37	2.37	2.37
100HP TRACTOR	.34	.34	.34	HOURS/ACRE	13.83	4.64	4.64	4.64
240HP TRACTOR	.11	.11	.11	HOURS/ACRE	17.95	2.01	2.01	2.01
SML BASIC COMBINE	.67	.67	.67	HOURS/ACRE	34.45	23.14	23.14	23.14
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66	6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14	12.60	16.10	18.20
LABOR	2.64	2.64	2.64	HOURS/ACRE	3.50	9.23	9.23	9.23
SUBTOTAL						145.16	156.67	163.58
TOTAL YEARLY PER ACRE COST						145.16	156.67	163.58
TOTAL YEARLY PER ACRE VALUE						195.30	249.55	282.10
NET RETURN PER ACRE						50.14	92.88	118.52
COST PER BUS						1.61	1.36	1.26
VALUE PER BUS						2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	10.17	10.17	10.17	GALS./ACRE	.80	8.12	8.12	8.12
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.22	1.22	1.22

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
CORN-SOYBEANS CONVENTIONAL FALL TILLAGE

03/11/80

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	90.0	115.0	130.0	BUS /ACRE		90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3000	.3000	.3000	BAGS/ACRE	45.00	13.50	13.50	13.50
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.18	2.70	2.70	2.70
NITROGEN ANHYDROUS	104.1	132.1	148.9	LBS. /ACRE	.10	10.41	13.21	14.89
PHOSPHORUS PHOSPHORUS	50.1	59.6	65.3	LBS. /ACRE	.17	8.52	10.13	11.10
POTASSIUM POTASSIUM	35.1	44.6	50.3	LBS. /ACRE	.08	2.81	3.57	4.02
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00	4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04	1.99	1.99	1.99
LIME	.2	.2	.2	TONS/ACRE	3.50	.56	.56	.56
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	2.86	3.19	3.39
SUBTOTAL						47.35	52.84	56.14
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34	2.79	2.79	2.79
30FT SPRAYER	.16	.16	.16	HOURS/ACRE	5.51	.85	.85	.85
24FT DISC	.09	.09	.09	HOURS/ACRE	19.18	1.65	1.65	1.65
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
CORN PLANTER 6ROW 38IN	.14	.14	.14	HOURS/ACRE	24.77	3.41	3.41	3.41
CULTIVATOR 6ROW 38IN	.27	.27	.27	HOURS/ACRE	5.01	1.36	1.36	1.36
ANHYDROUS APPLICATOR	.11	.11	.11	HOURS/ACRE	16.46	1.85	1.85	1.85
SML CORN HEAD 3ROW 38IN	.45	.45	.45	HOURS/ACRE	7.94	3.54	3.54	3.54
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
ROTARY HOE	.09	.09	.09	HOURS/ACRE	9.55	.88	.88	.88
40HP TRACTOR	.51	.51	.51	HOURS/ACRE	5.66	2.89	2.89	2.89
100HP TRACTOR	.47	.47	.47	HOURS/ACRE	13.83	6.56	6.56	6.56
240HP TRACTOR	.44	.44	.44	HOURS/ACRE	17.95	7.97	7.97	7.97
SML BASIC COMBINE	.45	.45	.45	HOURS/ACRE	34.45	15.34	15.34	15.34
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66	6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14	12.60	16.10	18.20
LABOR	3.04	3.04	3.04	HOURS/ACRE	3.50	10.65	10.65	10.65
SUBTOTAL						131.49	140.49	145.88
TOTAL YEARLY PER ACRE COST						131.49	140.49	145.88
TOTAL YEARLY PER ACRE VALUE						195.30	249.55	282.10
NET RETURN PER ACRE						63.81	109.06	136.22
COST PER BUS						1.46	1.22	1.12
VALUE PER BUS						2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	12.65	12.65	12.65	GALS./ACRE	.80	10.11	10.11	10.11
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.52	1.52	1.52

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
CORN-SOYBEANS NO TILLAGE

I N P U T S					UNIT PRICE		COST FOR	Y I E L D	L E V E L S
ITEM	90.0	115.0	130.0	BUS /ACRE			90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3250	.3250	.3250	BAGS/ACRE	45.00		14.63	14.63	14.63
FERTILIZERS AND CHEMICALS									
NITROGEN GRAN NITRO	25.0	25.0	25.0	LBS. /ACRE	.18		4.50	4.50	4.50
NITROGEN ANHYDROUS	127.9	168.0	192.1	LBS. /ACRE	.10		12.79	16.80	19.21
PHOSPHORUS PHOSPHORUS	64.1	78.0	86.3	LBS. /ACRE	.17		10.89	13.25	14.67
POTASSIUM POTASSIUM	45.5	59.9	68.5	LBS. /ACRE	.08		3.64	4.79	5.48
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00		4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04		1.99	1.99	1.99
HERBICIDE ALOCHOR	2.3	2.3	2.3	LBS. /ACRE	3.43		7.72	7.72	7.72
HERBICIDE CYANAZINE	1.8	1.8	1.8	LBS. /ACRE	3.01		5.27	5.27	5.27
LIME	.2	.2	.2	TONS/ACRE	3.50		.56	.56	.56
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00	PERCENT	4.23	4.72	5.01
SUBTOTAL							70.22	78.23	83.04
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)									
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93		.46	.46	.46
30FT SPRAYER	.16	.16	.16	HOURS/ACRE	5.51		.85	.85	.85
NO-TIL PLANTER 4ROW 38	.31	.31	.31	HOURS/ACRE	17.83		5.52	5.52	5.52
ANHYDROUS APPLICATOR	.11	.11	.11	HOURS/ACRE	16.46		1.85	1.85	1.85
SML CORN HEAD 3ROW 38IN	.45	.45	.45	HOURS/ACRE	7.94		3.54	3.54	3.54
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66		.44	.44	.44
40HP TRACTOR	.42	.42	.42	HOURS/ACRE	5.66		2.37	2.37	2.37
100HP TRACTOR	.34	.34	.34	HOURS/ACRE	13.83		4.64	4.64	4.64
240HP TRQCTOR	.11	.11	.11	HOURS/ACRE	17.95		2.01	2.01	2.01
SML BASIC COMBINE	.45	.45	.45	HOURS/ACRE	34.45		15.34	15.34	15.34
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44		3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66		6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS							0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14		12.60	16.10	18.20
LABOR	2.37	2.37	2.37	HOURS/ACRE	3.50		8.28	8.28	8.28
SUBTOTAL							138.06	149.57	156.47
TOTAL YEARLY PER ACRE COST							138.06	149.57	156.47
TOTAL YEARLY PER ACRE VALUE							195.30	249.55	282.10
NET RETURN PER ACRE							57.24	99.98	125.63
COST PER BUS							1.53	1.30	1.20
VALUE PER BUS							2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90		0.00	0.00	0.00
DIESEL	8.81	8.81	8.81	GALS./ACRE	.80		7.04	7.04	7.04
LUBRICATION (15 PERCENT OF FUEL COSTS)							1.06	1.06	1.06

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS — 03/11/80

EXAMPLE OF AVERAGE YEARLY BUDGET FOR

CORN-HAY — CONVENTIONAL FALL TILLAGE

ITEM	INPUTS 90.0	115.0	130.0	BUS /ACRE	UNIT PRICE	COST FOR YIELD LEVELS 90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3000	.3000	.3000	BAGS/ACRE	45.00	13.50	13.50	13.50
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.18	2.70	2.70	2.70
NITROGEN ANHYDROUS	0.0	32.9	60.9	LBS. /ACRE	.10	0.00	3.29	6.09
PHOSPHORUS PHOSPHORUS	50.1	59.6	65.3	LBS. /ACRE	.17	8.52	10.13	11.10
POTASSIUM POTASSIUM	35.1	44.6	50.3	LBS. /ACRE	.08	2.81	3.57	4.02
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00	4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04	1.99	1.99	1.99
LIME	0.0	0.0	0.0	TONS/ACRE	3.50	0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	2.15	2.51	2.78
SUBTOTAL						35.68	41.69	46.18
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18	3.30	3.30	3.30
MBD PLOW 7-16	.27	.27	.27	HOURS/ACRE	11.34	3.06	3.06	3.06
30FT SPRAYER	.16	.16	.16	HOURS/ACRE	5.51	.85	.85	.85
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
CORN PLANTER 6ROW 38IN	.14	.14	.14	HOURS/ACRE	24.77	3.41	3.41	3.41
ROTARY HOE	.09	.09	.09	HOURS/ACRE	9.55	.88	.88	.88
CULTIVATOR 6ROW 38IN	.27	.27	.27	HOURS/ACRE	5.01	1.36	1.36	1.36
SML CORN HEAD 3ROW 38IN	.45	.45	.45	HOURS/ACRE	7.94	3.54	3.54	3.54
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.51	.51	.51	HOURS/ACRE	5.66	2.89	2.89	2.89
100HP TRACTOR	.47	.47	.47	HOURS/ACRE	13.83	6.56	6.56	6.56
240HP TRACTOR	.44	.44	.44	HOURS/ACRE	17.95	7.93	7.93	7.93
SML BASIC COMBINE	.45	.45	.45	HOURS/ACRE	34.45	15.34	15.34	15.34
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66	6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14	12.60	16.10	18.20
LABOR	3.04	3.04	3.04	HOURS/ACRE	3.50	10.64	10.64	10.64
SUBTOTAL						119.86	129.38	135.96
TOTAL YEARLY PER ACRE COST						119.86	129.38	135.96
TOTAL YEARLY PER ACRE VALUE						195.30	249.55	282.10
NET RETURN PER ACRE						75.44	120.17	146.14
COST PER BUS						1.33	1.13	1.05
VALUE PER BUS						2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	12.64	12.64	12.64	GALS./ACRE	.80	10.10	10.10	10.10
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.51	1.51	1.51

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80

EXAMPLE OF AVERAGE YEARLY BUDGET FOR

CORN-HAY NO TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	90.0	115.0	130.0	BUS /ACRE		90.0 BUS	115.0 BUS	130.0 BUS
SEED	.3250	.3250	.3250	BAGS/ACRE	45.00	14.63	14.63	14.63
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	25.0	25.0	25.0	LBS. /ACRE	.18	4.50	4.50	4.50
NITROGEN ANHYDROUS	0.0	37.4	70.5	LBS. /ACRE	.10	0.00	3.74	7.05
PHOSPHORUS PHOSPHORUS	64.1	78.0	86.3	LBS. /ACRE	.17	10.89	13.25	14.67
POTASSIUM POTASSIUM	45.5	59.9	68.5	LBS. /ACRE	.08	3.64	4.79	5.48
INSECTICID INSECTICID	1.0	1.0	1.0	UNIT /ACRE	4.00	4.00	4.00	4.00
HERBICIDE 2-4D AMINE	.3	.3	.3	LBS. /ACRE	6.04	1.99	1.99	1.99
HERBICIDE ATRAZINE	2.0	2.0	2.0	LBS. /ACRE	2.00	4.00	4.00	4.00
HERBICIDE ALOCHOR	2.3	2.3	2.3	LBS. /ACRE	3.43	7.72	7.72	7.72
HERBICIDE 2-4D ESTER	1.3	1.3	1.3	LBS. /ACRE	6.04	7.55	7.55	7.55
LIME	0.0	0.0	0.0	TONS/ACRE	3.50	0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	3.78	4.25	4.59
SUBTOTAL						62.70	70.42	76.19
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
30FT SPRAYER	.23	.23	.23	HOURS/ACRE	5.51	1.24	1.24	1.24
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
20FT DISC	.11	.11	.11	HOURS/ACRE	11.95	1.36	1.36	1.36
NO-TIL PLANTER 4ROW 38	.34	.34	.34	HOURS/ACRE	17.83	6.07	6.07	6.07
SML CORN HEAD 2ROW 38IN	.67	.67	.67	HOURS/ACRE	4.84	3.25	3.25	3.25
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.49	.49	.49	HOURS/ACRE	5.66	2.77	2.77	2.77
100HP TRACTOR	.48	.48	.48	HOURS/ACRE	13.83	6.63	6.63	6.63
SML BASIC COMBINE	.67	.67	.67	HOURS/ACRE	34.45	23.14	23.14	23.14
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.33	.33	.33	HOURS/ACRE	18.66	6.16	6.16	6.16
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					.14	12.60	16.10	18.20
LABOR	2.76	2.76	2.76	HOURS/ACRE	3.50	9.66	9.66	9.66
SUBTOTAL						140.26	151.47	159.34
TOTAL YEARLY PER ACRE COST						140.26	151.47	159.34
TOTAL YEARLY PER ACRE VALUE						195.30	249.55	282.10
NET RETURN PER ACRE						55.04	98.08	122.76
COST PER BUS						1.56	1.32	1.23
VALUE PER BUS						2.17	2.17	2.17
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	10.26	10.26	10.26	GALS./ACRE	.80	8.20	8.20	8.20
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.23	1.23	1.23

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS — 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
SOYBEANS-CORN CONVENTIONAL FALL TILLAGE

I N P U T S					UNIT PRICE		COST FOR Y I E L D L E V E L S		
ITEM	26.0	31.0	39.0	BUS /ACRE			26.0 BUS	31.0 BUS	39.0 BUS
SEED	1.0000	1.0000	1.0000	BU /ACRE	9.50		9.50	9.50	9.50
FERTILIZERS AND CHEMICALS									
NITROGEN GRAN NITRO	10.0	10.0	10.0	LBS. /ACRE	.18		1.80	1.80	1.80
PHOSPHORUS PHOSPHORUS	20.0	20.0	20.0	LBS. /ACRE	.17		3.40	3.40	3.40
POTASSIUM POTASSIUM	30.0	30.0	30.0	LBS. /ACRE	.08		2.40	2.40	2.40
LIME	0.0	0.0	0.0	TONS/ACRE	3.50		0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00	PERCENT	1.10	1.10	1.10
SUBTOTAL							18.20	18.20	18.20
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)									
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53		1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93		.46	.46	.46
CULTIVATOR 6ROW 38IN	.27	.27	.27	HOURS/ACRE	5.01		1.36	1.36	1.36
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34		2.79	2.79	2.79
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18		3.30	3.30	3.30
30FT SPRAYER	.07	.07	.07	HOURS/ACRE	5.51		.39	.39	.39
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01		.98	.98	.98
CORN PLANTER 6ROW 38IN	.14	.14	.14	HOURS/ACRE	24.77		3.41	3.41	3.41
MED GRAIN HEAD 15FT	.24	.24	.24	HOURS/ACRE	3.69		.89	.89	.89
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66		.44	.44	.44
40HP TRACTOR	.56	.56	.56	HOURS/ACRE	5.66		3.19	3.19	3.19
100HP TRACTOR	.47	.47	.47	HOURS/ACRE	13.83		6.56	6.56	6.56
240HP TRACTOR	.42	.42	.42	HOURS/ACRE	17.95		7.49	7.49	7.49
MED BASIC COMBINE	.24	.24	.24	HOURS/ACRE	43.42		10.50	10.50	10.50
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44		3.77	3.77	3.77
2TON TRUCK	.25	.25	.25	HOURS/ACRE	18.66		4.66	4.66	4.66
CUSTOM MACHINERY AND LABOR COSTS							0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00		0.00	0.00	0.00
LABOR	2.73	2.73	2.73	HOURS/ACRE	3.50		9.57	9.57	9.57
SUBTOTAL							79.45	79.45	79.45
TOTAL YEARLY PER ACRE COST							79.45	79.45	79.45
TOTAL YEARLY PER ACRE VALUE							150.80	179.80	226.20
NET RETURN PER ACRE							71.35	100.35	146.75
COST PER BUS							3.06	2.56	2.04
VALUE PER BUS							5.80	5.80	5.80
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90		0.00	0.00	0.00
DIESEL	11.42	11.42	11.42	GALS./ACRE	.80		9.13	9.13	9.13
LUBRICATION (15 PERCENT OF FUEL COSTS)							1.37	1.37	1.37

