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The economics of soil and water conservation practices in Iowa as affected by tenure arrangements, capital availability, and farm size

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CHAPTER I. INTRODUCTION

Arable topsoil is important in sustaining human life. Soil is a necessary natural resource for most food production today, and is also a primary source of much of man's clothing and shelter. The loss of soil from the force of water or air movement at some level reduces the potential for any soil to satisfy these human needs.

Soil erosion was recognized on this continent years before the constitution was written. Land then was not scarce, and when the settlers eroded the soil beyond cultivability or exhausted the fertility of the soil, they could simply move west to better lands or cultivate virgin land on their own farms.

By 1935, from erosion surveys and various soil surveys, it was estimated that soil erosion had already ruined approximately 100 million acres in the United States for practical cultivation and that nearly an additional 100 million acres had lost "from one-half to all the topsoil" (Pimentel, 1976, p. 150). In this same year, with soil erosion still running rampant and recognized as a national menace, Congress passed the Soil Conservation Act. The act stipulated that the Soil Conservation Service (SCS) be responsible for a national soil conservation program on a permanent basis.

The SCS and the Agricultural Stabilization and Conservation Service (ASCS) have, since their inceptions, employed soil conservation programs offering technical assistance and cost-sharing programs as "carrot approaches" to reduce soil erosion. Land grant colleges have also provided education to aid in reducing soil erosion levels for several decades. A series of studies conducted at Iowa State University by Frey (1952), Held and Timmons (1958), and Blase and Timmons (1960) estimated that in the Ida-Monona-Hamburg soil association in Western Iowa average annual soil loss had decreased from 21.1 to 14.1 tons per acre from 1949 to 1957. Although soil loss levels were still well above tolerance (T)-values of about 4 to 5 tons per acre (approximate maximum annual soil erosion levels that will allow maintenance of soil productivity), apparently public unrest over the issue was settling during this period.

In the late 1960s and early 70s, soil degradation again entered the limelight when many environmentally conscious individuals and groups expressed concerns that sediment and chemicals in runoff water were polluting water and causing siltation in dams and waterways. Also, during the 70s several developments took place that aggravated the soil erosion problems. Increased foreign demand for feed grains, wheat, and soybeans enticed farmers to bring more marginal land out of pasture or forage crops into more erosive row-crop production. Rising energy prices and other factors applied inflationary pressures on the economy which, combined with the rise in real corn-grain and soybean prices and further inflationary expectations, caused land prices to triple over the decade. Many farmers who borrowed money at high interst rates of the late 70s and early 80s to purchase expensive land and machinery are in a position where they must farm intensively to survive. Even farmers who are not in binding financial situations are probably acting as short-run profit maximizers by raising row crops if they do not associate costs with high levels of soil erosion.

So, after almost a half-century of efforts to reduce soil erosion to acceptable levels (about 4 to 5 tons of soil erosion per acre), there is still insufficient cooperation or individual effort by the private farming sector to attain such goals. A recent estimate of the annual soil loss in the United States is 5 billion tons, of which roughly 4 billion tons are washed away and 1 billion tons are blown away (Pimentel, 1976). SCS State Conservationist William Brune in the spring of 1982 stated that "with the frequent heavy spring rains in Iowa, it is estimated that nearly two million acres of land have lost 20 tons or more of topsoil per acre . . . some fields have lost as much as 200 tons per acre" (the Sioux City Journal, May 28, 1982). Considering that under favorable conditions it takes 100 years naturally to form 150 tons per acre (roughly an acre inch) of new topsoil, it is apparent that such losses are depleting this vital resource.

The soil erosion occurring today may in the future result in reduced soil productivity, greater water pollution, further damage to wildlife and the environment in general, and may even jeopardize U.S. national security. However, soil erosion also imposes many costs on farmers and society in general that are much more obvious as they are incurred. Some of these are: (1) loss of nutrients such as nitrogen, phosphorus, and potassium; (2) lower infiltration rate and water-holding capacity; (3) deterioration of soil structure; (4) loss of cropland by gullying and streambank erosion; (5) increased power requirements for tillage operations; (6) division of fields by gullies; and (7) plant population reductions or the need to replant resulting from sedimentation, rill erosion, or crop drownage.

Several factors interact in determining soil erosion levels on any given soil. The more important factors are: (1) physical characteristics of the soil; (2) degree of slope of the soil surface; (3) slope length; (4) the length of time and the intensity with which rain or wind act on the soil; and (5) the amount and degree of soil coverage provided by plant foliage and residue. Although a small amount of soil erosion occurs naturally over time, the cultural practices used by farmers can greatly accelerate the soil erosion process and increase sediment delivery (soil that actually leaves fields and enters water movement systems). Tillage systems and crop rotations used by farmers greatly determine the time and degree to which soil is exposed to the elements. For example, moisture in soil that is tilled in the fall can expand and cause soil to crumble, allowing wind to blow it out of fields. Fields clean-tilled for seedbed preparation make the soil very susceptible to erosion from spring rains in Iowa. Also, structural practices used by farmers can alter the degree and length of soil slopes. Examples are terraces, catch basins, ridge-planting, listing, and contouring. Grass waterways and strip-cropping can be used in conjunction with these practices to aid in reducing soil erosion; both types of practices are often referred to as supporting practices. The above individual cultural practices or combinations of them--rotations, tillage systems, and supporting practices--will be referred to in this study as soil and water conservation practices. Synonyms that will frequently be used throughout are crop management systems or cropping systems.

Several economic, social, physical, and institutional factors may affect farmers' decisions on use of soil and water conservation practices. Among these are tenure, attributes of lease arrangements, age, attitude toward land stewardship, family size, wealth, cash flows, assumed discount rate of returns over time, length of planning horizon, awareness of erosion, education, product and input prices, cost-sharing and technical assistance programs, credit availability, capital costs, perceptions of risk associated with particular practices, management skills, farm size, field size, field borders, and others. The factor that must head-up this list, however, is the profitability of these alternative practices in the context of the farm firm. In the competitive industry of crop production, practices implemented that are not most profitable to the firm threaten its survival. Farm decisionmakers that operate the most efficiently, i.e. produce the largest output at the lowest per unit cost, can over time gain control of agricultural production resources, particularly land.

Many of the above mentioned factors indirectly and directly affect farm profitability, thus influencing farmer's decisions on use of soil and water conservation practices. This study will focus on the following three factors: (1) tenure and leasing arrangements; (2) capital constraints and costs; and (3) farm size.