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
SOYBEANS-CORN NO TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	26.0	31.0	39.0	BUS /ACRE		26.0 BUS	31.0 BUS	39.0 BUS
SEED	1.0000	1.0000	1.0000	BU /ACRE	9.50	9.50	9.50	9.50
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	10.0	10.0	10.0	LBS. /ACRE	.18	1.80	1.80	1.80
PHOSPHORUS PHOSPHORUS	20.0	20.0	20.0	LBS. /ACRE	.17	3.40	3.40	3.40
POTASSIUM POTASSIUM	30.0	30.0	30.0	LBS. /ACRE	.08	2.40	2.40	2.40
HERBICIDE ALACHOR	3.3	3.3	3.3	LBS. /ACRE	3.43	11.15	11.15	11.15
LIME	0.0	0.0	0.0	TONS/ACRE	3.50	0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	1.81	1.81	1.81
SUBTOTAL						30.06	30.06	30.06
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
30FT SPRAYER	.08	.08	.08	HOURS/ACRE	5.51	.47	.47	.47
NO-TIL PLANTER 4ROW 38	.31	.31	.31	HOURS/ACRE	17.83	5.52	5.52	5.52
SML GRAIN HEAD 13FT	.28	.28	.28	HOURS/ACRE	3.05	.85	.85	.85
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.58	.58	.58	HOURS/ACRE	5.66	3.27	3.27	3.27
100HP TRACTOR	.34	.34	.34	HOURS/ACRE	13.83	4.64	4.64	4.64
SML BASIC COMBINE	.28	.28	.28	HOURS/ACRE	34.45	9.61	9.61	9.61
PICK UP 3/4 TON	.33	.33	.33	HOURS/ACRE	11.44	3.77	3.77	3.77
2TON TRUCK	.25	.25	.25	HOURS/ACRE	18.66	4.66	4.66	4.66
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	2.13	2.13	2.13	HOURS/ACRE	3.50	7.44	7.44	7.44
SUBTOTAL						72.69	72.69	72.69
TOTAL YEARLY PER ACRE COST						72.69	72.69	72.69
TOTAL YEARLY PER ACRE VALUE						150.80	179.80	226.20
NET RETURN PER ACRE						78.11	107.11	153.51
COST PER BUS						2.80	2.34	1.86
VALUE PER BUS						5.80	5.80	5.80
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	6.93	6.93	6.93	GALS./ACRE	.80	5.54	5.54	5.54
LUBRICATION (15 PERCENT OF FUEL COSTS)						.83	.83	.83

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS — 03/11/80

EXAMPLE OF AVERAGE YEARLY BUDGET FOR

OAT, HAY-CORN — CONVENTIONAL FALL TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	62.0	76.0	82.0	BUS /ACRE		62.0 BUS	76.0 BUS	82.0 BUS
SEED	2.0000	2.0000	2.0000	BU+/ACRE	3.50	7.00	7.00	7.00
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	65.0	65.0	65.0	LBS. /ACRE	.18	11.70	11.70	11.70
PHOSPHORUS PHOSPHORUS	20.0	20.0	20.0	LBS. /ACRE	.17	3.40	3.40	3.40
POTASSIUM POTASSIUM	120.0	120.0	120.0	LBS. /ACRE	.08	9.60	9.60	9.60
OTHER FERT HAY SEED	12.0	12.0	12.0	LBS. /ACRE	2.20	26.40	26.40	26.40
LIME	4.0	4.0	4.0	TONS/ACRE	3.50	13.89	13.89	13.89
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	4.62	4.62	4.62
SUBTOTAL						76.61	76.61	76.61
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34	2.79	2.79	2.79
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18	3.30	3.30	3.30
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
MED GRAIN HEAD 15FT	.24	.24	.24	HOURS/ACRE	3.69	.89	.89	.89
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.67	.67	.67	HOURS/ACRE	5.66	3.81	3.81	3.81
100HP TRACTOR	.06	.06	.06	HOURS/ACRE	13.83	.90	.90	.90
240HP TRACTOR	.42	.42	.42	HOURS/ACRE	17.95	7.49	7.49	7.49
MED BASIC COMBINE	.24	.24	.24	HOURS/ACRE	43.42	10.50	10.50	10.50
PICK UP 3/4 TON	.15	.15	.15	HOURS/ACRE	11.44	1.72	1.72	1.72
2TON TRUCK	.25	.25	.25	HOURS/ACRE	18.66	4.66	4.66	4.66
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	2.16	2.16	2.16	HOURS/ACRE	3.50	7.55	7.55	7.55
SUBTOTAL						127.26	127.26	127.26
TOTAL YEARLY PER ACRE COST						127.26	127.26	127.26
TOTAL YEARLY PER ACRE VALUE						75.02	91.96	99.22
NET RETURN PER ACRE						-52.24	-35.30	-28.04
COST PER BUS						2.05	1.67	1.55
VALUE PER BUS						1.21	1.21	1.21
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	8.75	8.75	8.75	GALS./ACRE	.80	6.99	6.99	6.99
LUBRICATION (15 PERCENT OF FUEL COSTS)						1.05	1.05	1.05

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
OAT, HAY-CORN REDUCED TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	62.0	76.0	82.0	BUS /ACRE		62.0 BUS	76.0 BUS	82.0 BUS
SEED	2.0000	2.0000	2.0000	BU+/ACRE	3.50	7.00	7.00	7.00
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	65.0	65.0	65.0	LBS. /ACRE	.18	11.70	11.70	11.70
PHOSPHORUS PHOSPHORUS	20.0	20.0	20.0	LBS. /ACRE	.17	3.40	3.40	3.40
POTASSIUM POTASSIUM	120.0	120.0	120.0	LBS. /ACRE	.08	9.60	9.60	9.60
OTHER FERT HAY SEED	12.0	12.0	12.0	LBS. /ACRE	2.20	26.40	26.40	26.40
LIME	4.0	4.0	4.0	TONS/ACRE	3.50	13.89	13.89	13.89
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	4.62	4.62	4.62
SUBTOTAL						76.61	76.61	76.61
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
CHISEL PLOW 17FT	.13	.13	.13	HOURS/ACRE	7.36	.99	.99	.99
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
SML GRAIN HEAD 13FT	.28	.28	.28	HOURS/ACRE	3.05	.85	.85	.85
GRAIN WAGON	.26	.26	.26	HOURS/ACRE	1.66	.44	.44	.44
40HP TRACTOR	.67	.67	.67	HOURS/ACRE	5.66	3.81	3.81	3.81
100HP TRACTOR	.03	.03	.03	HOURS/ACRE	13.83	.36	.36	.36
240HP TRACTOR	.13	.13	.13	HOURS/ACRE	17.95	2.42	2.42	2.42
SML BASIC COMBINE	.28	.28	.28	HOURS/ACRE	34.45	9.61	9.61	9.61
PICK UP 3/4 TON	.15	.15	.15	HOURS/ACRE	11.44	1.72	1.72	1.72
2TON TRUCK	.25	.25	.25	HOURS/ACRE	18.66	4.66	4.66	4.66
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	1.82	1.82	1.82	HOURS/ACRE	3.50	6.35	6.35	6.35
SUBTOTAL						113.46	113.46	113.46
TOTAL YEARLY PER ACRE COST						113.46	113.46	113.46
TOTAL YEARLY PER ACRE VALUE						75.02	91.96	99.22
NET RETURN PER ACRE						-38.44	-21.50	-14.24
COST PER BUS						1.83	1.49	1.38
VALUE PER BUS						1.21	1.21	1.21
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	5.96	5.96	5.96	GALS./ACRE	.80	4.76	4.76	4.76
LUBRICATION (15 PERCENT OF FUEL COSTS)						.71	.71	.71

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-CORN CONVENTIONAL FALL TILLAGE

03/11/80

ITEM	INPUTS 1.9	2.2	2.4	TONS/ACRE	UNIT PRICE	COST FOR YIELD LEVELS 1.9 TONS	2.2 TONS	2.4 TONS
SEED	12.0000	12.0000	12.0000	LB /ACRE	2.20	26.40	26.40	26.40
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.10	1.50	1.50	1.50
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	LBS. /ACRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
HERBICIDE EPTC	2.5	2.5	2.5	LBS. /ACRE	2.42	6.05	6.05	6.05
HERBICIDE PROFLURALN	.8	.8	.8	LBS. /ACRE	5.60	4.20	4.20	4.20
LIME	1.0	1.0	1.0	TONS/ACRE	3.50	3.50	3.50	3.50
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	3.69	3.69	3.69
SUBTOTAL						61.24	61.24	61.24
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34	2.79	2.79	2.79
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18	3.30	3.30	3.30
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
40HP TRACTOR	.41	.41	.41	HOURS/ACRE	5.66	2.31	2.31	2.31
100HP TRACTOR	.06	.06	.06	HOURS/ACRE	13.83	.90	.90	.90
240HP TRACTOR	.42	.42	.42	HOURS/ACRE	17.95	7.49	7.49	7.49
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	1.07	1.07	1.07	HOURS/ACRE	3.50	3.74	3.74	3.74
SUBTOTAL						88.39	I!hPP8.39	88.39
TOTAL YEARLY PER ACRE COST						88.39	88.39	88.39
TOTAL YEARLY PER ACRE VALUE						44.50	51.52	56.21
NET RETURN PER ACRE						-43.89	-36.86	-32.18
COST PER TONS						46.52	40.18	36.83
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	4.88	4.88	4.88	GALS./ACRE	.80	3.90	3.90	3.90
LUBRICATION (15 PERCENT OF FUEL COSTS)						.58	.58	.58

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-CORN NO TILLAGE

INPUTS					UNIT PRICE	COST FOR YIELD LEVELS		
ITEM	1.9	2.2	2.4	TONS/ACRE		1.9 TONS	2.2 TONS	2.4 TONS
SEED	12.0000	12.0000	12.0000	LB /ACRE	2.20	26.40	26.40	26.40
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.10	1.50	1.50	1.50
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	LBS. /ACRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
HERBICIDE EPTC	2.5	2.5	2.5	LBS. /ACRE	2.42	6.05	6.05	6.05
HERBICIDE PROFLURALN	.8	.8	.8	LBS. /ACRE	5.60	4.20	4.20	4.20
LIME	4.0	4.0	4.0	TONS/ACRE	3.50	13.89	13.89	13.89
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	4.36	4.36	4.36
SUBTOTAL						72.30	72.30	72.30
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
STALK SHREDDER	.23	.23	.23	HOURS/ACRE	6.53	1.50	1.50	1.50
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
20FT DISC	.10	.10	.10	HOURS/ACRE	11.95	1.23	1.23	1.23
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
40HP TRACTOR	.41	.41	.41	HOURS/ACRE	5.66	2.31	2.31	2.31
100HP TRACTOR	.13	.13	.13	HOURS/ACRE	13.83	1.78	1.78	1.78
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	.64	.64	.64	HOURS/ACRE	3.50	2.26	2.26	2.26
SUBTOTAL						85.52	85.52	85.52
TOTAL YEARLY PER ACRE COST						85.52	85.52	85.52
TOTAL YEARLY PER ACRE VALUE						44.50	51.52	56.21
NET RETURN PER ACRE						-41.02	-34.00	-29.31
COST PER TONS						45.01	38.87	35.63
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	1.75	1.75	1.75	GALS./ACRE	.80	1.40	1.40	1.40
LUBRICATION (15 PERCENT OF FUEL COSTS)						.21	.21	.21

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-SOYBEANS CONVENTIONAL FALL TILLAGE

I N P U T S					UNIT PRICE	COST FOR Y I E L D L E V E L S		
ITEM	1.9	2.2	2.4	TONS/ACRE		1.9 TONS	2.2 TONS	2.4 TONS
SEED	12.0000	12.0000	12.0000	LB /ACRE	2.20	26.40	26.40	26.40
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.10	1.50	1.50	1.50
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	LBS. /ACRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
HERBICIDE EPTC	2.5	2.5	2.5	LBS. /ACRE	2.42	6.05	6.05	6.05
HERBICIDE PROFLURALN	.8	.8	.8	LBS. /ACRE	5.60	4.20	4.20	4.20
LIME	1.0	1.0	1.0	TONS/ACRE	3.50	3.50	3.50	3.50
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	3.69	3.69	3.69
SUBTOTAL						61.24	61.24	61.24
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
MBD PLOW 7-16	.25	.25	.25	HOURS/ACRE	11.34	2.79	2.79	2.79
24FT DISC	.17	.17	.17	HOURS/ACRE	19.18	3.30	3.30	3.30
48FT SPRINGTOOTH DRAG	.04	.04	.04	HOURS/ACRE	25.01	.98	.98	.98
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
40HP TRACTOR	.18	.18	.18	HOURS/ACRE	5.66	1.01	1.01	1.01
100HP TRACTOR	.06	.06	.06	HOURS/ACRE	13.83	.90	.90	.90
240HP TRACTOR	.42	.42	.42	HOURS/ACRE	17.95	7.49	7.49	7.49
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	.79	.79	.79	HOURS/ACRE	3.50	2.78	2.78	2.78
SUBTOTAL						84.63	84.63	84.63
TOTAL YEARLY PER ACRE COST						84.63	84.63	84.63
TOTAL YEARLY PER ACRE VALUE						44.50	51.52	56.21
NET RETURN PER ACRE						-40.13	-33.11	-28.42
COST PER TONS						44.54	38.47	35.26
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	4.33	4.33	4.33	GALS./ACRE	.80	3.46	3.46	3.46
LUBRICATION (15 PERCENT OF FUEL COSTS)						.52	.52	.52

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-SOYBEANS NO TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	1.9	2.2	2.4	TONS/ACRE		1.9 TONS	2.2 TONS	2.4 TONS
SEED	12.0000	12.0000	12.0000	LB /ACRE	2.20	26.40	26.40	26.40
FERTILIZERS AND CHEMICALS								
NITROGEN GRAN NITRO	15.0	15.0	15.0	LBS. /ACRE	.10	1.50	1.50	1.50
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	L BS./A CRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
HERBICIDE EPTC	2.5	2.5	2.5	LBS. /ACRE	2.42	6.05	6.05	6.05
HERBICIDE PROFLURALN	.8	.8	.8	LBS. /ACRE	5.60	4.20	4.20	4.20
LIME	4.0	4.0	4.0	TONS/ACRE	3.50	13.89	13.89	13.89
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	4.36	4.36	4.36
SUBTOTAL						72.30	72.30	72.30
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
20FT DISC	.10	.10	.10	HOURS/ACRE	11.95	1.23	1.23	1.23
14FT GRAIN DRILL	.18	.18	.18	HOURS/ACRE	20.53	3.68	3.68	3.68
40HP TRACTOR	.18	.18	.18	HOURS/ACRE	5.66	1.01	1.01	1.01
100HP TRACTOR	.13	.13	.13	HOURS/ACRE	13.83	1.78	1.78	1.78
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	.37	.37	.37	HOURS/ACRE	3.50	1.29	1.29	1.29
SUBTOTAL						81.77	81.77	81.77
TOTAL YEARLY PER ACRE COST						81.77	81.77	81.77
TOTAL YEARLY PER ACRE VALUE						44.50	51.52	56.21
NET RETURN PER ACRE						-37.27	-30.24	-25.56
COST PER TONS						43.04	37.17	34.07
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	1.20	1.20	1.20	GALS./ACRE	.80	.96	.96	.96
LUBRICATION (15 PERCENT OF FUEL COSTS)						.14	.14	.14

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-HARVEST CONVENTIONAL FALL TILLAGE

I N P U T S					UNIT PRICE	COST FOR	Y I E L D	L E V E L S
ITEM	3.7	4.3	4.8	TONS/ACRE		3.7 TONS	4.3 TONS	4.8 TONS
SEED	0.0000	0.0000	0.0000	LB /ACRE	0.00	0.00	0.00	0.00
FERTILIZERS AND CHEMICALS								
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	LBS. /ACRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
LIME	0.0	0.0	0.0	TONS/ACRE	3.50	0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	1.02	1.02	1.02
SUBTOTAL						16.92	16.92	16.92
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
100HP TRACTOR	.03	.03	.03	HOURS/ACRE	13.83	.36	.36	.36
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	.03	.03	.03	HOURS/ACRE	3.50	.11	.11	.11
SUBTOTAL						17.85	17.85	17.85
TOTAL YEARLY PER ACRE COST						17.85	17.85	17.85
TOTAL YEARLY PER ACRE VALUE						86.65	100.71	112.42
YOUR CONNECT TIME EXPIRES IN 5 MINUTES								
NET RETURN PER ACRE						68.81	82.86	94.57
COST PER TONS						4.82	4.15	3.72
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	.15	.15	.15	GALS./ACRE	.80	.12	.12	.12
LUBRICATION (15 PERCENT OF FUEL COSTS)						.02	.02	.02

FAYETTE SOILS 480 AC GRAIN MANAGEMENT-CONSERVATION BUDGETS 03/11/80
EXAMPLE OF AVERAGE YEARLY BUDGET FOR
HAY-HARVEST NO TILLAGE

INPUTS					UNIT PRICE	COST FOR YIELD LEVELS		
ITEM	3.7	4.3	4.8	TONS/ACRE		3.7 TONS	4.3 TONS	4.8 TONS
SEED	0.0000	0.0000	0.0000	LB /ACRE	0.00	0.00	0.00	0.00
FERTILIZERS AND CHEMICALS								
PHOSPHORUS PHOSPHORUS	30.0	30.0	30.0	LBS. /ACRE	.17	5.10	5.10	5.10
POTASSIUM POTASSIUM	60.0	60.0	60.0	LBS. /ACRE	.18	10.80	10.80	10.80
LIME	0.0	0.0	0.0	TONS/ACRE	3.50	0.00	0.00	0.00
INTEREST ON OPERATING CAPITAL FOR 7. MONTHS					11.00 PERCENT	1.02	1.02	1.02
SUBTOTAL						16.92	16.92	16.92
FIELD OPERATIONS (MACHINERY ADJUSTMENT FACTOR OF 1.00)								
40FT BRDCAST FERTSPREAD	.03	.03	.03	HOURS/ACRE	17.93	.46	.46	.46
100HP TRACTOR	.03	.03	.03	HOURS/ACRE	13.83	.36	.36	.36
CUSTOM MACHINERY AND LABOR COSTS						0.00	0.00	0.00
HAULING AND DRYING CHARGES					0.00	0.00	0.00	0.00
LABOR	.03	.03	.03	HOURS/ACRE	3.50	.11	.11	.11
SUBTOTAL				.		17.85	17.85	17.85
TOTAL YEARLY PER ACRE COST						17.85	17.85	17.85
TOTAL YEARLY PER ACRE VALUE						86.65	100.71	112.42
NET RETURN PER ACRE						68.81	82.86	94.57
COST PER TONS						4.82	4.15	3.72
VALUE PER TONS						23.42	23.42	23.42
GASOLINE	0.00	0.00	0.00	GALS./ACRE	.90	0.00	0.00	0.00
DIESEL	.15	.15	.15	GALS./ACRE	.80	.12	.12	.12
LUBRICATION (15 PERCENT OF FUEL COSTS)						.02	.02	.02

APPENDIX C

EMPIRICAL RESULTS FROM MODEL RUNS OF POLICY OPTIONS ON REPRESENTATIVE FARMS

APPENDIX C

EMPIRICAL RESULTS FROM MODEL RUNS OF POLICY OPTIONS ON REPRESENTATIVE FARMS

The following tables of the results from seven policy simulation runs on all eight representative farms. The following policy options are associated with runs A through G.

Run A	Baseline;
Run B	Maximum soil loss limit;
Run C	Cost-share subsidy;
Run D	Tillage subsidy;
Run E	Soil loss tax;
Run F	Combined policy; and
Run G	Minimum conservation plan.

480 GRAIN FARM - FAYETTE SOILS RUN A DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCOMMM	519.17	77.88	0.00	207.67	32.02	1103.25	20.19	19.036	384.34
2	ST. ROWS	C.F.	CSCOMMM	1337.66	200.65	0.00	527.63	82.49	2833.54	52.02	17.324	901.19
3	ST. ROWS	C.F.	CSCOMMM	671.06	101.79	0.00	271.44	41.85	1427.90	26.39	18.489	487.92
7	ST. ROWS	C.F.	CS	738.00	221.40	0.00	0.00	0.00	1301.83	14.76	31.043	458.19
8	ST. ROWS	C.F.	CSCOMMM	1155.39	172.08	0.00	454.78	71.90	2579.50	43.02	17.247	741.97
9	ST. ROWS	C.F.	CSCOMMM	1274.63	194.55	0.00	489.73	78.49	2871.63	46.96	15.514	728.54
11	ST. ROWS	C.F.	CSCOMMM	1513.67	225.44	0.00	595.81	94.20	3379.38	56.36	16.274	917.20
12	ST. ROWS	C.F.	CSCOMMM	1226.72	188.19	0.00	494.87	77.37	2605.40	48.79	20.300	990.44
13	ST. ROWS	C.F.	CS	1145.43	347.10	0.00	0.00	0.00	2020.01	23.14	33.579	777.02
14	ST. ROWS	C.F.	CSCOMMM	430.76	65.34	0.00	174.24	26.86	916.58	16.94	21.553	365.11
TOTAL				10012.49	1794.42	0.00	3216.17	505.18	21039.02	348.57	19.370	6751.92

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

480 GRAIN FARM - FAYETTE SOILS RUN B DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSCMMMM	502.20	75.33	0.00	0.00	36.27	1058.44	19.53	4.348	84.92
2	CONT STRIP	MULCH	CSCMMMM	1296.51	194.48	0.00	0.00	93.64	2740.11	50.42	3.857	194.47
3	CONT STRIP	MULCH	CSCMMMM	650.97	98.74	0.00	0.00	47.54	1380.53	25.60	4.243	108.62
7	CONT STRIP	MULCH	CSCMMMM	411.43	61.71	0.00	0.00	28.80	948.86	14.40	2.202	31.71
8	CONT STRIP	MULCH	CSCMMMM	1119.94	166.80	0.00	0.00	81.02	2472.23	41.70	3.872	161.46
9	CONT STRIP	MULCH	CSCMMMM	1238.80	189.08	0.00	0.00	89.32	2793.98	45.64	3.441	157.05
11	CONT STRIP	MULCH	CSCMMMM	1469.62	218.88	0.00	0.00	106.31	3252.34	54.72	3.439	188.18
12	CONT STRIP	MULCH	CSCMMMM	1185.49	181.86	0.00	0.00	86.89	2485.53	47.15	4.703	221.75
13	CONT STRIP	MULCH	CSCMMMM	637.56	96.60	0.00	0.00	45.08	1471.99	22.54	2.500	56.35
14	CONT STRIP	MULCH	CSOMMM	242.53	73.58	0.00	196.20	30.25	826.80	16.35	4.156	67.95
TOTAL				8755.05	1357.06	0.00	196.20	645.12	19430.81	338.05	3.764	1272.45

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 GRAIN FARM - FAYETTE SOILS RUN C DATE: 02/28/80

PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CSCMMMM	519.17	77.88	0.00	0.00	37.50	1162.45	20.19	12.317	248.68
2	ST. ROWS	MULCH	CSCMMMM	1337.66	200.65	0.00	0.00	96.61	2995.09	52.02	11.210	583.14
3	ST. ROWS	MULCH	CSCMMMM	671.06	101.79	0.00	0.00	49.01	1505.47	26.39	11.964	315.73
7	ST. ROWS	MULCH	CS	738.00	221.40	0.00	0.00	0.00	1327.00	14.76	16.556	244.37
8	ST. ROWS	MULCH	CSCMMMM	1155.39	172.08	0.00	0.00	83.58	2689.87	43.02	11.160	480.10
9	ST. ROWS	MULCH	CSCMMMM	1274.63	194.55	0.00	0.00	91.91	3015.66	46.96	10.038	471.38
11	ST. ROWS	MULCH	CSCMMMM	1513.67	225.44	0.00	0.00	109.50	3523.97	56.36	10.530	593.47
12	ST. ROWS	MULCH	CSCMMMM	1226.72	188.19	0.00	0.00	89.91	2741.29	48.79	13.135	640.86
13	ST. ROWS	MULCH	CS	1145.43	347.10	0.00	0.00	0.00	2059.92	23.14	17.909	414.41
14	ST. ROWS	MULCH	CSCMMMM	430.76	65.34	0.00	0.00	31.22	960.71	16.94	13.946	236.25
TOTAL				10012.49	1794.42	0.00	0.00	589.24	21981.43	348.57	12.131	4228.40

480 GRAIN FARM - FAYETTE SOILS RUN D DATE: 02/28/80

FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CSCMMMM	519.17	77.88	0.00	0.00	37.50	1162.45	20.19	12.317	248.68
2	ST. ROWS	MULCH	CSCMMMM	1337.66	200.65	0.00	0.00	96.61	2995.09	52.02	11.210	583.14
3	ST. ROWS	MULCH	CSCMMMM	671.06	101.79	0.00	0.00	49.01	1505.47	26.39	11.964	315.73
7	CONTOUR	MULCH	CS	720.00	216.00	0.00	0.00	0.00	1341.72	14.40	9.609	138.37
8	ST. ROWS	MULCH	CSCMMMM	1155.39	172.08	0.00	0.00	83.58	2689.87	43.02	11.160	480.10
9	ST. ROWS	MULCH	CSCMMMM	1274.63	194.55	0.00	0.00	91.91	3015.66	46.96	10.038	471.38
11	ST. ROWS	MULCH	CSCMMMM	1513.67	225.44	0.00	0.00	109.50	3523.97	56.36	10.530	593.47
12	ST. ROWS	MULCH	CSCMMMM	1226.72	188.19	0.00	0.00	89.91	2741.29	48.79	13.135	640.86
13	CONTOUR	MULCH	CS	1115.73	338.10	0.00	0.00	0.00	2078.19	22.54	10.909	245.89
14	ST. ROWS	MULCH	CSCMMMM	430.76	65.34	0.00	0.00	31.22	960.71	16.94	13.946	236.25
TOTAL				9964.79	1780.02	0.00	0.00	589.24	22014.42	347.61	11.374	3953.87

480 GRAIN FARM - FAYETTE SOILS RUN E DATE: 02/28/80

FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CSCMMMM	519.17	77.88	0.00	0.00	37.50	1038.11	20.19	12.317	248.68
2	ST. ROWS	MULCH	CSCMMMM	1337.66	200.65	0.00	0.00	96.61	2 703.52	52.02	11.210	583.14
3	ST. ROWS	MULCH	CSCMMMM	671.06	101.79	0.00	0.00	49.01	1347.61	26.39	11.964	315.73
7	ST. ROWS	MULCH	CS	738.00	221.40	0.00	0.00	0.00	1204.82	14.76	16.556	244.37
8	ST. ROWS	MULCH	CSCMMMM	1155.39	172.08	0.00	0.00	83.58	2449.82	43.02	11.160	480.10
9	ST. ROWS	MULCH	CSCMMMM	1274.63	194.55	0.00	0.00	91.91	2779.97	46.96	10.038	471.38
11	ST. ROWS	MULCH	CSCMMMM	1513.67	225.44	0.00	0.00	109.50	3227.23	56.36	10.530	593.47
12	ST. ROWS	MULCH	CSCMMMM	1226.72	188.19	0.00	0.00	89.91	2420.86	48.79	13.135	640.86
13	ST. ROWS	MULCH	CS	1145.43	347.10	0.00	0.00	0.00	1852.71	23.14	17.909	414.41
14	ST. ROWS	MULCH	CSCMMMM	430.76	65.34	0.00	0.00	31.22	842.59	16.94	13.946	236.25
TOTAL				10012.49	1794.42	0.00	0.00	589.24	19867.23	348.57	12.131	4228.40

SOIL LOSS TAXED AT $ .50 PER TON

480 GRAIN FARM - FAYETTE SOILS RUN F DATE: 02/28/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSCMMM	502.20	75.33	0.00	0.00	36.27	1155.90	19.53	4.348	84.92
2	CONT STRIP	MULCH	CSCMMM	1296.51	194.48	0.00	0.00	93.64	2987.17	50.42	3.857	194.47
3	CONT STRIP	MULCH	CSCMMM	650.97	98.74	0.00	0.00	47.54	1503.41	25.60	4.243	108.62
7	CONT STRIP	MULCH	CSCMMM	411.43	61.71	0.00	0.00	28.80	1015.10	14.40	2.202	31.71
8	CONT STRIP	MULCH	CSCMMM	1119.94	166.80	0.00	0.00	81.02	2676.56	41.70	3.872	161.46
9	CONT STRIP	MULCH	CSCMMM	1238.80	189.08	0.00	0.00	89.32	3010.31	45.64	3.441	157.05
11	CONT STRIP	MULCH	CSCMMM	1469.62	218.88	0.00	0.00	106.31	3516.09	54.72	3.439	188.18
12	CONT STRIP	MULCH	CSCMMM	1185.49	181.86	0.00	0.00	86.89	2723.64	47.15	4.703	221.75
13	CONT STRIP	MULCH	CSCMMM	637.56	96.60	0.00	0.00	45.08	1576.80	22.54	2.500	56.35
14	CONT STRIP	MULCH	CSOMMM	242.53	73.58	0.00	196.20	30.25	901.35	16.35	4.156	67.95
TOTAL				8755.05	1357.06	0.00	196.20	645.12	21066.33	338.05	3.764	1272.45

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 GRAIN FARM - FAYETTE SOILS RUN G DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSCMMMM	502.20	75.33	0.00	0.00	36.27	1058.44	19.53	4.348	84.92
2	CONT STRIP	MULCH	CSCMMMM	1296.51	194.48	0.00	0.00	93.64	2740.11	50.42	3.857	194.47
3	CONT STRIP	MULCH	CSCMMMM	650.97	98.74	0.00	0.00	47.54	1380.53	25.60	4.243	108.62
7	CONTOUR	MULCH	CS	720.00	216.00	0.00	0.00	0.00	1255.32	14.40	9.609	138.37
8	CONT STRIP	MULCH	CSCMMMM	1119.94	166.80	0.00	0.00	81.02	2472.23	41.70	3.872	161.46
9	CONT STRIP	MULCH	CSCMMMM	1238.80	189.08	0.00	0.00	89.32	2793.98	45.64	3.441	157.05
11	CONT STRIP	MULCH	CSCMMMM	1469.62	218.88	0.00	0.00	106.31	3252.34	54.72	3.439	188.18
12	CONT STRIP	MULCH	CSCMMMM	1185.49	181.86	0.00	0.00	86.89	2485.53	47.15	4.703	221.75
13	CONTOUR	MULCH	CS	1115.73	338.10	0.00	0.00	0.00	1942.95	22.54	10.909	245.89
14	CONT STRIP	MULCH	CSCMMMM	415.76	63.06	0.00	0.00	30.13	868.39	16.35	5.079	83.04
TOTAL				9715.02	1742.33	0.00	0.00	571.12	20249.82	338.05	4.685	1583.75

ST. ROWS DELETED FROM RUN

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN A DATE: 03/04/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	ST. ROWS	C.S.	CSIMMMM	780.30	0.00	113.58	0.00	112.71	3574.55	52.02	12.229	636.15
7	ST. ROWS	C.S.	CSIMMMM	246.00	0.00	35.42	0.00	34.44	1218.17	14.76	8.278	122.18
8	ST. ROWS	C.S.	CSIMMMM	276.77	0.00	39.62	0.00	39.91	1344.12	17.48	11.507	201.14
9	ST. ROWS	C.F.	CSMMMM	673.98	200.76	0.00	0.00	97.51	3401.12	43.02	13.189	567.39
10	ST. ROWS	C.F.	CSMMMM	743.53	226.97	0.00	0.00	107.23	3809.77	46.96	11.864	557.13
14	ST. ROWS	C.F.	CS	1145.43	347.10	0.00	0.00	0.00	2053.21	23.14	33.579	777.02
12	ST. ROWS	C.S.	CSIMMMM	609.12	0.00	90.07	0.00	86.18	2881.60	38.88	11.479	446.30
TOTAL				4475.13	774.83	278.69	0.00	477.99	18282.54	236.26	13.999	3307.32