Objectives of the Study

The objectives of this study are to determine possible effects of tenure, capital constraints and costs, and farm size on the economics of soil and water conservation practices in Iowa. Specific objectives are to: (1) analyze the economics of various soil and water conservation practices from the perspective of individual farm owner- and tenant-operators and landlords under various resource acquisition arrangements, assuming each is the decisionmaker and a maximizer of annual before-tax net returns; (2) analyze effects that particular soil erosion restriction policies may have on net returns and selected soil and water conservation practices of the above parties; (3) analyze effects of capital constraints and costs on use of soil and water conservation practices by the above parties; and (4) discuss effects that farm size may have on use of soil and water conservation practices.

Organization of the Report

Chapter II presents a discussion of the methodology of the study and brief model descriptions of the farms analyzed. Chapter III discusses effects of tenure and leasing arrangements on economics of soil and water conservation practices. Chapter IV describes the effects of capital constraints and costs on use of soil and water conservation practices by parties of the modeled tenure arrangements. Chapter V presents a discussion of possible effects that farm size may have on use of soil and water conservation practices. Chapter VI discusses limitations of the study and presents several policy implications drawn from the analysis. Chapter VII contains an overall summary of the first six chapters and general conclusions. Brief literature reviews of the topics of discussion are included in the appropriate chapters.

CHAPTER II. METHODOLOGY

It is initially suspected that the relative profitability of crop management systems with respect to maximum net returns or minimum soil erosion levels is very soil specific. In addition, soils, machinery complements, capital availability, and other resource characteristics are very specific to individual farm situations. Even the methods by which production resources are acquired vary from farm to farm. Also, in considering alternative soil erosion restriction policies, it is imperative to examine the effects of their implementation on individual farm incomes and changes in use of soil and water conservation practices. For these reasons, this study analyzes the economics of soil and water conservation practices utilizing linear programming (LP) models of various individual representative farms in Iowa. Such models are useful in optimizing a particular goal or objective function subject to input and output prices, technical production coefficients, and available resources.[1] In this study LP models are used to maximize 1985 before-tax net returns to the farm owner and/or operator subject to various capital, land, labor, and soil erosion constraints, technical production coefficients representing various crop management systems, and prices of production inputs and crop outputs.

[1]For additional information on the theory, uses, and mechanics of linear programming, see Agrawal & Heady (1972), Sposito (1975), or Heady & Candler (1973).

Mathematical Representation of the Models

A general mathematical representation of the models used in this study is presented as follows:

$$\text{Maximize:} \quad Z = \sum_i Q_i P_i - \sum_k \sum_l \sum_m \sum_n X_{klmn} C_{klmn} - \sum_q F_q C_q^F - \sum_r H_r C_r^H$$

$$- \sum_s L_s C_s^L - \sum_t E_t C_t^E - \sum_u K_u C_u^K - SC^s - TC^t \qquad (2.1)$$

subject to:

$$\sum_k \sum_l \sum_m X_{klmn} \leq AA_n \qquad (2.2)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} LR_{klmns} - L_s \leq LA_s \qquad (2.3)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} HR_{klmnr} - H_r \leq 0 \qquad (2.4)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} ER_{klmnt} - E_t \leq 0 \qquad (2.5)$$

$$\sum_k \sum_l \sum_n X_{kl4n} TC_n - T \leq 0 \qquad (2.6)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} KR_{klmnu} + \sum_q F_q KR_{qu}^F + \sum_r H_r KR_{ru}^H$$

$$+ \sum_s L_s KR_{su}^L + \sum_t E_t KR_{tu}^E + \sum_n T_n KR_{nu}^T - K_u \leq 0 \qquad (2.7)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} SLA_{klmn} - S = 0 \qquad (2.8)$$

$$\sum_k \sum_l \sum_m X_{klmn} SLA_{klmn} \leq SLA_n \qquad (2.9)$$

$$\sum_k \sum_l \sum_m \sum_n X_{klmn} DR_{klmn} \leq DRA \qquad (2.10)$$

$$\sum_{k}\sum_{l}\sum_{m}\sum_{n} X_{klmn}\ FR_{klmnq} - F_q \leq 0 \qquad (2.11)$$

$$Q_i - \sum_{k}\sum_{l}\sum_{m}\sum_{n} X_{klmn}\ QC_{klmni} \leq 0 \qquad (2.12)$$

where:

$i = 1, \ldots I$ for the crop products sold,

$k = 1, \ldots 15$ for the crop rotations,

$l = 1, \ldots 5$ for the tillage systems,

$m = 1, \ldots 4$ for the supporting practices (4 = terracing),

$n = 1, \ldots N$ for the SMUs,

$q = 1, \ldots 3$ for the fertilizers (N, P, and K),

$r = 1, 2$ for herbicides and insecticides,

$s = 1, 2, 3$ for spring, fall, and other time periods,

$t = 1, 2, 3$ for the sources of energy (diesel, LP gas, and electricity),

$u = 1, 2, 3$ for short, medium and long term capital costs.

and where:

Q_i = the number of units of crop i sold,

P_i = the price of one unit of crop i,

X_{klmn} = the number of acres of rotation k with tillage system l and supporting practice m on SMU n,

C_{klmn} = the per acre cost to the landowner or operator of rotation k with tillage system l and supporting practice m on SMU n (excluding fertilizer, herbicide, fuel, insecticide, hired labor, energy, capital, erosion tax, and terracing costs),

F_q = the number of pounds of fertilizer q purchased,

C_q^F = the cost per pound of fertilizer q,

H_r = the number of units of herbicide or insecticide r,

C_r^H = the cost per unit of herbicide or insecticide r,

L_s = the number of hours of hired labor required in time period s,

C_s^L = the cost per hour of hired labor in time period s,

E_t = the number of units of energy source t,

C_t^E = the cost per unit of energy source t,

K_u = the number of dollars of capital of term u required,

C_u^K = the cost of one dollar of capital of term u,

S = the number of tons of soil loss,

C^s = the tax on one ton of soil loss (for use only when conservation taxes on soil loss are imposed),

T = the total terracing costs in dollars,

C^t = the fraction of total terracing costs paid by the farmer or landowner (i.e. the amount not subsidized or paid for by the government),

AA_n = the total acres of SMU n available,

LR_{klmns} = the total hours of labor required in time period s to raise one acre of crop rotation k, using tillage system l, and supporting practice m, on SMU n,

LA_s = total hours of non-hired labor available in time period s,

HR_{klmnr} = total units herbicide or insecticide r required to raise one acre of crop rotation k, using tillage system l and supporting practice m, on SMU n,

ER_{klmnt} = the total units of energy source t required to raise one acre of crop rotation k, using tillage system l and supporting practice m, on SMU n,