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN B DATE: 03/04/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	CONT STRIP	MULCH	CSIMMMM	756.30	0.00	110.08	0.00	109.24	3405.79	50.42	3.507	176.82
7	CONT STRIP	MULCH	CSIMMMM	240.00	0.00	34.56	0.00	33.60	1178.57	14.40	2.002	28.83
8	CONT STRIP	MULCH	CSIMMMM	268.53	0.00	38.73	0.00	38.73	1288.78	16.96	3.318	56.27
9	CONT STRIP	MULCH	CSCOMMM	1119.94	166.80	0.00	440.83	69.70	3291.01	41.70	4.224	176.14
10	CONT STRIP	MULCH	CSMMMM	722.63	220.59	0.00	0.00	104.21	3697.97	45.64	2.815	128.48
12	CONT STRIP	MULCH	CSIMMMM	591.73	0.00	87.50	0.00	83.72	2761.13	37.77	3.040	114.82
14	CONT STRIP	MULCH	CSCOMMM	637.56	96.60	0.00	241.50	38.64	1933.55	22.54	2.727	61.47
TOTAL				4336.69	483.99	270.87	682.33	477.84	17556.80	229.43	3.238	742.83

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN C DATE: 03/04/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	ST. ROWS	MULCH	CSIMMMM	780.30	0.00	113.58	0.00	112.71	3681.89	52.02	10.191	530.14
7	ST. ROWS	MULCH	CSIMMMM	246.00	0.00	35.42	0.00	34.44	1248.33	14.76	6.898	101.81
8	ST. ROWS	MULCH	CSMMMM	276.77	84.49	0.00	0.00	39.91	1468.75	17.48	8.630	150.85
9	ST. ROWS	MULCH	CSCOMMM	1155.39	172.08	0.00	454.78	71.90	3534.57	43.02	12.174	523.73
10	ST. ROWS	MULCH	CSMMMM	743.53	226.97	0.00	0.00	107.23	3945.80	46.96	8.213	385.68
12	ST. ROWS	MULCH	CSICOMMM	1044.21	0.00	77.20	416.57	63.32	2962.63	38.88	13.392	520.68
14	ST. ROWS	MULCH	CSIMMMM	381.81	0.00	54.76	0.00	53.99	1940.33	23.14	7.462	172.67
TOTAL				4628.01	483.54	280.96	871.35	483.50	18782.30	236.26	10.097	2385.56

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN D DATE: 03/05/80
FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	ST. ROWS	MULCH	CSIMMMM	780.30	0.00	113.58	0.00	112.71	3681.89	52.02	10.191	530.14
7	CONTOUR	MULCH	CS	720.00	216.00	0.00	0.00	0.00	1340.86	14.40	9.609	138.37
8	ST. ROWS	MULCH	CSMMMM	276.77	84.49	0.00	0.00	39.91	1468.75	17.48	8.630	150.85
9	ST. ROWS	MULCH	CSIMMMM	673.98	0.00	96.80	0.00	97.51	3339.53	43.02	10.145	436.44
10	ST. ROWS	MULCH	CSMMMM	743.53	226.97	0.00	0.00	107.23	3945.80	46.96	8.213	385.68
12	ST. ROWS	MULCH	CSICOMMM	1044.21	0.00	77.20	416.57	63.32	2962.63	38.88	13.392	520.68
14	ST. ROWS	MULCH	CSCOMMM	654.53	99.17	0.00	247.93	39.67	2050.27	23.14	8.954	207.20
TOTAL				4893.32	626.63	287.58	664.50	460.35	18789.73	235.90	10.044	2369.35

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN E DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	ST. ROWS	MULCH	CSMMMM	780.30	234.09	0.00	0.00	112.71	3663.98	52.02	9.172	477.13
7	ST. ROWS	MULCH	CSIMMMM	246.00	0.00	35.42	0.00	34.44	1197.42	14.76	6.898	101.81
8	ST. ROWS	MULCH	CSMMMM	276.77	84.49	0.00	0.00	39.91	1393.32	17.48	8.630	150.85
9	ST. ROWS	MULCH	CSIMMMM	673.98	0.00	96.80	0.00	97.51	3121.31	43.02	10.145	436.44
10	ST. ROWS	MULCH	CSMMMM	743.53	226.97	0.00	0.00	107.23	3752.96	46.96	8.213	385.68
12	ST. ROWS	MULCH	CSIMMMM	609.12	0.00	90.07	0.00	86.18	2775.28	38.88	9.566	371.93
14	ST. ROWS	MULCH	CSIMMMM	381.81	0.00	54.76	0.00	53.99	1853.99	23.14	7.462	172.67
TOTAL				3711.51	545.55	277.06	0.00	531.97	17758.26	236.26	8.874	2096.51

SOIL LOSS TAXED AT $ .50 PER TON

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN F DATE: 03/05/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	CONT STRIP	MULCH	CSIMMMM	756.30	0.00	110.08	0.00	109.24	3624.11	50.42	3.507	176.82
7	CONT STRIP	MULCH	CSICOMMM	411.43	0.00	29.62	156.34	24.69	1242.70	14.40	2.803	40.36
8	CONT STRIP	MULCH	CSCOMMM	460.34	70.26	0.00	179.29	28.35	1445.13	16.96	3.982	67.53
9	CONT STRIP	MULCH	CSMMMM	653.30	194.60	0.00	0.00	94.52	3463.00	41.70	3.168	132.11
10	CONT STRIP	MULCH	CSCOMMM	1238.80	189.08	0.00	482.48	76.28	3891.19	45.64	3.754	171.33
12	CONT STRIP	MULCH	CSIMMMM	591.73	0.00	87.50	0.00	83.72	2921.27	37.77	3.040	114.82
14	CONT STRIP	MULCH	CSICOMMM	637.56	0.00	45.72	241.50	38.64	1920.73	22.54	3.182	71.72
TOTAL				4749.46	453.94	272.92	1059.61	455.44	18508.13	229.43	3.377	774.70

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN G DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
2	CONT STRIP	MULCH	CSIMMMM	756.30	0.00	110.08	0.00	109.24	3405.79	50.42	3.507	176.82
7	CONT STRIP	MULCH	CSIMMMM	240.00	0.00	34.56	0.00	33.60	1178.57	14.40	2.002	28.83
8	CONT STRIP	MULCH	CSMMMM	268.53	81.97	0.00	0.00	38.73	1371.13	16.96	2.986	50.64
9	CONT STRIP	MULCH	CSCOMMM	1119.94	166.80	0.00	440.83	69.70	3291.01	41.70	4.224	176.14
10	CONT STRIP	MULCH	CSMMMM	722.63	220.59	0.00	0.00	104.21	3697.97	45.64	2.815	128.48
12	CONT STRIP	MULCH	CSICOMMM	1014.39	0.00	75.00	404.68	61.51	2762.48	37.77	4.256	160.75
14	CONT STRIP	MULCH	CSIMMMM	371.91	0.00	53.34	0.00	52.59	1826.45	22.54	2.273	51.23
TOTAL				4493.70	469.36	272.98	845.51	469.58	17533.40	229.43	3.369	772.89

ST. ROWS DELETED FROM RUN

160 ACRE GRAIN FARM - FAYETTE SOILS RUN A DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCOMMM	978.43	146.76	0.00	396.81	60.34	2207.51	38.05	20.420	776.98
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1762.29	19.28	36.256	699.02
3	ST. ROWS	C.F.	CSCOMMM	175.11	26.27	0.00	70.05	11.38	407.58	6.81	17.578	119.71
4	ST. ROWS	C.F.	CSCOMMM	493.17	74.24	0.00	193.55	30.23	1140.53	18.56	18.323	340.07
5	ST. ROWS	C.F.	CSCOMMM	407.34	61.32	0.00	162.06	24.97	944.70	15.33	16.714	256.23
8	ST. ROWS	C.F.	CS	1363.68	411.95	0.00	0.00	0.00	2463.00	28.41	36.412	1034.46
TOTAL				4362.45	1009.74	0.00	822.47	126.92	8925.61	126.44	25.518	3226.47

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

160 ACRE GRAIN FARM - FAYETTE SOILS RUN B DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSOMMM	551.40	165.42	0.00	447.25	68.01	1976.54	36.76	3.897	143.25
2	ST. ROWS	NO-TIL	CSOMMM	298.84	89.97	0.00	228.15	36.63	1264.44	19.28	4.834	93.20
3	CONT STRIP	MULCH	CSCOMMM	170.23	25.53	0.00	68.09	11.06	377.41	6.62	4.834	32.00
4	CONT STRIP	MULCH	CSCOMMM	477.49	71.88	0.00	187.40	29.27	1042.51	17.97	4.595	82.57
5	CONT STRIP	MULCH	CSCOMMM	395.38	59.52	0.00	157.30	24.23	869.39	14.88	3.830	56.99
8	ST. ROWS	NO-TIL	CSOMMM	430.89	132.58	0.00	331.45	53.98	1839.68	28.41	4.855	137.93
TOTAL				2324.23	544.90	0.00	1419.64	223.18	7369.97	123.92	4.406	545.95

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE GRAIN FARM - FAYETTE SOILS RUN C DATE: 02/28/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCOMMM	978.43	146.76	0.00	396.81	60.34	2207.51	38.05	20.420	776.98
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1762.29	19.28	36.256	699.02
3	ST. ROWS	C.F.	CSCOMMM	175.11	26.27	0.00	70.05	11.38	407.58	6.81	17.578	119.71
4	ST. ROWS	C.F.	CSCOMMM	493.17	74.24	0.00	193.55	30.23	1140.53	18.56	18.323	340.07
5	ST. ROWS	C.F.	CSCOMMM	407.34	61.32	0.00	162.06	24.97	944.70	15.33	16.714	256.23
8	ST. ROWS	C.F.	CS	1363.68	411.95	0.00	0.00	0.00	2463.00	28.41	36.412	1034.46
TOTAL				4362.45	1009.74	0.00	822.47	126.92	8925.61	126.44	25.518	3226.47

160 ACRE GRAIN FARM - FAYETTE SOILS RUN D DATE: 02/28/80

FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCOMMM	978.43	146.76	0.00	396.81	60.34	2207.51	38.05	20.420	776.98
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1762.29	19.28	36.256	699.02
3	ST. ROWS	C.F.	CSCOMMM	175.11	26.27	0.00	70.05	11.38	407.58	6.81	17.578	119.71
4	ST. ROWS	C.F.	CSCOMMM	493.17	74.24	0.00	193.55	30.23	1140.53	18.56	18.323	340.07
5	ST. ROWS	C.F.	CSCOMMM	407.34	61.32	0.00	162.06	24.97	944.70	15.33	16.714	256.23
8	CONTOUR	MULCH	CS	1328.16	401.22	0.00	0.00	0.00	2464.29	27.67	12.686	351.02
TOTAL				4326.93	999.01	0.00	822.47	126.92	8926.90	125.70	20.231	2543.02

160 ACRE GRAIN FARM - FAYETTE SOILS RUN E DATE: 02/28/80

FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	NO-TIL	CSOMMM	539.04	164.88	0.00	437.58	66.59	2040.36	38.05	7.207	274.23
2	ST. ROWS	MULCH	CS	944.72	289.20	0.00	0.00	0.00	1559.60	19.28	19.336	372.80
3	ST. ROWS	NO-TIL	CSOMMM	96.47	29.51	0.00	77.18	12.60	383.17	6.81	6.204	42.25
4	ST. ROWS	NO-TIL	CSOMMM	272.21	83.52	0.00	213.44	33.41	1059.24	18.56	6.467	120.03
5	ST. ROWS	NO-TIL	CSOMMM	224.84	68.99	0.00	178.85	27.59	882.34	15.33	5.899	90.43
8	ST. ROWS	MULCH	CS	1363.68	411.95	0.00	0.00	0.00	2164.27	28.41	19.420	551.72
TOTAL				3440.96	1048.05	0.00	907.05	140.19	8088.97	126.44	11.479	1451.46

SOIL LOSS TAXED AT $ .50 PER TON

160 ACRE GRAIN FARM - FAYETTE SOILS RUN F DATE: 02/28/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	NO-TIL	CSCOMMM	892.74	136.54	0.00	362.35	55.14	2145.26	36.76	3.464	127.34
2	CONT STRIP	MULCH	CSCOMMM	525.00	80.36	0.00	200.89	32.14	1308.35	18.75	3.159	59.23
3	CONT STRIP	MULCH	CSCOMMM	170.23	25.53	0.00	68.09	11.06	407.33	6.62	4.834	32.00
4	CONT STRIP	MULCH	CSCOMMM	477.49	71.88	0.00	187.40	29.27	1131.82	17.97	4.595	82.57
5	CONT STRIP	MULCH	CSCOMMM	395.38	59.52	0.00	157.30	24.23	941.26	14.88	3.830	56.99
8	CONT STRIP	MULCH	CSCOMMM	758.95	114.63	0.00	292.51	47.43	1875.16	27.67	3.198	88.49
TOTAL				3219.79	488.46	0.00	1268.54	199.27	7809.18	122.65	3.641	446.62

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE GRAIN FARM - FAYETTE SOILS RUN G DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	C.F.	CSCOMMM	945.26	141.79	0.00	383.35	58.29	2004.01	36.76	7.360	270.55
2	CONTOUR	C.F.	CS	918.75	281.25	0.00	0.00	0.00	1658.53	18.75	23.692	444.23
3	CONT STRIP	C.F.	CSCOMMM	170.23	25.53	0.00	68.09	11.06	377.87	6.62	6.848	45.33
4	CONT STRIP	C.F.	CSCOMMM	477.49	71.88	0.00	187.40	29.27	1044.08	17.97	6.510	116.98
5	CONT STRIP	C.F.	CSCOMMM	395.38	59.52	0.00	157.30	24.23	870.69	14.88	5.426	80.74
8	CONTOUR	C.F.	CS	1328.16	401.22	0.00	0.00	0.00	2320.54	27.67	23.785	658.13
TOTAL				4235.27	981.19	0.00	796.14	122.85	8275.72	122.65	13.175	1615.97

ST. ROWS DELETED FROM RUN

160 ACRE LIVESTOCK FARM - FAYETTE SOILS　　RUN A　　DATE: 02/29/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCMMMM	488.65	73.56	0.00	0.00	34.94	1509.17	18.39	16.647	306.14
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1756.60	19.28	36.256	699.02
4	ST. ROWS	C.F.	CSCMMMM	493.96	74.36	0.00	0.00	35.32	1525.58	18.59	17.237	320.44
6	ST. ROWS	C.S.	CSICMMMM	220.80	0.00	16.32	0.00	15.96	622.66	8.40	15.831	132.98
8	ST. ROWS	C.S.	CSICMMMM	778.70	0.00	55.97	0.00	56.78	2308.84	28.39	12.129	344.34
TOTAL				2926.83	437.12	72.29	0.00	143.00	7722.85	93.05	19.376	1802.91

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

160 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN B DATE: 02/29/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSICMMMM	473.50	0.00	34.62	0.00	33.86	1253.62	17.82	3.882	69.18
2	CONT STRIP	C.S.	CSICMMMM	525.00	0.00	37.50	0.00	37.50	1496.38	18.75	3.949	74.04
4	CONT STRIP	MULCH	CSCMMMM	478.29	72.00	0.00	0.00	34.20	1406.96	18.00	4.209	75.76
6	CONT STRIP	MULCH	CSCMMMM	214.23	32.60	0.00	0.00	15.49	633.96	8.15	3.790	30.89
8	CONT STRIP	C.F.	CSCMMMM	758.40	114.55	0.00	0.00	55.30	2387.58	27.65	4.260	117.79
TOTAL				2449.42	219.15	72.12	0.00	176.35	7178.50	90.37	4.068	367.66

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN C DATE: 02/29/80

PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCMMMM	488.65	73.56	0.00	0.00	34.94	1509.17	18.39	16.647	306.14
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1756.60	19.28	36.256	699.02
4	ST. ROWS	C.F.	CSCMMMM	493.96	74.36	0.00	0.00	35.32	1525.58	18.59	17.237	320.44
6	ST. ROWS	C.S.	CSICMMMM	220.80	0.00	16.32	0.00	15.96	622.66	8.40	15.831	132.98
8	ST. ROWS	C.S.	CSICMMMM	778.70	0.00	55.97	0.00	56.78	2308.84	28.39	12.129	344.34
TOTAL				2926.83	437.12	72.29	0.00	143.00	7722.85	93.05	19.376	1802.91

160 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN D DATE: 02/29/80
FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CSCMMMM	488.65	73.56	0.00	0.00	34.94	1509.17	18.39	16.647	306.14
2	ST. ROWS	C.F.	CS	944.72	289.20	0.00	0.00	0.00	1756.60	19.28	36.256	699.02
4	ST. ROWS	C.F.	CSCMMMM	493.96	74.36	0.00	0.00	35.32	1525.58	18.59	17.237	320.44
6	ST. ROWS	C.S.	CSICMMMM	220.80	0.00	16.32	0.00	15.96	622.66	8.40	15.831	132.98
8	ST. ROWS	C.S.	CSICMMMM	778.70	0.00	55.97	0.00	56.78	2308.84	28.39	12.129	344.34
TOTAL				2926.83	437.12	72.29	0.00	143.00	7722.85	93.05	19.376	1802.91

160 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN E DATE: 02/29/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CCMMMM	570.09	0.00	0.00	0.00	40.76	1402.39	18.39	9.364	172.20
2	ST. ROWS	MULCH	CSCMMMM	539.84	82.63	0.00	0.00	38.56	1659.05	19.28	8.862	170.86
4	ST. ROWS	MULCH	CCMMMM	576.29	0.00	0.00	0.00	41.21	1414.56	18.59	9.696	180.25
6	ST. ROWS	MULCH	CSICMMMM	220.80	0.00	16.32	0.00	15.96	564.87	8.40	11.610	97.52
8	ST. ROWS	MULCH	CSICMMMM	778.70	0.00	55.97	0.00	56.78	2151.35	28.39	8.895	252.53
TOTAL				2685.72	82.63	72.29	0.00	193.27	7192.22	93.05	9.386	873.37

SOIL LOSS TAXED AT $ .50 PER TON

160 ACRE LIVESTOCK FARM - FAYETTE SOILS RUN F DATE: 02/29/80

PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	MULCH	CSICMMMM	473.50	0.00	34.62	0.00	33.86	1340.93	17.82	3.882	69.18
2	CONT STRIP	MULCH	CSICMMMM	525.00	0.00	37.50	0.00	37.50	1564.18	18.75	2.896	54.30
4	CONT STRIP	MULCH	CSCMMMM	478.29	72.00	0.00	0.00	34.20	1496.24	18.00	4.209	75.76
6	CONT STRIP	MULCH	CSCMMMM	214.23	32.60	0.00	0.00	15.49	673.81	8.15	3.790	30.89
8	CONT STRIP	MULCH	CSCMMMM	758.40	114.55	0.00	0.00	55.30	2499.92	27.65	2.929	80.99
TOTAL				2449.42	219.15	72.12	0.00	176.35	7575.08	90.37	3.443	311.11

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE LIVESTOCK FARM - FAYETTE SOILS   RUN G   DATE: 02/29/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONT STRIP	C.S.	CSICMMMM	473.50	0.00	34.62	0.00	33.86	1272.89	17.82	5.294	94.34
2	CONT STRIP	C.S.	CSICMMMM	525.00	0.00	37.50	0.00	37.50	1496.38	18.75	3.949	74.04
4	CONT STRIP	C.F.	CSCMMMM	478.29	72.00	0.00	0.00	34.20	1417.04	18.00	6.122	110.20
6	CONT STRIP	C.F.	CSCMMMM	214.23	32.60	0.00	0.00	15.49	638.47	8.15	5.512	44.92
8	CONT STRIP	C.F.	CSCMMMM	758.40	114.55	0.00	0.00	55.30	2387.58	27.65	4.260	117.79
TOTAL				2449.42	219.15	72.12	0.00	176.35	7212.36	90.37	4.883	441.29

ST. ROWS DELETED FROM RUN

480 ACRE GRAIN FARM - DOWNS SOILS RUN A DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	1226.25	372.78	0.00	0.00	0.00	2629.57	19.62	15.898	311.92
2	ST. ROWS	C.F.	CS	2524.80	789.00	0.00	0.00	0.00	5623.20	39.45	12.915	509.50
3	ST. ROWS	C.F.	CS	1244.88	385.32	0.00	0.00	0.00	2723.52	19.76	14.803	292.51
4	ST. ROWS	C.F.	CS	1138.26	345.21	0.00	0.00	0.00	2396.13	18.66	18.431	343.92
5	ST. ROWS	C.F.	CS	1128.67	344.34	0.00	0.00	0.00	2331.76	19.13	21.337	408.18
6	ST. ROWS	C.F.	CS	2498.09	774.60	0.00	0.00	0.00	5555.62	38.73	12.151	470.61
7	ST. ROWS	C.F.	CS	1169.47	357.61	0.00	0.00	0.00	2464.67	19.33	18.092	349.72
8	ST. ROWS	C.F.	CS	3392.69	1026.36	0.00	0.00	0.00	7001.77	57.02	21.205	1209.11
9	ST. ROWS	C.F.	CS	989.51	289.39	0.00	0.00	0.00	1802.22	18.67	21.784	406.71
10	ST. ROWS	C.F.	CS	959.04	284.16	0.00	0.00	0.00	1798.02	17.76	18.330	325.54
11	ST. ROWS	C.F.	CS	2272.68	693.36	0.00	0.00	0.00	4695.20	38.52	20.172	777.03
12	ST. ROWS	C.F.	CS	2465.12	755.44	0.00	0.00	0.00	5292.85	39.76	16.485	655.44
13	ST. ROWS	C.F.	CS	2427.30	743.85	0.00	0.00	0.00	5211.65	39.15	16.525	646.95
14	ST. ROWS	C.F.	CS	3163.86	969.57	0.00	0.00	0.00	6793.11	51.03	16.735	853.99
16	ST. ROWS	C.F.	CS	1183.80	355.14	0.00	0.00	0.00	2440.60	19.73	19.920	393.02
TOTAL				27784.42	8486.13	0.00	0.00	0.00	58759.89	456.32	17.431	7954.14

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

480 ACRE GRAIN FARM - DOWNS SOILS RUN B DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2558.26	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5536.62	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2667.17	19.44	4.464	86.78
4	CONTOUR	NO-TIL	CS	1062.56	320.60	0.00	0.00	0.00	2083.63	18.32	4.857	88.98
5	ST. ROWS	NO-TIL	CC	2142.56	0.00	0.00	0.00	0.00	1671.20	19.13	4.742	90.71
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5481.22	38.27	3.651	139.72
7	CONTOUR	NO-TIL	CS	1088.48	331.28	0.00	0.00	0.00	2131.71	18.93	4.389	83.08
8	ST. ROWS	NO-TIL	CC	6443.26	0.00	0.00	0.00	0.00	5078.77	57.02	4.712	268.68
9	CONT STRIP	MULCH	CSCMMMM	555.14	81.18	0.00	0.00	39.54	1359.46	18.33	1.999	36.64
10	ST. ROWS	MULCH	CSCMMMM	548.02	81.19	0.00	0.00	39.07	1402.02	17.76	4.481	79.58
11	CONTOUR	NO-TIL	CS	2108.40	640.05	0.00	0.00	0.00	4025.35	37.65	4.952	186.44
12	CONTOUR	NO-TIL	CS	2306.90	703.80	0.00	0.00	0.00	4632.76	39.10	4.009	156.75
13	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5062.03	38.34	4.932	189.09
14	CONTOUR	MULCH	CS	3097.52	949.24	0.00	0.00	0.00	6594.22	49.96	4.997	249.65
16	CONTOUR	NO-TIL	CS	1097.25	327.25	0.00	0.00	0.00	2087.37	19.25	4.801	92.42
TOTAL				30213.71	6451.50	0.00	0.00	78.61	52371.79	449.66	4.428	1991.07

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 ACRE GRAIN FARM - DOWNS SOILS RUN C DATE: 02/28/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	1226.25	372.78	0.00	0.00	0.00	2653.11	19.62	8.479	166.36
2	ST. ROWS	MULCH	CS	2524.80	789.00	0.00	0.00	0.00	5668.18	39.45	6.888	271.73
3	ST. ROWS	MULCH	CS	1244.88	385.32	0.00	0.00	0.00	2746.84	19.76	7.895	156.01
4	ST. ROWS	MULCH	CS	1138.26	345.21	0.00	0.00	0.00	2419.64	18.66	9.830	183.43
5	ST. ROWS	MULCH	CS	1128.67	344.34	0.00	0.00	0.00	2357.39	19.13	11.380	217.70
6	ST. ROWS	MULCH	CS	2498.09	774.60	0.00	0.00	0.00	5599.00	38.73	6.481	251.01
7	ST. ROWS	MULCH	CS	1169.47	357.61	0.00	0.00	0.00	2489.41	19.33	9.649	186.52
8	ST. ROWS	MULCH	CS	3392.69	1026.36	0.00	0.00	0.00	7077.04	57.02	11.309	644.84
9	ST. ROWS	MULCH	CS	989.51	289.39	0.00	0.00	0.00	1831.71	18.67	11.618	216.91
10	ST. ROWS	MULCH	CS	959.04	284.16	0.00	0.00	0.00	1825.37	17.76	9.776	173.62
11	ST. ROWS	MULCH	CS	2272.68	693.36	0.00	0.00	0.00	4746.82	38.52	10.759	414.44
12	ST. ROWS	MULCH	CS	2465.12	755.44	0.00	0.00	0.00	5341.36	39.76	8.792	349.57
13	ST. ROWS	MULCH	CS	2427.30	743.85	0.00	0.00	0.00	5259.41	39.15	8.814	345.07
14	ST. ROWS	MULCH	CS	3163.86	969.57	0.00	0.00	0.00	6855.37	51.03	8.925	455.44
16	ST. ROWS	MULCH	CS	1183.80	355.14	0.00	0.00	0.00	2466.25	19.73	10.624	209.61
TOTAL				27784.42	8486.13	0.00	0.00	0.00	59336.90	456.32	9.297	4242.24

480 ACRE GRAIN FARM - DOWNS SOILS RUN D DATE: 02/28/80
FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2673.64	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5770.20	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2783.81	19.44	4.464	86.78
4	CONTOUR	MULCH	CS	1117.52	338.92	0.00	0.00	0.00	2449.02	18.32	6.136	112.41
5	CONTOUR	MULCH	CS	1100.94	335.88	0.00	0.00	0.00	2361.42	18.66	6.878	128.34
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5710.84	38.27	3.651	139.72
7	CONTOUR	MULCH	CS	1145.27	350.21	0.00	0.00	0.00	2508.70	18.93	5.543	104.93
8	CONTOUR	MULCH	CS	3317.72	1003.68	0.00	0.00	0.00	7119.72	55.76	6.991	389.82
9	CONTOUR	MULCH	CS	971.49	284.12	0.00	0.00	0.00	1872.59	18.33	7.976	146.20
10	CONTOUR	MULCH	CS	943.38	279.52	0.00	0.00	0.00	1868.77	17.47	6.392	111.67
11	CONTOUR	MULCH	CS	2221.35	677.70	0.00	0.00	0.00	4771.76	37.65	6.255	235.50
12	CONTOUR	MULCH	CS	2424.20	742.90	0.00	0.00	0.00	5414.96	39.10	5.065	198.04
13	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5292.07	38.34	4.932	189.09
14	CONTOUR	MULCH	CS	3097.52	949.24	0.00	0.00	0.00	6893.98	49.96	4.997	249.65
16	CONTOUR	MULCH	CS	1155.00	346.50	0.00	0.00	0.00	2470.16	19.25	6.064	116.73
TOTAL				27258.01	8325.58	0.00	0.00	0.00	59961.64	447.64	5.476	2451.42

480 ACRE GRAIN FARM - DOWNS SOILS RUN E DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	1226.25	372.78	0.00	0.00	0.00	2569.93	19.62	8.479	166.36
2	ST. ROWS	MULCH	CS	2524.80	789.00	0.00	0.00	0.00	5532.31	39.45	6.888	271.73
3	ST. ROWS	MULCH	CS	1244.88	385.32	0.00	0.00	0.00	2668.84	19.76	7.895	156.01
4	ST. ROWS	MULCH	CS	1138.26	345.21	0.00	0.00	0.00	2327.93	18.66	9.830	183.43
5	ST. ROWS	MULCH	CS	1128.67	344.34	0.00	0.00	0.00	2248.54	19.13	11.380	217.70
6	ST. ROWS	MULCH	CS	2498.09	774.60	0.00	0.00	0.00	5473.50	38.73	6.481	251.01
7	ST. ROWS	MULCH	CS	1169.47	357.61	0.00	0.00	0.00	2396.15	19.33	9.649	186.52
8	ST. ROWS	MULCH	CS	3392.69	1026.36	0.00	0.00	0.00	6754.62	57.02	11.309	644.84
9	ST. ROWS	MULCH	CS	989.51	289.39	0.00	0.00	0.00	1723.26	18.67	11.618	216.91
10	ST. ROWS	MULCH	CS	959.04	284.16	0.00	0.00	0.00	1738.56	17.76	9.776	173.62
11	ST. ROWS	MULCH	CS	2272.68	693.36	0.00	0.00	0.00	4539.60	38.52	10.759	414.44
12	ST. ROWS	MULCH	CS	2465.12	755.44	0.00	0.00	0.00	5166.58	39.76	8.792	349.57
13	ST. ROWS	MULCH	CS	2427.30	743.85	0.00	0.00	0.00	5086.88	39.15	8.814	345.07
14	ST. ROWS	MULCH	CS	3163.86	969.57	0.00	0.00	0.00	6627.65	51.03	8.925	455.44
16	ST. ROWS	MULCH	CS	1183.80	355.14	0.00	0.00	0.00	2361.44	19.73	10.624	209.61
TOTAL				27784.42	8486.13	0.00	0.00	0.00	57215.78	456.32	9.297	4242.24

SOIL LOSS TAXED AT $ .50 PER TON

480 ACRE GRAIN FARM - DOWNS SOILS RUN F DATE: 02/28/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2704.99	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5812.64	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2810.05	19.44	4.464	86.78
4	CONTOUR	NO-TIL	CS	1062.56	320.60	0.00	0.00	0.00	2220.48	18.32	4.857	88.98
5	CONTOUR	NO-TIL	CC	2089.92	0.00	0.00	0.00	0.00	1729.04	18.66	2.866	53.48
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5749.11	38.27	3.651	139.72
7	CONTOUR	NO-TIL	CS	1088.48	331.28	0.00	0.00	0.00	2277.09	18.93	4.389	83.08
8	CONTOUR	NO-TIL	CC	6300.88	0.00	0.00	0.00	0.00	5265.42	55.76	2.913	162.43
9	CONT STRIP	MULCH	CSCMMMM	555.14	81.18	0.00	0.00	39.54	1432.60	18.33	1.999	36.64
10	CONT STRIP	MULCH	CSCMMMM	539.07	79.86	0.00	0.00	38.43	1415.64	17.47	1.641	28.67
11	CONTOUR	NO-TIL	CS	2108.40	640.05	0.00	0.00	0.00	4320.90	37.65	4.952	186.44
12	CONTOUR	NO-TIL	CS	2306.90	703.80	0.00	0.00	0.00	4921.32	39.10	4.009	156.75
13	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5358.01	38.34	4.932	189.09
14	CONTOUR	MULCH	CS	3097.52	949.24	0.00	0.00	0.00	6981.41	49.96	4.997	249.65
16	CONTOUR	NO-TIL	CS	1097.25	327.25	0.00	0.00	0.00	2241.18	19.25	4.801	92.42
TOTAL				30009.74	6450.17	0.00	0.00	77.97	55239.88	447.64	4.014	1796.67