TC_n = the total costs of terracing one acre of SMU n,

KR_{klmnu} = the amount of capital of term u needed to raise one acre of crop rotation k with tillage system l, supporting practice m, on SMU n,

KR^F_{qu} = the amount of capital of term u needed to purchase one pound of fertilizer q,

KR^H_{ru} = the amount of capital of term u needed to purchase one unit of herbicide or insecticide r,

KR^L_{su} = the amount of capital of term u needed to buy one hour of labor in time period s,

KR^E_{tu} = the amount of capital of term u needed to buy one unit of energy source t,

KR^T_{nu} = the amount of capital of term u required to put terracing on one acre of SMU n,

SLA_{klmn} = the amount of annual soil loss per acre under rotation k, using tillage system l and supporting practice m, on SMU n,

SLA_n = the amount of soil loss that is acceptable on SMU n,

DR_{klmn} = 1 when annual soil loss per acre under crop rotation k, using tillage system 1 and supporting practice m, on SMU n is greater than T-values,

= 0 otherwise,

DRA = 0 when annual per acre soil loss is constrained to t-values,

= otherwise,

FR_{klmnq} = the amount of fertilizer q needed per acre of crop rotation k, using tillage system land supporting practice m, on SMU n, and

QC_{klmni} = the amount of crop product i produced per acre of crop rotation k, using tillage system 1 and supporting practice m, on SMU n.

Explanation of the Equations of the Models

Equation (2.1) is the objective function used in this study. The objective of the models is to maximize the net returns to land, management, and family labor. With the exception of conservation taxes on soil loss, these are before-tax returns.

Therefore, equation (2.1) is maximized subject to the system of constraints represented by equations (2.2 - 2.12). Equation (2.2) states that the total acres of a given SMU used cannot exceed the acres owned or rented. Equation (2.3) states that the total labor required for raising crops cannot exceed the total amount of family labor plus the labor hired during the cropping seasons. Equation (2.4) states that the amount of herbicides and insecticides required cannot exceed the amount purchased. Equation (2.5) constrains the amount of energy used from different sources to be less than or equal to the amount purchased. Equation (2.6) constrains the total terracing costs to equal the total actual costs of terracing.

Equation (2.7) states that the total requirements of short-, medium-, and long-term capital cannot exceed the amount borrowed. Equation (2.8) constrains the sum of the soil loss from each SMU to equal the total soil loss for the whole farm. Equation (2.9) states that the level of soil loss on a given SMU cannot exceed a certain specified level.

In Equation (2.10), when DRA is set to zero, soil loss for any given activity is constrained to be less than or equal to t-values. Equation (2.11) constrains the total amount of fertilizers required to be equal to or less than the amount purchased. Equation (2.12) constrains the amount of each crop product sold to be less than or equal to the amount raised.

Representative Farms

This study essentially is an expanded sensitivity analysis of the LP models representing 18 Iowa farms used in a larger study of the economics of soil and water conservation practices by Pope, Bhide and Heady (1982a and 1982b). The farms are synthesized case studies that represent different erosiveness classes, principal soil associations, land resource areas, and major water drainage systems in Iowa. Three to five soil mapping units (SMUs) are specified for each farm based on soil surveys for the areas in which the farms are located. Farm sizes are set according to the average size of commercial farms in the areas.

This study utilizes four of the models that were developed in the initial study. These farm models were selected from the original farm models based on the sensitivity of the LP model solutions in the base study and also to represent different erosiveness levels, from fairly unerosive to extremely erosive. A map of the locations of all 18 farms is shown in Figure 1. The farms used in this study are located in east central Boone County (#2), northwest Van Buren County (#9), northeast Jasper County (#17) and southwestern Ida County (#18). These farms are defined in terms of soil delineation, land resource area, watershed, erosiveness class, and size in Table 1.

The Boone County farm consists of soils of the Clarion-Nicollet-Webster principal soil association. This is the largest soil association in Iowa, extending over approximately 12,000 square miles of northcentral Iowa, roughly 20 percent of the state. The topography is nearly level to gently sloping, with a few strongly sloping areas. Many low lying areas are poorly drained, and one-third to one-half of this soil association area has been artificially drained. This is the least erosive farm modeled in this study.

The Van Buren County farm is made up of soils of the Lindley-Keswick-Weller soil association which occurs in south central and southeastern Iowa. This soil association occupies about 1,700 square miles or three percent of the state. A large portion of the soils in this association are derived from loess and glacial till parent materials, and are moderately to severely erosive. Topography varies from nearly level to very steep. The modeled Van Buren County farm is moderately erosive.

The Jasper County farm is located in the Tama-Muscatine soil association of central Iowa. This soil association occupies about 4,000 square miles or seven percent of the state, and consists of a loess-covered glacial till plain. The topography in the Tama-Muscatine association varies from nearly level to very steep. In Jasper County, the topography consists of rounded, gently sloping divides, moderate to strongly sloping side slopes and narrow valleys. The modeled Jasper County farm is very erosive.

The Ida County farm is located in the Monona-Ida-Hamburg soil association of western Iowa. This association covers about 2,900 square miles or five percent of the state. The topography consists of narrow, gently sloping ridges and steep side slopes that gradually change to nearly level alluvial valleys. The steep loess soils of the Ida County farm make it the most erosive farm of the study.