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 ACRE GRAIN FARM - DOWNS SOILS RUN G DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2558.26	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5536.62	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2667.17	19.44	4.464	86.78
4	CONTOUR	MULCH	CS	1117.52	338.92	0.00	0.00	0.00	2339.10	18.32	6.136	112.41
5	CONTOUR	MULCH	CS	1100.94	335.88	0.00	0.00	0.00	2249.46	18.66	6.878	128.34
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5481.22	38.27	3.651	139.72
7	CONTOUR	MULCH	CS	1145.27	350.21	0.00	0.00	0.00	2395.12	18.93	5.543	104.93
8	CONTOUR	MULCH	CS	3317.72	1003.68	0.00	0.00	0.00	6785.16	55.76	6.991	389.82
9	CONTOUR	MULCH	CS	971.49	284.12	0.00	0.00	0.00	1762.61	18.33	7.976	146.20
10	CONTOUR	MULCH	CS	943.38	279.52	0.00	0.00	0.00	1763.95	17.47	6.392	111.67
11	CONTOUR	MULCH	CS	2221.35	677.70	0.00	0.00	0.00	4545.86	37.65	6.255	235.50
12	CONTOUR	MULCH	CS	2424.20	742.90	0.00	0.00	0.00	5180.36	39.10	5.065	198.04
13	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5062.03	38.34	4.932	189.09
14	CONTOUR	MULCH	CS	3097.52	949.24	0.00	0.00	0.00	6594.22	49.96	4.997	249.65
16	CONTOUR	MULCH	CS	1155.00	346.50	0.00	0.00	0.00	2354.66	19.25	6.064	116.73
TOTAL				27258.01	8325.58	0.00	0.00	0.00	57275.80	447.64	5.476	2451.42

ST. ROWS DELETED FROM RUN

480 ACRE LIVESTOCK FARM - DOWNS SOILS   RUN A   DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	1226.25	372.78	0.00	0.00	0.00	2657.82	19.62	15.898	311.92
2	ST. ROWS	C.F.	CS	2524.80	789.00	0.00	0.00	0.00	5680.01	39.45	12.915	509.50
3	ST. ROWS	C.F.	CS	1244.88	385.32	0.00	0.00	0.00	2751.98	19.76	14.803	292.51
4	ST. ROWS	C.F.	CS	1138.26	345.21	0.00	0.00	0.00	2423.00	18.66	18.431	343.92
5	ST. ROWS	C.F.	CS	1128.67	344.34	0.00	0.00	0.00	2359.21	19.13	21.337	408.18
6	ST. ROWS	C.F.	CS	2498.09	774.60	0.00	0.00	0.00	5611.40	38.73	12.151	470.61
7	ST. ROWS	C.F.	CS	1151.07	349.10	0.00	0.00	0.00	2450.27	18.87	18.441	347.98
9	ST. ROWS	C.F.	CSCMMMM	595.68	90.10	0.00	0.00	40.30	1994.79	17.52	7.206	126.25
10	ST. ROWS	C.F.	CSMMMM	329.84	96.46	0.00	0.00	46.99	1815.51	18.67	6.293	117.49
12	ST. ROWS	C.S.	CSIMMMM	757.56	0.00	110.42	0.00	103.36	4249.68	38.52	5.379	207.20
13	ST. ROWS	C.F.	CS	2465.12	755.44	0.00	0.00	0.00	5350.11	39.76	16.485	655.44
14	ST. ROWS	C.F.	CS	2427.30	743.85	0.00	0.00	0.00	5268.02	39.15	16.525	646.95
15	ST. ROWS	C.F.	CS	2376.56	720.76	0.00	0.00	0.00	5058.96	38.96	18.190	708.68
18	ST. ROWS	C.F.	CS	1183.80	355.14	0.00	0.00	0.00	2469.01	19.73	19.920	393.02
TOTAL				21047.88	6122.10	110.42	0.00	190.65	50139.77	386.53	14.332	5539.65

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

480 ACRE LIVESTOCK FARM - DOWNS SOILS RUN B DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2557.11	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5534.29	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2666.00	19.44	4.464	86.78
4	ST. ROWS	MULCH	CSMMMM	379.42	115.07	0.00	0.00	51.32	2265.76	18.66	3.686	68.78
5	ST. ROWS	MULCH	CSMMMM	376.22	114.78	0.00	0.00	51.33	2222.76	19.13	4.267	81.63
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5478.92	38.27	3.651	139.72
7	ST. ROWS	MULCH	CSMMMM	383.69	116.37	0.00	0.00	51.89	2291.26	18.87	3.688	69.59
9	ST. ROWS	MULCH	CSIMMMM	347.48	0.00	50.81	0.00	47.01	1979.51	17.52	4.504	78.91
10	ST. ROWS	MULCH	CSMMMM	329.84	96.46	0.00	0.00	46.99	1869.38	18.67	4.357	81.35
12	ST. ROWS	MULCH	CSMMMM	757.56	231.12	0.00	0.00	103.36	4475.73	38.52	4.034	155.39
13	ST. ROWS	MULCH	CSMMMM	821.71	251.81	0.00	0.00	111.33	4982.01	39.76	3.297	131.09
14	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5059.73	38.34	4.932	189.09
15	ST. ROWS	MULCH	CSMMMM	792.19	240.25	0.00	0.00	107.14	4730.65	38.96	3.638	141.74
18	ST. ROWS	MULCH	CSIMMMM	394.60	0.00	57.55	0.00	52.94	2239.17	19.73	4.427	87.34
TOTAL				14346.33	4182.77	108.36	0.00	623.31	48352.28	384.03	4.046	1553.94

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 LIVESTOCK FARM - DOWNS SOILS RUN C DATE: 03/05/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	1226.25	372.78	0.00	0.00	0.00	2657.82	19.62	15.898	311.92
2	ST. ROWS	C.F.	CS	2524.80	789.00	0.00	0.00	0.00	5680.01	39.45	12.915	509.50
3	ST. ROWS	C.F.	CS	1244.88	385.32	0.00	0.00	0.00	2751.98	19.76	14.803	292.51
4	ST. ROWS	C.F.	CS	1138.26	345.21	0.00	0.00	0.00	2423.00	18.66	18.431	343.92
5	ST. ROWS	C.F.	CS	1128.67	344.34	0.00	0.00	0.00	2359.21	19.13	21.337	408.18
6	ST. ROWS	C.F.	CS	2498.09	774.60	0.00	0.00	0.00	5611.40	38.73	12.151	470.61
7	ST. ROWS	C.F.	CS	1151.07	349.10	0.00	0.00	0.00	2450.27	18.87	18.441	347.98
9	ST. ROWS	MULCH	CSMMMM	347.48	105.12	0.00	0.00	47.01	2040.68	17.52	4.053	71.01
10	ST. ROWS	MULCH	CSMMMM	329.84	96.46	0.00	0.00	46.99	1869.38	18.67	4.357	81.35
12	ST. ROWS	MULCH	CSIMMMM	757.56	0.00	110.42	0.00	103.36	4324.28	38.52	4.483	172.69
13	ST. ROWS	C.F.	CS	2465.12	755.44	0.00	0.00	0.00	5350.11	39.76	16.485	655.44
14	ST. ROWS	C.F.	CS	2427.30	743.85	0.00	0.00	0.00	5268.02	39.15	16.525	646.95
15	ST. ROWS	C.F.	CS	2376.56	720.76	0.00	0.00	0.00	5058.96	38.96	18.190	708.68
18	ST. ROWS	C.F.	CS	1183.80	355.14	0.00	0.00	0.00	2469.01	19.73	19.920	393.02
TOTAL				20799.68	6137.12	110.42	0.00	197.36	50314.13	386.53	14.006	5413.75

480 LIVESTOCK FARM - DOWNS SOILS　　RUN D　　DATE: 03/05/80

FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.88	365.37	0.00	0.00	0.00	2672.49	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	778.60	0.00	0.00	0.00	5767.87	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2782.64	19.44	4.464	86.78
4	CONTOUR	MULCH	CS	1117.52	338.92	0.00	0.00	0.00	2447.92	18.32	6.136	112.41
5	ST. ROWS	MULCH	CSMMMM	376.22	114.78	0.00	0.00	51.33	2222.76	19.13	4.267	81.63
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5708.54	38.27	3.651	139.72
7	CONTOUR	MULCH	CS	1126.67	341.70	0.00	0.00	0.00	2461.87	18.47	5.632	104.02
9	ST. ROWS	MULCH	CSIMMMM	347.48	0.00	50.81	0.00	47.01	1979.51	17.52	4.504	78.91
10	ST. ROWS	MULCH	CSMMMM	329.84	96.46	0.00	0.00	46.99	1869.38	18.67	4.357	81.35
12	CONTOUR	MULCH	CS	2221.35	677.70	0.00	0.00	0.00	4769.50	37.65	6.255	235.50
13	CONTOUR	MULCH	CS	2424.20	742.90	0.00	0.00	0.00	5412.61	39.10	5.065	198.04
14	CONTOUR	MULCH	CS	2377.08	728.46	0.00	0.00	0.00	5289.77	38.34	4.932	187.09
15	CONTOUR	MULCH	CS	2321.05	703.93	0.00	0.00	0.00	5060.65	38.05	5.450	207.37
18	ST. ROWS	MULCH	CSIMMMM	394.60	0.00	57.55	0.00	52.94	2239.17	19.73	4.427	87.34
TOTAL				20422.55	6033.30	108.36	0.00	198.27	50684.68	380.85	4.844	1844.70

480 LIVESTOCK FARM - DOWNS SOILS RUN E DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	1226.25	372.78	0.00	0.00	0.00	2568.76	19.62	8.479	166.36
2	ST. ROWS	MULCH	CS	2524.80	789.00	0.00	0.00	0.00	5529.94	39.45	6.888	271.73
3	ST. ROWS	MULCH	CS	1244.88	385.32	0.00	0.00	0.00	2667.65	19.76	7.895	156.01
4	ST. ROWS	MULCH	CS	1138.26	345.21	0.00	0.00	0.00	2326.81	18.66	9.830	183.43
5	ST. ROWS	MULCH	CSMMMM	376.22	114.78	0.00	0.00	51.33	2181.95	19.13	4.267	81.63
6	ST. ROWS	MULCH	CS	2498.09	774.60	0.00	0.00	0.00	5471.18	38.73	6.481	251.01
7	ST. ROWS	MULCH	CS	1151.07	349.10	0.00	0.00	0.00	2352.95	18.87	9.835	185.59
9	ST. ROWS	MULCH	CS	1042.44	315.36	0.00	0.00	0.00	2078.75	17.52	10.809	189.37
10	ST. ROWS	MULCH	CSMMMM	329.84	96.46	0.00	0.00	46.99	1828.71	18.67	4.357	81.35
12	ST. ROWS	MULCH	CSIMMMM	757.56	0.00	110.42	0.00	103.36	4237.94	38.52	4.483	172.69
13	ST. ROWS	MULCH	CS	2465.12	755.44	0.00	0.00	0.00	5164.19	39.76	8.792	349.57
14	ST. ROWS	MULCH	CS	2427.30	743.85	0.00	0.00	0.00	5084.53	39.15	8.814	345.07
15	ST. ROWS	MULCH	CS	2376.56	720.76	0.00	0.00	0.00	4860.63	38.96	9.701	377.95
18	ST. ROWS	MULCH	CS	1183.80	355.14	0.00	0.00	0.00	2360.26	19.73	10.624	209.61
TOTAL				20742.13	6117.80	110.42	0.00	201.68	48714.24	386.53	7.817	3021.17

SOIL LOSS TAXED AT $ .50 PER TON

480 ACRE LIVESTOCK FARM.- DOWNS SOILS RUN F DATE: 03/05/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1201.68	365.37	0.00	0.00	0.00	2703.63	19.23	4.741	91.17
2	CONTOUR	MULCH	CS	2491.52	776.60	0.00	0.00	0.00	5610.30	38.93	3.888	151.36
3	CONTOUR	MULCH	CS	1224.72	379.08	0.00	0.00	0.00	2808.69	19.44	4.464	86.78
4	ST. ROWS	MULCH	CSHHHH	379.42	115.07	0.00	0.00	51.32	2265.76	18.66	3.686	68.78
5	ST. ROWS	MULCH	CSHHHH	376.22	114.78	0.00	0.00	51.33	2222.76	19.13	4.267	81.63
6	CONTOUR	MULCH	CS	2468.42	765.40	0.00	0.00	0.00	5746.81	38.27	3.651	139.72
7	ST. ROWS	MULCH	CSHHHH	383.69	116.37	0.00	0.00	51.69	2291.26	18.87	3.688	69.59
9	ST. ROWS	MULCH	CSIHHHH	347.48	0.00	50.61	0.00	47.01	1979.51	17.52	4.504	78.91
10	ST. ROWS	MULCH	CSHHHH	329.64	96.46	0.00	0.00	46.99	1669.38	18.67	4.357	81.35
12	ST. ROWS	MULCH	CSHHHH	757.56	231.12	0.00	0.00	103.36	4475.73	38.52	4.034	155.39
13	CONTOUR	NO-TIL	CS	2306.90	703.80	0.00	0.00	0.00	5013.01	39.10	4.009	156.75
14	CONTOUR	MULCH	CS	2377.08	726.46	0.00	0.00	0.00	5355.71	38.34	4.932	189.09
15	ST. ROWS	MULCH	CSHHHH	792.19	240.25	0.00	0.00	107.14	4730.65	38.96	3.638	141.74
18	ST. ROWS	MULCH	CSIHHHH	394.60	0.00	57.55	0.00	52.94	2239.17	19.73	4.427	87.34
TOTAL				15831.52	4634.76	108.36	0.00	511.98	49512.77	383.37	4.120	1579.61

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

480 ACRE LIVESTOCK FARM - DOWNS SOILS   RUN G   DATE: 03/05/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	C.F.	CS	1201.66	365.37	0.00	0.00	0.00	2562.68	19.23	8.870	170.75
2	CONTOUR	C.F.	CS	2491.52	778.60	0.00	0.00	0.00	5548.30	38.93	7.291	283.84
3	CONTOUR	C.F.	CS	1224.72	377.06	0.00	0.00	0.00	2672.22	17.44	6.371	162.73
4	CONT STRIP	MULCH	CSIMMMM	372.51	0.00	54.35	0.00	50.38	2122.43	18.32	1.563	28.63
5	CONT STRIP	MULCH	CSIMMMM	366.78	0.00	53.80	0.00	50.07	2048.86	18.66	1.444	26.75
6	CONTOUR	C.F.	CS	2468.42	765.40	0.00	0.00	0.00	5473.47	38.27	6.846	262.00
7	CONTOUR	C.F.	CS	1126.67	341.70	0.00	0.00	0.00	2355.48	18.47	10.559	195.02
9	CONT STRIP	MULCH	CSMMMM	339.94	102.84	0.00	0.00	45.99	1955.11	17.14	1.296	22.21
10	CONT STRIP	MULCH	CSMMMM	323.83	94.71	0.00	0.00	46.13	1799.59	18.33	1.636	27.99
12	CONTOUR	C.F.	CS	2221.35	677.70	0.00	0.00	0.00	4549.44	37.65	11.728	441.56
13	CONTOUR	C.F.	CS	2424.20	742.90	0.00	0.00	0.00	5188.96	39.10	9.496	371.29
14	CONTOUR	C.F.	CS	2377.08	728.46	0.00	0.00	0.00	5070.47	38.34	9.247	354.53
15	CONTOUR	C.F.	CS	2321.05	703.93	0.00	0.00	0.00	4641.48	38.05	10.218	388.79
18	CONTOUR	C.F.	CS	1155.00	346.50	0.00	0.00	0.00	2357.36	19.25	11.370	218.87
TOTAL				20415.15	6027.19	108.15	0.00	192.57	48566.07	379.18	7.799	2957.38

ST. ROWS DELETED FROM RUN

160 ACRE GRAIN FARM - DOWNS SOILS RUN A DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	3788.09	1174.60	0.00	0.00	0.00	8719.35	58.73	12.407	728.66
2	ST. ROWS	C.F.	CS	1090.41	334.78	0.00	0.00	0.00	2303.06	19.13	26.351	504.09
4	ST. ROWS	C.F.	CS	965.09	291.96	0.00	0.00	0.00	2073.16	16.22	19.715	319.78
5	ST. ROWS	C.F.	CS	969.80	279.75	0.00	0.00	0.00	1805.97	18.65	21.412	399.33
6	ST. ROWS	C.F.	CS	2055.76	624.07	0.00	0.00	0.00	4246.61	36.71	23.932	878.54
TOTAL				8869.15	2705.16	0.00	0.00	0.00	19148.15	149.44	18.940	2830.41

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

160 ACRE GRAIN FARM - DOWNS SOILS RUN B DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	3736.49	1158.60	0.00	0.00	0.00	8427.08	57.93	3.684	213.41
2	CONTOUR	NO-TIL	CC	2036.12	0.00	0.00	0.00	0.00	1758.35	18.68	3.978	74.31
4	CONTOUR	MULCH	CC	1884.96	0.00	0.00	0.00	0.00	1818.43	15.84	4.779	75.70
5	ST. ROWS	NO-TIL	CC	1846.35	0.00	0.00	0.00	0.00	1483.05	18.65	4.758	88.74
6	CONTOUR	NO-TIL	CC	3803.28	0.00	0.00	0.00	0.00	3195.47	35.88	3.470	124.50
TOTAL				13307.20	1158.60	0.00	0.00	0.00	16682.38	146.98	3.923	576.66

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE GRAIN FARM - DOWNS SOILS RUN C DATE: 02/28/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	3788.09	1174.60	0.00	0.00	0.00	8719.35	58.73	12.407	728.66
2	ST. ROWS	C.F.	CS	1090.41	334.78	0.00	0.00	0.00	2303.06	19.13	26.351	504.09
4	ST. ROWS	C.F.	CS	965.09	291.96	0.00	0.00	0.00	2073.16	16.22	19.715	319.78
5	ST. ROWS	C.F.	CS	969.80	279.75	0.00	0.00	0.00	1805.97	18.65	21.412	399.33
6	ST. ROWS	C.F.	CS	2055.76	624.07	0.00	0.00	0.00	4246.61	36.71	23.932	878.54
TOTAL				8869.15	2705.16	0.00	0.00	0.00	19148.15	149.44	18.940	2830.41

160 ACRE GRAIN FARM - DOWNS SOILS RUN D DATE: 02/28/80

FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	3736.49	1158.60	0.00	0.00	0.00	8774.66	57.93	3.684	213.41
2	CONTOUR	MULCH	CS	1074.10	326.90	0.00	0.00	0.00	2309.22	18.68	9.548	178.36
4	ST. ROWS	C.F.	CS	965.09	291.96	0.00	0.00	0.00	2073.16	16.22	19.715	319.78
5	CONTOUR	MULCH	CS	952.64	274.80	0.00	0.00	0.00	1832.82	18.32	7.819	143.24
6	ST. ROWS	C.F.	CS	2055.76	624.07	0.00	0.00	0.00	4246.61	36.71	23.932	878.54
TOTAL				8784.08	2676.33	0.00	0.00	0.00	19236.47	147.86	11.723	1733.34

160 ACRE GRAIN FARM - DOWNS SOILS RUN E DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	3788.09	1174.60	0.00	0.00	0.00	8438.41	58.73	6.617	388.62
2	ST. ROWS	MULCH	CS	1090.41	334.78	0.00	0.00	0.00	2146.15	19.13	14.054	268.85
4	ST. ROWS	MULCH	CS	965.09	291.96	0.00	0.00	0.00	1967.20	16.22	10.515	170.55
5	ST. ROWS	MULCH	CS	969.80	279.75	0.00	0.00	0.00	1681.39	18.65	11.420	212.98
6	ST. ROWS	MULCH	CS	2055.76	624.07	0.00	0.00	0.00	3970.67	36.71	12.764	468.57
TOTAL				8869.15	2705.16	0.00	0.00	0.00	18203.82	149.44	10.102	1509.57

SOIL LOSS TAXED AT $ .50 PER TON

160 ACRE GRAIN FARM - DOWNS SOILS RUN F DATE: 02/28/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	3736.49	1158.60	0.00	0.00	0.00	8840.70	57.93	3.684	213.41
2	CONTOUR	NO-TIL	CC	2036.12	0.00	0.00	0.00	0.00	1904.05	18.68	3.978	74.31
4	CONTOUR	MULCH	CC	1884.96	0.00	0.00	0.00	0.00	1943.73	15.84	4.779	75.70
5	CONTOUR	NO-TIL	CC	1813.68	0.00	0.00	0.00	0.00	1557.57	18.32	3.258	59.69
6	CONTOUR	NO-TIL	CC	3803.28	0.00	0.00	0.00	0.00	3474.26	35.88	3.470	124.50
TOTAL				13274.53	1158.60	0.00	0.00	0.00	17720.31	146.65	3.734	547.61

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE GRAIN FARM - DOWNS SOILS RUN G DATE: 02/28/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	C.F.	CS	3736.49	1158.60	0.00	0.00	0.00	8512.52	57.93	6.907	400.12
2	CONTOUR	C.F.	CS	1074.10	326.90	0.00	0.00	0.00	2219.46	18.68	17.902	334.41
4	CONTOUR	C.F.	CS	942.48	285.12	0.00	0.00	0.00	1983.88	15.84	11.319	179.29
5	CONTOUR	C.F.	CS	952.64	274.80	0.00	0.00	0.00	1740.67	18.32	14.661	268.59
6	CONTOUR	C.F.	CS	2009.28	609.96	0.00	0.00	0.00	4063.77	35.88	15.616	560.30
TOTAL				8714.99	2655.38	0.00	0.00	0.00	18520.30	146.65	11.884	1742.72

ST. ROWS DELETED FROM RUN

READY 15.25.54

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN A DATE: 03/03/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	1299.54	403.65	0.00	0.00	0.00	3028.03	19.69	9.197	181.09
2	ST. ROWS	C.F.	CS	2489.84	764.60	0.00	0.00	0.00	5625.07	39.21	14.047	550.78
3	ST. ROWS	C.S.	CSICMMMM	628.30	0.00	46.02	0.00	42.44	2032.19	19.29	8.780	169.37
5	ST. ROWS	C.F.	CSCMMMM	561.55	85.15	0.00	0.00	38.66	2057.83	16.11	6.179	99.54
8	ST. ROWS	C.F.	CS	1512.06	456.23	0.00	0.00	0.00	3178.06	26.07	20.313	529.56
TOTAL				6491.29	1709.63	46.02	0.00	81.10	15921.18	120.37	12.714	1530.34

MULCH DELETED FROM RUN
NO-TIL DELETED FROM RUN
CONTOUR DELETED FROM RUN
CONT STRIP DELETED FROM RUN
TERRACES DELETED FROM RUN

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN B DATE: 03/03/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	1299.54	403.65	0.00	0.00	0.00	2997.80	19.69	4.905	96.58
2	CONTOUR	MULCH	CS	2450.47	752.51	0.00	0.00	0.00	5412.83	38.59	4.203	162.19
3	CONT STRIP	C.F.	CSCMMMM	613.65	94.20	0.00	0.00	41.45	2076.08	18.84	3.461	65.21
5	ST. ROWS	MULCH	CSCMMMM	561.55	85.15	0.00	0.00	38.66	2045.26	16.11	4.248	68.44
8	ST. ROWS	MULCH	CSICMMMM	864.03	0.00	62.57	0.00	58.84	2813.59	26.07	4.965	129.44
TOTAL				5789.24	1335.51	62.57	0.00	138.95	15345.56	119.30	4.374	521.85

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE LIVESTIOC FARM - DOWNS SOILS RUN C DATE: 03/03/80
PARTIAL PRACTICE COST, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	C.F.	CS	1299.54	403.65	0.00	0.00	0.00	3028.03	19.69	9.197	181.09
2	ST. ROWS	C.F.	CS	2489.84	764.60	0.00	0.00	0.00	5625.07	39.21	14.047	550.78
3	ST. ROWS	C.S.	CSICMMMM	628.30	0.00	46.02	0.00	42.44	2032.19	19.29	8.780	169.37
5	ST. ROWS	C.F.	CSCMMMM	561.55	85.15	0.00	0.00	38.66	2057.83	16.11	6.179	99.54
8	ST. ROWS	C.F.	CS	1512.06	456.23	0.00	0.00	0.00	3178.06	26.07	20.313	529.56
TOTAL				6491.29	1709.63	46.02	0.00	81.10	15921.18	120.37	12.714	1530.34

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN D DATE: 03/04/80
FULL PRACTICE COSTS, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1287.66	399.96	0.00	0.00	0.00	3066.78	19.51	2.674	52.17
2	CONTOUR	MULCH	CS	2450.47	752.51	0.00	0.00	0.00	5644.37	38.59	4.203	162.19
3	ST. ROWS	C.S.	CSICMMMM	628.30	0.00	46.02	0.00	42.44	2032.19	19.29	8.780	169.37
5	ST. ROWS	C.F.	CSCMMMM	561.55	85.15	0.00	0.00	38.66	2057.83	16.11	6.179	99.54
8	ST. ROWS	C.F.	CS	1512.06	456.23	0.00	0.00	0.00	3178.06	26.07	20.313	529.56
TOTAL				6440.04	1693.85	46.02	0.00	81.10	15979.23	119.57	8.471	1012.83

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN E DATE: 03/04/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	ST. ROWS	MULCH	CS	1299.54	403.65	0.00	0.00	0.00	2949.51	19.69	4.905	96.58
2	ST. ROWS	MULCH	CS	2489.84	764.60	0.00	0.00	0.00	5421.92	39.21	7.492	293.76
3	ST. ROWS	C.S.	CSICMMMM	628.30	0.00	46.02	0.00	42.44	1947.51	19.29	8.780	169.37
5	ST. ROWS	MULCH	CSCMMMM	561.55	85.15	0.00	0.00	38.66	2011.04	16.11	4.248	68.44
8	ST. ROWS	MULCH	CS	1512.06	456.23	0.00	0.00	0.00	3005.17	26.07	10.834	282.44
TOTAL				6491.23	1709.63	46.02	0.00	81.10	15335.15	120.37	7.565	910.58

SOIL LOSS TAXED AT $ .50 PER TON

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN F DATE: 03/04/80
PARTIAL PRACTICE COST, TILLAGE SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	MULCH	CS	1287.66	399.96	0.00	0.00	0.00	3082.38	19.51	2.674	52.17
2	CONTOUR	MULCH	CS	2450.47	752.51	0.00	0.00	0.00	5694.92	38.59	4.203	162.19
3	CONT STRIP	MULCH	CSCMMMM	613.65	94.20	0.00	0.00	41.45	2144.76	18.84	2.379	44.82
5	CONTOUR	MULCH	CC	1922.72	0.00	0.00	0.00	0.00	2078.59	15.76	4.133	65.14
8	ST. ROWS	MULCH	CSICMMMM	864.03	0.00	62.57	0.00	58.84	2813.59	26.07	4.965.	129.44
TOTAL				7138.53	1246.67	62.57	0.00	100.29	15814.24	118.77	3.820	453.76

SOIL LOSS LIMITED TO 5.0 TONS PER ACRE

160 ACRE LIVESTOCK FARM - DOWNS SOILS RUN G DATE: 03/04/80
FULL PRACTICE COSTS, NO SUBSIDIES

FIELD	PRACTICE	TILLAGE	ROTATION	CORN	SOYBEANS	SILAGE	OATS	HAY	PROFIT	ACRES	TONS/ACRE	EROSION
1	CONTOUR	C.F.	CS	1287.66	399.96	0.00	0.00	0.00	2979.66	19.51	5.013	97.80
2	CONTOUR	C.F.	CS	2450.47	752.51	0.00	0.00	0.00	5468.20	38.59	7.881	304.13
3	CONTOUR	C.F.	CS	1073.88	329.70	0.00	0.00	0.00	2216.06	18.84	17.924	337.69
5	CONT STRIP	C.F.	CSCMMMM	549.35	83.30	0.00	0.00	37.82	1974.82	15.76	1.849	29.14
8	CONT STRIP	C.S.	CSICMMMM	845.47	0.00	61.22	0.00	57.58	2726.70	25.51	2.169	55.33
TOTAL				6206.83	1565.47	61.22	0.00	95.40	15365.44	118.21	6.971	824.09

ST. ROWS DELETED FROM RUN

READY 11.30.51
FILES

LIST OF REFERENCES

Alt, Klaus, and E. O. Heady. "Economics and the Environment: Impacts of Erosion Restraints on Crop Production in the Iowa River Basin." Card Report 75. Ames: Iowa State University, December 1977.

Amemiya, Minoru. "Conservation Tillage in the Western Cornbelt." Journal of Soil and Water Conservation, January-February 1977, pp. 29-36.

American Society of Agricultural Engineers. National Symposium on Soil Erosion and Sedimentation. Pub. 4-77. St. Joseph, Michigan, 1977.

Anderson, Jay, E. O. Heady and W. D. Shrader. "Profit Maximixing Plans for Soil Conserving Farming in the Spring Valley Creek Watershed in Southwest Iowa." Research Bulletin 519. Ames, Iowa: Agricultural and Home Economics Experiment Station, Iowa State University, July 1963.

Baily, Warren and Ronald Aines. "How Wheat Farmers Would Adjust to Different Programs." Report No. 65. U.S. Department of Agriculture, 1961.

Baker, Gladys, W. D. Rasmussen, V. Wiser and J. M. Porter. Century of Service, the First 100 Years of U.S.D.A. Washington, D.C.: Centennial Committee, U.S. Department of Agriculture, February 1963.

Barlowe, Raleigh. Land Resource Economics. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1972.

Bauder, J. W., W. W. Wilson, S. D. Evans, M. J. Lindstrom and J. B. Swan. "Tillage Systems in Southwest and West Central Minnesota." Extension Folder 491. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979.

Bauder, J. W., G. W. Randall, J. B. Swan, J. A. True, and C. F. Halsey. "Tillage Practices in South Central Minnesota." Extension Folder 492. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979.

Bauder, J. W., C. F. Halsey and W. E. Jokela. "Tillage: Its Role in Controlling Soil Erosion by Water." Extension Folder 479. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979.

Baumann, Ross V., E. O. Heady and Andrew Aandahl. "Costs and Returns for Soil Conserving Systems of Farming on Ida-Monona Soils in Iowa." Research Bulletin 429. Ames, Iowa: Agricultural Experiment Station, Iowa State University, June 1955.

Baumol, William. Economic Theory and Operations Analysis. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965.

Beasley, R. P. Erosion and Sediment Pollution Control. Ames: Iowa State University Press, 1972.

Beneke, Raymond, and Ronald Winterboer. Linear Programming Applications to Agriculture. Ames: Iowa State University Press, 1973.

Bennett, Hugh Hammond. Soil Conservation. New York: McGraw Hill Book Co., 1939.

Benson, Fred J. "User's Guide for Machine, A Computerized Machinery Cost Calculating Procedure." CDA 604G. St. Paul, Minn.: Department of Agricultural and Applied Economics and Agricultural Extension Service, University of Minnesota, February 1978.

Benson, Fred, W. E. Anthony, Kenneth Egertson, Earl Fuller and Paul Hasbergen. "What to Grow in Southeast Minnesota in 1979?" FM 418.7. St. Paul, Minn.: Agricultural Extension Service and Department of Agricultural and Applied Economics, January 1979.

Benson, Fred, and Bruce Hutteberg. "Minnesota Farm Machinery Economic Cost Estimates for 1979." FM 609. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, February 1979.

Blase, Melvin, and J. F. Timmons. "Soil Erosion Control in Western Iowa." Research Bulletin 498. Ames, Iowa: Agricultural and Home Economics Extension Service, Iowa State University, October 1961.

Breimyer, Harold F. Individual Freedom and the Economic Organization of Agriculture. Urbana, Ill.: University of Illinois Press, 1965.

Carkner, Richard. "A Case Study of the Economic Impacts of Farm Soil Loss Controls." Ph.D. dissertation, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1974.

Castle, Emery. "Property Rights and the Political Economy of Resource Scarcity." American Journal of Agricultural Economics, February 1978, pp. 1-9.

Chappelle, Daniel E. "Economic Model Building and Computers in Forestry Research." Journal of Forestry, May 1966, p. 329.