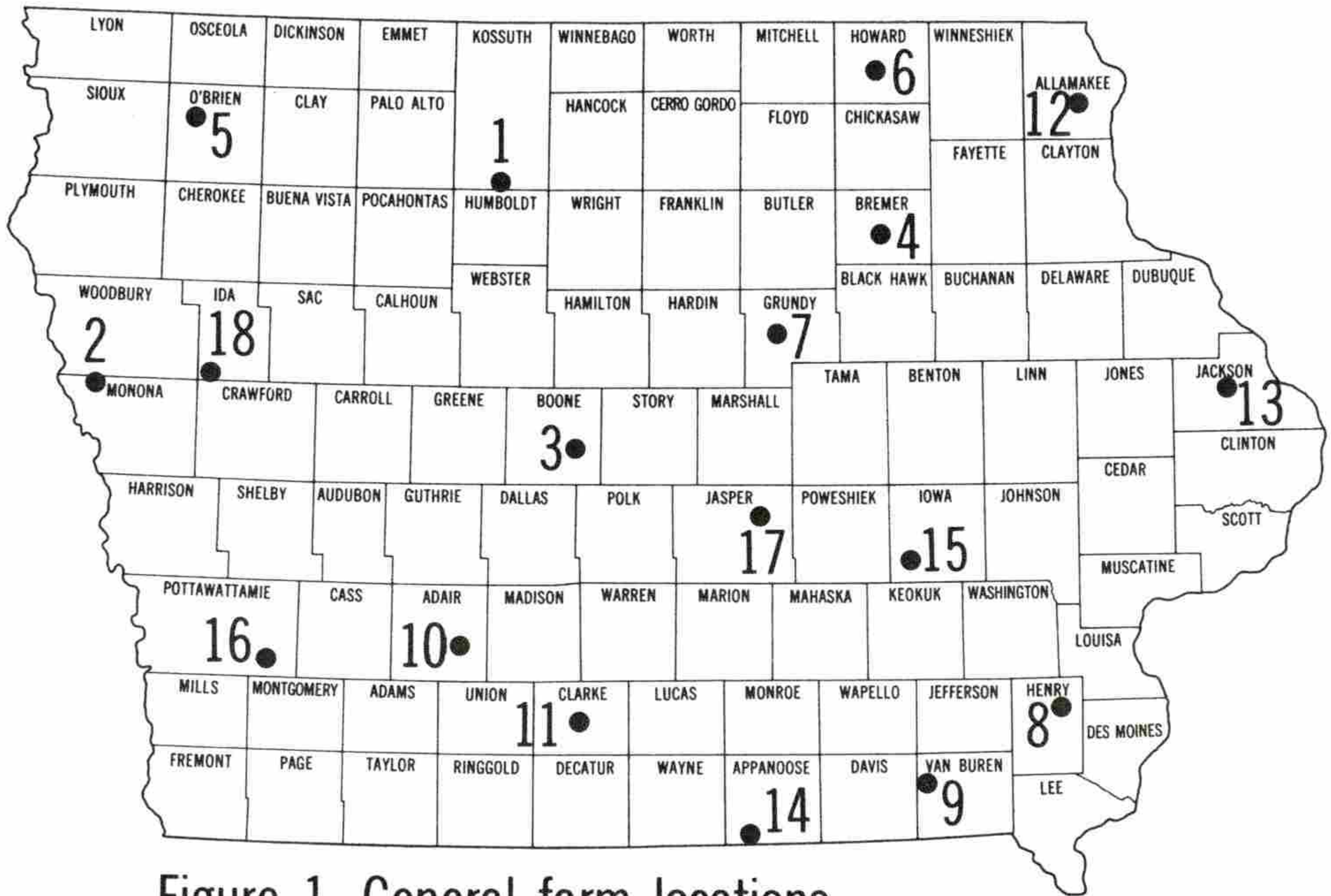

Figure 1. General farm locations

Table 1. Farm descriptions

Boone County Farm

Principal Soil Association: Clarion-Nicollet-Webster,

Location: East Central Boone, Land Resource Area: 103,

River Basin: Des Moines River, Erosiveness Class: #2,

Gross farm size: 350, Net farm size: 320.

Soil Type Name	Soil Type Legend	Slope Class	Erosion Phase	Capability Class	% Net Farm Acres	Acres of SMU
Webster sicl	107	A	1	IIw-1	45	144
Nicollet loam	55	A	1	I-1	25	80
Clarion loam	138	B	1	IIe-1	23	74
Clarion loam	138	C	2	IIIe-1	7	22

Van Buren County Farm

Principal Soil Association: Lindley-Keswick-Weller,

Location: Northwest Van Buren, Land Resource Area: 109,

River Basin: Des Moines River, Erosiveness Class: #6,

Gross farm size: 390 acres, Net farm size: 360 acres.

Soil Type Name	Soil Type Legend	Slope Class	Erosion Phase	Capability Class	% Net Farm Acres	Acres of SMU
Lindley loam	65	E	2	VIe	40	144
Pershing sil	131	B	1	IIe	30	108
Weller sil	132	C	2	IIIe	30	108

Table 1. (continued)

Jasper County Farm

Principal Soil Association: Tama-Muscatine,

Location: Northeast Jasper, Land Resource Area: 108,

River Basin: Skunk River, Erosiveness Class: #10,

Gross farm size: 370, Net farm size: 340.

Soil Type Name	Soil Type Legend	Slope Class	Erosion Phase	Capability Class	% Net Farm Acres	Acres of SMU
Tama sic l	120	C	2	IIIe-1	60	204
Downs sil	162	D	2	IIIe-3	20	68
Muscatine sicl	119	A	1	I-1	10	34
Shelby loam	24	E	2	IVe-1	10	34

Ida County Farm

Principal Soil Association: Monona-Ida-Hamburg,

Location: Southwestern Ida, Land Resource Area: 107,

River Basin: Western Iowa, Erosiveness Class: #10,

Gross farm size: 340 acres, Net farm size: 310 acres.

Soil Type Name	Soil Type Legend	Slope Class	Erosion Phase	Capability Class	% Net Farm Acres	Acres of SMU
Ida sil	1	D	3	IIIe	15	47
Ida sil	1	E	3	IVe	30	93
Monona sil	10	C	2	IIe	18	56
Monona sil	10	D	2	IIIe	17	52
Napier sil	12	C	1	IIIe	20	62

Activity and Data Descriptions

Various crop management systems made up of combinations of five tillage systems, four supporting practices, and fifteen crop rotations on the three to five SMUs are represented by the crop production activities in the models. The five tillage systems were chosen such that they represent a wide variation in degree of soil disturbance and amount of plant residue left on the soil surface. They (and their respective abbreviations used in the model summaries in Appendix A) are, in order of low surface residue to high surface residue, (1) conventional fall moldboard plow (conv); (2) fall chisel plow (chisel); (3) spring-disk (disk); (4) till-plant (till); and (5) slot-plant (slot). The supporting practices (and their respective abbreviations) that are modeled include contouring (contour), strip-cropping (strip), terracing (terrace), and none (none). Grass waterways, although not explicitly modeled, are assumed to be used in conjunction with other supporting practices when needed.

The models represent cash crop farms, i.e. all crops are raised and sold for cash. The crop rotations modeled include combinations of corn, soybeans, oats, alfalfa, and pasture. Corn silage was not included in the rotations because it is seldom raised as a cash crop in Iowa. In cases where a decisionmaker selects a rotation with alfalfa, oats (straw), or pasture, it is assumed that some livestock production activity exists that will purchase these inputs at the assumed prices.

The crop rotations included in this study are identified as follows:

1.	C	5.	CB
2.	CCCOM	6.	CCB
3.	CCOMM	7.	CBCOMM
4.	COMMM	8.	P

where: C is corn grain; B is soybeans; O is oats; M is meadow (alfalfa); and P is permanent pasture.