Ciriacy-Wantrup, S. V. Resource Conservation Economics and Policies. Berkeley: University of California Press, 1963.

Clawson, Marion, and B. Held. Soil Conservation in Percspective. Baltimore, Md.: John Hopkins Press, 1965.

Cosper, Harold. "The Influence of Tillage Systems on Corn Yields and Soil Loss in Ohio, Indiana, Illinois and Iowa." Working Paper No. 54. Washington, D.C.: Economic Research Service, July 1978.

Cosper, Harold. "Soil Taxonomy as a Guide to Economic Feasibility of Soil Tillage Systems in Reducing Nonpoint Pollution." ESCS staff report. Washington, D.C.: Economics, Statistics and Cooperative Service, U.S. Department of Agriculture, March 1979.

Cosper, Harold. "The Influence of Tillage Systems on Corn Yields and Soil Loss in Ohio, Indiana, Illinois, and Iowa." Working Paper No. 54. Washington, D.C.: Economics, Statistics and Cooperatives Service, 1978.

Council on Environmental Quality. Environmental Quality--1978. Washington, D.C.: Government Printing Office, December 1978.

"Erosion Costs You More Than Soil." Wallaces Farmer, 24 February 1979.

Frick, G. E., I. F. Fellows and S. B. Weeks, "Economies of Scale in Dairying--An Exploration in Farm Management Research Methodology." Research Bulletin 285. Storrs: Connecticut Agricultural Experiment Station, 1952.

Galloway, H. M., D. R. Griffith, J. V. Mannering. "Adaptability of Various Tillage-Planting Systems to Indiana Soils." AV-210. West LaFayette, Ind.: Cooperative Extension Service, Purdue University, 1977.

Galloway, H. M., and D. R. Griffith. "Tillage: Which Is Best for Each Soil Type?" Crops and Soils Magazine, June-September 1980, pp. 9-14.

Gunterman, K. L., Ming T. Lee and Earl R. Swanson. "The Economics of Off-Site Erosion." Annals of Regional Science, November 1976, pp. 117-126.

General Accounting Office. Report to the Congress Comptroller General General of the United States. Washington, D.C.: Government Printing Office, p. 177.

Halsey, Clifton, and J. W. Bauder. "Estimating the Effects of Crop Residue Mulches on Soil Erosion by Water." Extension Folder 477. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979.

Halsey, Clifton, and Kathryn Bolin. "Grassed Waterways--Construction and Maintenance." Extension Folder 480. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1979.

Heady, E. O. Agricultural Supply Functions. Ames: Iowa State University Press, 1961.

Held, Barnell, and John F. Timmons. "Soil Erosion Control in Process in Western Iowa." Research Bulletin 460. Ames, Iowa: Agricultural and Home Economics Experiment Station, Iowa State University, August 1958.

Held, Burnell, M. G. Blase and John F. Timmons. "Soil Erosion and Some Means for Its Control." Special Report 29. Ames, Iowa: Agricultural and Home Economics Experiment Station, Iowa State University, August 1962.

Holmes, Beatrice. "Institutional Bases for Control of Nonpoint Source Pollution Under the Clean Water Act." WH-554, U.S. Environmental Protection Agency, November 1979.

James, Sydney. Midwest Farm Planning Manual. Ames: Iowa State University Press, 1975.

Jensen, Harold, and E. O. Heady. "Costs, Returns and Capital Requirements for Soil-Conserving Farming on Rented Farms in Western Iowa." Research Bulletin 423. Ames, Iowa: Agricultural Experiment Station, Iowa State College, March 1955.

Johnson, G. S., and J. A. Moore. "The Effects of Conservation Practices on Nutrient Loss." St. Paul, Minn.: Agricultural Engineering Department, University of Minnesota, 1978.

Landgren, Norman, and Jay Anderson. "A Method for Evaluating Erosion Control in Farm Planning." Vol. 14 (2). Washington, D.C.: U.S. Department of Agriculture, Agricultural Economics Research, 1962.

Larson, W. E., and James Swan. "Tillage of Wet and Dry Soils." Crops and Soils Magazine, March 1970.

Libby, Lawrence W. "Economic and Social Realities of Soil and Water Conservation." Resource Development Occasional Paper. East Lansing: Michigan State University, October 1979.

McDonald, Angus. "Early American Soil Conservationists." Miscellaneous Publication 449. Washington, D.C.: U.S. Department of Agriculture, Soil Conservation Service, October 1941.

McGrann, James M. "Farm Level Economic Evaluation of Erosion Control." Proceedings from American Society of Agricultural Engineers. Palmer House, Chicago, Illinois, December 1978.

Minnesota Code of Agency Rules. "Soil and Water Conservation Board Cost Share Program." 6 MCAR 7.001-7.005, St. Paul, Minnesota, 1978.

Minnesota Conservation Needs Committee. Minnesota Soil and Water Conservation Needs Inventory. St. Paul: Minnesota Conservation Needs Committee, August 1971.

Minnesota Pollution Control Agency. "Agriculture Package I, II and III, Water Quality Management Planning, 208." St. Paul: Minnesota Pollution Control Agency, May 1979.

Morgan, Robert J. Governing Soil Conservation. Baltimore, Md.: John Hopkins Press, 1965.

Musgrave, G. W. "The Quantitative Evaluation of Factors in Water Erosion, A First Approximation." Journal of Soil and Water Conservation 2 (1947).

Niehaus, Robert D. "Data and Procedures for Calculating the 1975 Normalized Prices for the United States Water Resources Council." Working Paper No. 22, Economic Research Service, January 1977.

Nelson, L. V., L. S. Robertson and M. H. Erdmann. "No Till Corn: Guidelines." Extension Bulletin E-904. East Lansing, Mich.: Cooperative Extension Service, Michigan State University, 1976.

Osteen, Craig, and W. D. Seitz. "Regional Economic Impacts of Policies to Control Erosion and Sedimentation in Illinois and Other Cornbelt States." American Journal of Agricultural Economics, August 1978, pp. 510-517.

Overdahl, C. J. "Fertilizing Corn." In Soils, Soil Management and Fertilizer Monographs. Special Report 24. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1978.

Overdahl, C. J., and G. E. Ham. "Fertilizing Soybeans," In Soils, Soil Management and Fertilizer Monographs. Special Report 24. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1978.

Parks, W. Robert. Soil Conservation Districts in Action. Ames: Iowa State University Press, 1952.

Paulson, W., A. E. Peterson, J. B. Swan, R. Higgs. "Tillage Study Summary 1976-78." A Report on Field Research on Soils. Soils Series 105. St. Paul, Minn.: Department of Soil Science, University of Minnesota, 1979.

Pimentel, David, et al. "Land Degradation: Effects on Food and Energy Resources." Science, October 1976, p. 149.

Plaxico, James S., and Luther Tweeten. "Representative Farms for Policy and Projections Research." Journal of Farm Economics, December 1963.

Redalen, Munger, Searle, Mann and Valan. "A Bill for an Act Relating to Soil and Water Conservation: Imposing Duties upon Land Occupiers to Apply and Maintain Wind and Water Erosion Control Systems." H.F. 1211. Introduced in the Minnesota State Legislature, 5 April 1979.

Risser, James. "Soil Erosion Creates a Crisis Down on the Farm." Conservation Foundation Letter. Washington, D.C., December 1978.

Rosenberry, Paul. "Research Needs Related to Erosion and Sediment Control." Proceedings of Iowa Academy of Science. Des Moines, Iowa, 1973.

Rosenberry, Paul, and W. C. Moldenhauer. "Economic Implications of Soil Conservation." Journal of Soil and Water Conservation, November-December 1971, pp. 220-224.

Rosenberry, Paul, Lacy Harmon and Russell Knutson. Soil Depletion Study Reference Report: Southern Iowa Rivers Basin. Des Moines: U.S. Department of Agriculture, Soil Conservation Service and Economics, Statistics and Cooperatives Service, February 1980.

Rust, R. H., and L. D. Hanson. "Crop Equivalent Rating Guide for Soils in Minnesota." Miscellaneous Report 132. St. Paul, Minn.: Agricultural Experiment Station, University of Minnesota, 1975.

Schmid, A. Allen. Property, Power and Public Choice. New York: Praeger Publishing Co., 1978.

Schulte, E. E. "Fertility Needs Under Conservation." Crops and Soils Magazine, January 1979, pp. 10-11.

Schwab, Glenn, R. K. Frevert, K. K. Barnes and T. W. Edminster. Elementary Soil and Water Engineering. New York: John Wiley & Sons, Inc., 1971.

Seitz, W. D. "Environmental Regulation: A Framework for Determining Research Needs." American Journal of Agricultural Economics, November 1979, pp. 818-823.

Seitz, W. D., and R. G. F. Spitz. "Soil Erosion Control Policies: Institutional Alternatives and Costs." Journal of Soil and Water Conservation, May-June 1978, pp. 118-125.

Seitz, W. D., C. Robert Taylor, R. G. F. Spitz, Craig Osteen and Mack Nelson. "Economic Impacts of Soil Erosion Control." Land Economics, February 1979, pp. 28-42.

Sharp, B. M. H., and Daniel Bromley. "Agricultural Pollution: The Economics of Coordination." American Journal of Agricultural Economics, November 1979, pp. 591-599.

Sharp, B. M., and Daniel W. Bromley. "Soil as an Economic Resource." Economic Issues No. 38. Madison, Wis.: Department of Agricultural Economics, University of Wisconsin, October 1979.

Sharples, Jerry A. "The Representative Farm Approach to Estimation of Supply Response." American Journal of Agricultural Economics, May 1969.

Siemens, J. C., and W. R. Oschwald. "Corn-Soybean Tillage Systems: Erosion Control Effects on Crop Production Costs." Transactions of the American Society of Agricultural Engineers, 1978, pp. 293-302.

Smith, W. G., and E. O. Heady. "Use of a Dynamic Model in Programming Optimum Conservation Farm Plans on Ida-Monona Soils." Research Bulletin 475. Ames, Iowa: Agricultural and Home Economics Extension Service, Iowa State University, February 1960.

Soil Erosion Prediction and Control. Proceedings of a National Conference on Soil Erosion, May 24-26, 1976. West Lafayette, Ind.: Purdue University, 1976.

Southeast Minnesota Farm Management Association. 1978 Annual Report. Economics Report ER 78-2. St. Paul, Minn.: Department of Agriculture and Applied Economics and Institute of Agriculture, University of Minnesota, March 1979.

Swan, J. B., W. W. Nelson and R. R. Allmaras. "Soil Management by Fall Tillage for Corn." Extension Folder 264. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1972.

Swan, James B., and John A. True. "Management Considerations in Primary Tillage for Corn and Soybeans." Special Report 64. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1977.

Swan, J. B., and J. A. True. "Tillage for Corn and Soybeans." In Soils, Soil Management and Fertilizer Monographs. Special Report 24. St. Paul, Minn.: Agricultural Extension Service, University of Minnesota, 1978.

Taylor, C. Robert, and Klaus Frohberg. "The Welfare Effects of Erosion Controls Banning Pesticides, and Limiting Fertilizer Application in the Cornbelt." American Journal of Agricultural Economics, February 1977, pp. 25-35.

VanDoren, D. M., G. B. Triplett, Jr., and J. E. Henry. "No-Till Is Profitable on Many Soil Types." Crops and Soils Magazine, August-September 1975, pp. 7-9.

U.S. Congress. "Federal Water Pollution Control Act Amendments of 1972." PL 92-500. Washington, D.C.: Government Printing Office, October 1972.

U.S. Congress. "Soil and Water Resources Conservation Act of 1977." PL 95-192. Washington, D.C.: Government Printing Office, November 1977.

U.S. Environmental Protection Agency. "Environmental Impact of Land Use on Water Quality, Final Report on the Black Creek Project." EPA-905/9-77-007-A. Chicago, Illinois, October 1977.

U.S. Department of Agriculture. "Appraisal 1980, Soil and Water Resources Conservation Act." Review draft.

U.S. Department of Agriculture. Agricultural Research Service and Purdue Agricultural Experiment Station. "Predicting Rainfall Erosion Losses from Cropland East of the Rocky Mountains." Agricultural Handbook 282, May 1965.

U.S. Department of Agriculture. Agricultural Stabilization and Conservation Service. "1980 Rural Clean Water Program." Federal Register, 21 December 1979.

U.S. Department of Agriculture. Agricultural Stabilization and Conservation Service. 1977 Agricultural Conservation Program Accomplishments. Washington, D.C.: Government Printing Office, 1978.

U.S. Department of Agriculture. Agricultural Stabilization and Conservation Service. "State Program Handbook. Minnesota Agricultural Conservation Program." 1-Mn(ACP) (Rev. 3). St. Paul, Minnesota, December 1979.

U.S. Department of Agriculture. Conservation Needs Inventory Committee. Basic Statistics of the National Inventory of Soil and Water Conservation Needs. Washington, D.C.: Government Printing Office, January 1971.

U.S. Department of Agriculture. Economics, Statistics and Cooperatives Service. "Current Normalized Prices," September 1979.

U.S. Department of Agriculture. Economics, Statistics and Cooperatives Service. "Multiple Objective Resource Evaluation System." East Lansing, Mich.: Natural Resources Economics Division, January 1973.

U.S. Department of Agriculture. "Program Report and Environmental Impact Statement, Soil and Water Resources Conservation Act." Review draft.

U.S. Department of Agriculture. Science and Education Administration. "Predicting Rainfall Erosion Losses." Agricultural Handbook 537. December 1978.

U.S. Department of Agriculture. Soil Conservation Service. "Soil Taxonomy." Agricultural Handbook 436. Washington, D.C.: Government Printing Office, December 1975.

U.S. Department of Agriculture. Soil Conservation Service. "Grassed Backslope Terraces Smooth Out Your Farming Operation." St. Paul, Minnesota, March 1977.

U.S. Department of Agriculture. Soil Conservation Service. "Technical Guide." Section III-1-A. St. Paul, Minnesota, May 1976.

U.S. Department of Agriculture. Southeast Ohio River Basin Report. Columbus, Ohio: Soil Conservation Service, Economics, Statistics and Cooperatives Service and Forest Service, 1979.

U.S. Department of Agriculture. The Southeast Minnesota Tributaries Basin Report (draft). St. Paul, Minn.: Soil Conservation Service; Economics, Statistics and Cooperatives Service and Forest Service, 1980.

U.S. Department of Agriculture. Southern Iowa River Basin Study Main Report (draft). Des Moines, Iowa: Soil Conservation Service; Economics, Statistics and Cooperatives Service and Forest Service, February 1979.

U.S. Department of Agriculture. Water and Related Land Resources, Wisconsin River Basin. Madison, Wis.: Soil Conservation Service; Economics, Statistics and Cooperatives Service and Forest Service, 1979.

U.S. Department of Commerce. Bureau of Census. 1974 Agricultural Census, Minnesota State and County Data. Washington, D.C.: Government Printing Office, April 1977.

U.S. Water Resources Council. "Water and Related Land Resources, Establishment of Principles and Standards for Planning." Federal Register, 10 September 1973.

Wade, James C., and E. O. Heady. "Controlling Non-Point Sediment Sources with Cropland Management: A National Economic Assessment." American Journal of Agricultural Economics, February 1977, pp. 13-24.

Walker, David J. "An Economic Analysis of Alternative Environmental and Resource Policies for Controlling Soil Loss and Sedimentation from Agriculture." Ph.D. dissertation. Department of Economics, Iowa State University, Ames, Iowa, 1977.

Wischmeir, W. H., and D. D. Smith. "Predicting Rainfall Erosion Losses--A Guide to Conservation Farming." Agricultural Handbook No. 537. Washington, D.C.: U.S. Department of Agriculture, Science and Education Administration, December 1978.

Whitaker, F. D., H. G. Heineman and R. E. Burwell. "Fertilizing Corn Adequately with Less Nitrogen." Journal of Soil and Water Conservation, January-February 1978.

Zingg, A. W. "Degree and Length of Land Slope as It Affects Soil Loss and Runoff." Agricultural Engineering 21 (1940).