Crop management systems that include all combinations of the above mentioned crop rotations, tillage systems, and supporting practices are defined in the models with the following exceptions: (1) strip-cropping is used for only the COMMM and CCOMM rotations; (2) only the conventional tillage system is used on pasture and pasture cannot be strip-cropped or contoured; (3) till-plant and slot-plant systems are done on the contour on SMUs of slope class C or steeper; and (4) the till-plant system is not used on the COMMM rotation.

Due to lack of substantial evidence showing consistently lower yields on reduced tillage cropping systems, yields for the cropping activities are assumed to be equal across all tillage systems and supporting practices for crops in a given rotation on a given SMU. Yields used in the models are 1985 estimates derived from a statistical model developed by Pope (1981) using time-series data. The projected 1985 yields for the various crops per SMU in the farms selected for this study are given in Table 2.

Table 2. Estimated 1985 crop yields for selected soils in Iowa

Farm County	Farm Soil No.	SMU No.	1985 Crop Yields Corn (bu./A)	Soybeans (bu./A)	Oats (bu./A)	Meadow (tons/A)	Pasture (AUM)
Boone	1	107A1	136	48	96	5.4	7.6
	2	55A1	147	51	103	6.1	8.6
	3	138B1	136	48	96	5.7	7.9
	4	138C2	126	45	88	5.2	7.3
Van Buren	1	65E2	0	0	0	2.5	2.6
	2	131B1	125	44	68	5.1	7.2
	3	132C2	106	37	58	4.4	5.7
Jasper	1	120C2	145	50	101	6.0	8.4
	2	162D2	126	45	88	5.2	7.3
	3	119A1	164	58	114	6.7	9.4
	4	24E2	82	28	58	3.4	4.7
Ida	1	1D3	85	30	60	3.2	4.5
	2	1E3	68	24	47	2.6	3.6
	3	10C2	112	40	78	4.2	6.5
	4	10D2	94	33	65	3.5	5.5
	5	12C1	124	44	87	4.6	7.2

Nitrogen fertilizer levels are based on corn yield levels, sequence of corn in the rotation, and soil drainage characteristics. Phosphorus and potassium fertilization rates are also based on crop yields and represent "maintenance" levels. All fertilizer application rates were developed with aid from Iowa State University agronomists.

Each cropping activity (representing one acre of a SMU) includes machinery ownership costs and all operating input requirements or costs (fertilizer, pesticides, fuel, seed, etc.). The machinery ownership costs (taxes, insurance, housing, and depreciation) and operating costs (fuel, lubrication, and repairs) are calculated as per acre costs based on machinery time requirements for each field operation in each crop sequence of each rotation. A list of field operations for the crop sequences corn following beans and beans following corn for the five tillage systems is given in Tables 3 and 4. The machinery and equipment from which these costs are derived are considered an efficient size for the sizes of farms modeled. Fuel requirements are assumed to be 5 percent higher under contour farming compared to straight row farming.

For each production activity representing a crop management system, soil erosion (movement) caused by rainfall is approximated using the Universal Soil Loss Equation (USLE). This equation is formulated as

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

Table 3. Description of tillage systems for corn following beans

Field operation	Conventional	Chisel	Disk	Till-plant	Slot-plant
Broadcast granular P & K	X	X	X	X	X
Chisel plow (Fall)	X	X			
Anhydrous Ammonia	X[a]	X[b,a]	X[b,c]	X[b,c]	X
Disk-harrow (Spring)	X				
Field cultivator	X	X			
Offset disk (Spring)			X		
Plant, double disk openers	X	X			
Plant, slot planter w/coulters			X		X
Plant, till-plant				X	
Pre-emergence herbicide[d]	X	X	X	X	X
Sweep cultivation	2X				
Rolling cultivaton		2X	2X	2X	1.5X
Harvest	X	X	X	X	X

[a]Fall.

[b]Must have rolling coulters on applicator.

[c]Spring.

[d]Depends on herbicide program.

Table 4. Description of tillage systems for beans following corn

Field operation	Conventional	Chisel	Disk	Till-plant	Slot-plant
Shred stalks (Fall)		X			
Disk stalks (Fall)	X				
Moldboard plow (Fall)	X				
Chisel plow (Fall)		X			
Disk-harrow (Spring)	X	X			
Field cultivator (Spring)	X				
Offset disk (Spring)			X		
Plant, double disk openers	X				
Plant, slot-planter w/coulters		X	X		X
Plant, till-planter				X	
Pre-emergence herbicide[a]	X	X	X	X	X
Sweep cultivation	2X				
Rolling cultivation		2X	2X	2X	1.5X
Harvest	X	X	X	X	X

[a]Depends on herbicide program.

where A = average annual soil loss in tons per acre,

R = rainfall factor,

K = soil erodibility factor,

L = slope length factor,

S = slope gradient factor,

C = cropping and management factor, and

P = conservation or supporting practice factor.

For more information on how these factors are used and calculated see Wischmeier and Smith (1978).

Purchasing activities supply off-farm inputs such as capital, hired labor, fuel, fertilizers, and pesticides to the crop production activities. Selling activities provide income to the decisionmaker from his selected cropping activities. Input and output prices represent 1980 price levels. These prices are listed in Table 5.

For a complete discussion of the models and details on prices, soil loss coefficients, and other data used in this study see Pope, Bhide, and Heady (1982a). These models are used as tools to aid in analyzing effects of tenure and capital constraints on economics of soil and water conservation practices in Iowa. The models are solved under various scenarios reflecting different leasing arrangements, capital constraints, soil erosion restrictions, and assumptions about farmers' willingness and ability to use various soil and water conservation practices. These scenarios and discussions of the model solution results will be elaborated on in the following chapters.

Table 5. Input and output prices

Item	Unit	Price paid ($/unit)	Price received ($/unit)
Fertilizer			
Nitrogen (anhydrous ammonia: 82% N)	lb.	0.14	--
Phosphorus (super phosphate: 45% P_2O_5)	lb.	0.27	--
Potassium (muriate of potash: 60% K_2O)	lb.	0.12	--
Fuel			
Diesel	gal.	1.29	--
LP gas	gal.	0.686	
Other Inputs			
Hired labor	hrs.	4.50	--
Capital	dollars	0.15	--
Crops Corn grain	bu.	--	2.56
Soybeans	bu.	--	7.30
Oats	bu.	--	1.56
Straw	ton	--	50.00
Alfalfa	ton	--	57.73
Pasture	AUM	--	8.00

CHAPTER III. TENURE EFFECTS ON ECONOMICS OF SOIL AND WATER CONSERVATION PRACTICES

Owner-operatorship is only one means of obtaining and allocating resources in the crop production process. A large portion of Iowa farms obtain control of agricultural resources through some form of leasing arrangement. Many of these leasing arrangements are based on custom or are formulated in local "leasing" markets under conditions of less than perfect competition. Such leases undoubtedly influence the efficiency with which the resources employed within them are allocated. This chapter focuses on how tenure can be expected to affect the allocation of these available resources that comprise the various soil and water conservation practices and how that allocation affects soil erosion.

Literature Review

Several regression analyses have been done using data from a USDA national land ownership survey (Lewis, 1980) in attempts to relate land owner and tenure classes to soil erosion levels and investments in such soil conserving measures as terracing, grass waterways, and gully controls during the three year period 1975 to 1977. Baron (1981) found in his analysis that in most of the areas he observed owner-operators and owners who leased their land on share terms were more likely to invest in soil conserving practices than owners who leased their land on cash terms. Lee, (1980) using similar cross sectional data, found that for full operators (those who operate only land that they own) higher income levels were associated with lower rates of erosion nationally and within five out of ten regions that she studied in the United States, apparently because they farmed less erosive land and used more conservation practices. However, she found no difference in soil erosion as measured by the Universal Soil Loss Equation (USLE) between tenure groups at the national level or between most regions. She also found no significant difference in mean soil losses between different types of ownership groups (corporations, partnerships, proprietorships, etc.). Where differences existed at regional levels, they were mostly attributable to physical (more erosive soils) rather than management factors. Lee concluded that as a group, landlords do not automatically appear to have higher levels of soil erosion than owner-operators or those who combine landlord, tenant, and owner-operator functions. In another study utilizing the same data sources, Otte (1982) found that type of owner was related to soil erosion levels.

Perhaps the few above discrepancies in data analyses findings result from the generality of such broad surveys. An important fact apparent in the data was that very few of the respondents reported investing in any of the soil conservation practices during the three year period (Schertz and Wunderlich, 1982).

Many tenure-soil erosion studies have focused on specific regions or soil association areas. In a series of studies conducted at Iowa

State University, tenure problems and owner resistance to conservation practices were found to be present on highly erosive sample farms in a western Iowa "land base laboratory" (Frey, 1952; Held and Timmons, 1958; Blase and Timmons, 1961; Hauser, 1976). In the most recent study, Hauser found, using analysis of variance, that strictly owner-operators were averaging five tons annual soil loss per acre less than strictly renter-operators. He also found that expected length of tenure was negatively associated with soil erosion (longer expectancy, less erosion) but that the stipulation of conservation investment cost-sharing in the lease didn't affect soil loss levels.

Ervin (1981) used a similar sample method to study tenure effects on soil erosion on potentially erosive farms in Monroe County, Missouri. He, like Hauser, found soil erosion as measured by the USLE to be significantly greater on rented farms than on owner-operated farms. To strengthen this finding, he found that the higher erosion rates on rented farms were produced on soils less erosion prone than soils farmed by owner-operators. This implied lower levels of soil conservation efforts on the rented lands. Ervin also concluded that significantly more owner-operated land in the sample had terraces, grass waterways, contour farming, and crop rotations with hay or pasture than the rented farms. He found little significant difference in the percentage of owned and rented farms where conservation tillage was utilized, and speculated that its use was perhaps based more on cost considerations rather than or in addition to erosion control benefits. Ervin used regression analysis to test for significant statistical associations between erosion losses and several tenure factors hypothesized to affect erosion. He found that lease length, type of lease (cash, share, or both), and total acres rented were not associated with soil erosion levels in the study area. He did find strong significance of physical erosion potential and fairly good significance of conservation investment cost-sharing provisions in the lease in explaining soil erosion rates.

Kraft (1978) conducted a survey of 31 dairy farmers on four soil associations in Ontario County, New York. He found that all 31 farmers managed rented land differently than their own land. Farmers who could not obtain long-term leases on rented land tended to exploit or mine it by raising continuous corn for four to six years, not practicing strip cropping, and not raising alfalfa. Kraft found that once the farmers purchased land they formerly rented, they would change rotations to keep forages on the steeper slopes and shorter corn rotations on the leveler parcels. They would also invest more heavily in fertilizer, lime, and drainage.

Hoover and Wiitila (1980) analyzed responses from 106 sample operators and 69 landlords in the erosion prone Maple Creek watershed in northeast Nebraska. They found a large discrepancy between the Soil Conservation Service estimates of soil erosion hazard on farms and operator and landlord views of the soil erosion problems on their farms.

The main reason given by sample operators for not using various soil and water conserving practices was landlord objection. Other important reasons were machine difficulties (e.g., point rows), extra work involved, and too low of cost-sharing levels offered by the public agencies. Hoover and Wiitila stated that "whereas the SCS measures soil erosion problems in terms of amount of soil movement, operators tend to classify the problems according to visible soil movement and short-run effects of soil erosion on the economic, physical, and operational aspects of farming" (p. iv).

In a study utilizing cropping budgets, conservation practices under crop-share leases were found to reduce landlord income (Jensen, Heady and Baumann, 1955).

Resource Allocation Theory Applied to Leasing

Economic theory suggests that, under conditions of perfect competition, the resources owned and managed by a single decisionmaker, whose objective is to maximize profits, are allocated in agricultural production in a cost efficient fashion. Heady (1955) has theorized that for a crop-share lease to be potentially as efficient as production and resource allocation under owner-operatorship the following four conditions must be fulfilled by the lease contract: (1) costs (at least direct variable costs) must be shared in the same proportion as production (output) is shared for each particular crop; (2) the shares of all competitive crops must be the same; (3) allowing for normal yield and price uncertainties, the prospects for returns on investments over time must be the same under the share lease as in its absence; and (4) the output received by each party must represent the product of the respective resources contributed by each. Condition (3) might be attained by guaranteeing compensation to the tenant for unexhausted investment should he leave before realizing its full returns or by setting the lease length for a period long enough that the tenant would realize full returns on his share of investment. Condition (4) is guaranteed by condition (1) for any resources for which costs are shared in exact proportion to the output share. Condition (4) applies to the specialized resources that each party of the lease contributes individually (e.g., land by the landlord, machinery by the tenant). This last condition is at best only approximated in most leasing situations.

Since a cash renter realizes the full crop outputs from his contribution of non-land production resources, and the cash rent represents a fixed cost to him and a fixed return to the landlord, the tenant and landlord have no conflicts in sharing costs and outputs in the short-run. Perhaps the more important problem in arranging an efficient cash lease is setting "fair" rents such that condition (4) is satisfied. Also, factors such as risk associated with the large fixed rental payment and short-run benefits to the renter from exploiting the landlord's land may cause inefficiencies in resource allocation and use by the cash tenant.

The following analysis will focus on how different cost-sharing and crop output-sharing arrangements representing different crop-share leases affect selections of soil and water conservation practices as compared to selections of the owner-operator under various soil erosion level restrictions. There is little need to analyze variations of condition (2) as present crop-share leases in Iowa generally stipulate that competitive cash crops are to be shared in the same proportion. It is assumed that lease lengths are for a long enough period that all parties can realize full returns on their shares of any investments they make. For example, machinery ownership costs and terrace installation costs are represented in the models as annualized costs. Also, multi-year rotations such as CBCOMM are represented in the models as single period cropping activities. Inefficiencies resulting from any types of risks or uncertainties are not incorporated in the models.

For purposes of this study, a short-run situation is assumed in that farm sizes are fixed, i.e. the owner-operator or landlord has a fixed amount of land to farm or rent out. From the tenant's perspective, he has the opportunity to rent that fixed amount of land from the landlord. This would not preclude his renting additional land in reality; however the objectives of the study can be attained by assuming that a fixed amount of land is available.

Normally in a short-run situation the owner-operator and tenants have a fixed machinery complement. As modeled in this study, machinery costs are specified per cropping activity (on a per acre basis). All operators are allowed to "choose" different machine complements (representing different tillage methods) based on their profitability in each different scenario for which the LP models are solved.

Modeled Leasing Arrangements

Basically, three different tenure arrangements are modeled in this study. One is the owner-operator who pays all costs and receives all crop outputs. His scenario numbers are followed by the letter A in the model summaries in Appendix A. (All land charges are essentially fixed costs that bear no influence on crop management system decisions to the extent they can be met--they are therefore ignored in this analysis.) The other two are crop-share leases prevalent in Iowa and will be described below. A cash leasing arrangement was not explicitly modeled in this study. Since the cash renter views his per acre cash rent as a fixed cost and also pays all variable costs and receives all product (output), his selections of crop management systems would match those of the owner-operator under equivalent scenarios on three conditions: (1) his per acre fixed rents are at levels below the net returns per acre per SMU realized by the owner-operator, (2) his operating capital availability over and above his fixed rents are at least as great as that of the owner-operator, and (3) he is guaranteed compensation for unexhausted investments. It is quite realistic to assume that condition (1) is satisfied. Condition (2) is also satisfied in this chapter as capital is assumed to be unlimited. In this analysis, condition (3) is assumed to be met.

The first crop-share lease to be defined will be referred to as the 50-50 lease. This lease is one of the more prevalent leases in Iowa in which some of the variable input costs are shared between landlord and tenant in proportion to their sharing of output. Under this arrangement the landlord contributes his land and 50 percent of the costs of fertilizer, herbicides, insecticide, seed, and the drying of corn grain. He receives 50 percent of all crop outputs (corn grain, soybeans, oats, straw, alfalfa, and pasture) as return to his land and capital contributions. This landlord will hereafter be referred to as the 50-50 landlord--a letter"C" follows his scenario numbers in the model solution summaries in Appendix A.

Under this lease arrangement the tenant contributes 50 percent of the costs of fertilizer, herbicides, insecticide, seed, and the drying of corn grain, all labor, and all machinery and machine related costs. He also receives 50 percent of the crop outputs as return on his capital, labor, and managerial abilities. This tenant will be referred to as the "50-50 tenant"--a "B" follows his scenario numbers in Appendix A.

The second crop-share lease that is modeled will be referred to as the 35-65 lease. Under this leasing arrangement the landlord furnishes only his land for the production of crop outputs, of which he receives 35 percent as return on his land. This landlord will hereafter be referred to as the 0-35 landlord, meaning he pays no operating costs and receives 35 percent of the crop outputs as a variable share rent. An "E" follows the scenario numbers for this landlord in the model solution summaries in Appendix A.

Under this same lease arrangement, the tenant pays all machinery and variable cropping costs and supplies all labor; he receives 65 percent of the crop outputs as return on his labor, capital, and managerial abilities. This tenant will be referred to as the 100-65 tenant (he pays all costs and receives 65 percent of the crop outputs)--the letter "D" follows his scenario numbers in Appendix A.

A diagrammatical representation of the costs and revenues associated with a particular crop production activity in the linear programming models will help illustrate why different activities may be viewed as "most profitable" by the owner-operator and the various leasing parties. For purposes of comparison, all parties are assumed to have unlimited capital.

Figure 2 represents the costs and revenues for a particular crop production activity for the owner operator and various lease parties. The areas inside the solid rectangles represent the costs (C) paid and revenues (R) received by each farm <u>operator</u> from his share of output.

The total areas below the dashed lines (inclusive of any enclosed areas) represent total costs paid and revenues received by the owner operator.

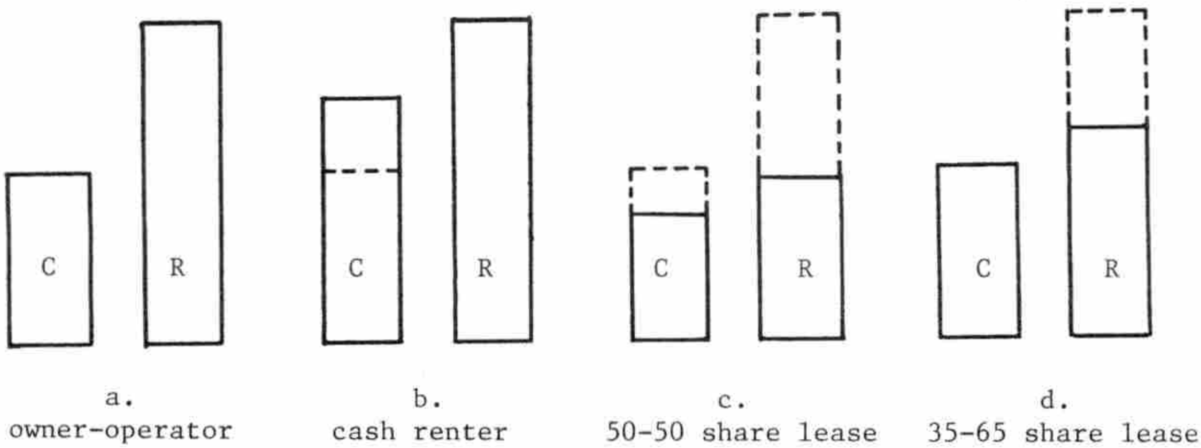

Figure 2. Divisions of costs and revenues for an owner-operator and parties of various leasing arrangements for a typical crop production activity in a linear programming model

In Figure 2a area C represents the total non-land production costs for a given crop management system that the owner-operator must pay to obtain gross revenues of area R. Given unlimited capital the owner-operator chooses the crop production activity (one acre of a particular SMU under a particular crop management system) for which R-C is greatest. The cash renter (represented by Figure 2b) must pay all costs incurred by the owner-operator, in addition to a fixed per acre cash rent (the area above the dashed line in area C) and receives the same total revenues, area R. The cash renter also selects cropping activities with the largest net returns (R minus the solid rectangle C). Since the cash rent represents a fixed outlay, the cash renter chooses the same crop production activities as the owner-operator provided R > C by an amount greater than the opportunity cost of his labor and management. Since the landlord receives the area of C above the dashed line as a fixed rent, there are no conflicts between landlord and tenant in farm planning.

Figure 2c represents the corresponding costs and returns of the same cropping activity for the 50-50 tenant arrangement as modeled in this study. Here solid rectangle C represents the tenant's costs which are always less than the full non-land costs of the owner-operator since certain costs are shared "50-50" with the landlord. This tenant receives exactly half of the returns received by the owner-operator for the given cropping activity. Since this tenant as modeled also will choose cropping activities based on his largest net return (area R-C in 2c) there is every possibility that he may find a different cropping activity more profitable than that which is most profitable to the owner-operator. (In fact, several activities may be unprofitable to him.) In Figure 2c the landlord's variable costs are represented by the dashed-in area above C; his revenues are the dashed-in half of the gross revenues. Since he is also maximizing net returns (his share of revenues minus his share of costs), there is no reason why he should find the same cropping activity as those selected by the tenant or the owner-operator to be most profitable. It is easy to see in Figure 2c that the closer total costs come to being shared "50-50", the more compatible the landlord and tenant will become in farm planning, and the closer their farm plan will match that of the owner-operator.

Figure 2d represents the 35-65 leasing arrangement modeled in this study. The 100-65 tenant pays the same total cropping costs as does the owner-operator; however, he receives only 65 percent of the total revenues. Depending on the relationship between costs and revenues for a given cropping activity, this tenant may find that an activity other than that selected by the owner-operator is most profitable to him. Many activities that are profitable to the owner-operator may be unprofitable to this tenant (if $C > R$ in 2d). Since the landlord pays no cropping costs and receives 35 percent of the crop outputs, he will simply desire the activity with the greatest gross revenue (the dashed-in area above R in 2d). Such division of costs and revenues can obviously lead to tenant and landlord incompatibility and farm plans quite different from those of an owner-operator.

As discussed above, even under conditions of unlimited capital availability the various lease parties may select crop management systems that are different from each other and the owner-operator because of the ways costs and revenues are shared. Under conditions of various soil erosion level restrictions, the tenure farm plans may diverge even further. This divergence will be pointed out in the discussion section below. Models representing all four farms, all three tenure arrangements (owner-operator, 50-50 crop-share, and 35-65 crop-share), and all tenure parties as decisionmakers will be solved under the following scenarios.

Scenario Descriptions

Under scenario one the objective of all tenure parties is to maximize 1985 before-tax net returns with total disregard to soil erosion. It is assumed that the decisionmakers are able or willing to use only the conventional fall moldboard plow system.

Scenario two is identical to scenario one except that the decisionmakers are assumed to be able and willing to use all crop management systems modeled.

Scenario three assumes that the decisionmakers are able and willing to use all crop management systems; however, they must maximize 1985 before-tax net returns subject to the constraint that soil movement as measured by the USLE cannot exceed T-values on any acre of the farm. It is assumed that the land owners pay all terrace installation and maintenance costs. One solution is solved for the 50-50 tenant for each of the Jasper and Van Buren county farms where he assumes all terrace maintenance costs. This is done to see if it is profitable for a tenant to assume terrace maintenance costs. No other tenant models are solved under this scenario as they would adopt terracing activities consistently if no terracing costs are paid by them.

Scenario four is the same as scenario three except that here landowners and tenants must each pay 50 percent of the terrace installation costs. The terrace maintenance costs are borne by the parties in the same manner as the shared costs. For example, the 100-65 tenant pays all, the 50-50 tenant pays half, etc.

Scenario five assumes that the decisionmaker maximizes 1985 net returns subject to the condition that he is taxed (or places a negative value of) $0.50 a ton on soil movement as measured by the USLE. Again all crop management systems are available to the decisonmakers.

Scenarios six and seven are exactly the same as scenario five except that soil movement is valued at $1.00 and $3.00 a ton, respectively. The last three scenarios were run for the leasing parties on the Jasper and Van Buren county farms only.

Solution summaries of all models representing various tenure arrangements and scenarios are given in Appendix A.

Results and Discussion

In scenario one, soil erosion losses are totally disregarded and the decisionmaker is allowed to maximize net returns assuming he is willing or able to use only the conventional fall moldboard plow tillage system. Under such conditions corn-soybean (CB) rotations with straight-row farming are generally most profitable for the owner-operator. On some of the more erosive soils, corn and soybean yields are low enough in relation to production costs that pasture or a corn-oats-meadow-meadow-meadow (COMMM) rotation are the most profitable.

The 50-50 tenant solutions are similar to the owner-operator solutions except that on even more of the erosive, less productive soils the COMMM and pasture rotations are more profitable for the tenant than the CB rotation. The slope E SMU on the Van Buren farm is taken out of production entirely by this tenant.

The 100-65 tenant solutions vary even further from the owner-operator solutions on some of the farms. All D and E slope SMUs are put into a COMMM rotation or go out of production entirely. The corn and soybean yields simply are not great enough to make this tenant's share of returns pay for the total costs associated with the CB rotation on these SMUs.

Both landlords are somewhat incompatible (the 0-35 landlord moreso) with their tenants in that the CB rotation is generally most profitable for them on most SMUs. Erosion levels for the landlords and owner-operator model solutions are extremely high on the more erosive farms, as the CB conventional tillage crop management system is a very erosive cropping activity. The soil movement levels in the 50-50 tenant solutions are less than, or equal to, those in the owner-operator solutions. For the 100-65 tenant, soil erosion is even less, as more COMMM and pasture activities are selected in the optimal solution.

The tenure party incompatibilities and lower soil erosion levels for the two tenants may be overstated in this scenario for two reasons: (1) tenants are not allowed to choose lower fertilizer levels on the CB rotations; and (2) in the model summaries land that is taken out of production is assumed to have soil erosion levels of zero.

Soil and Water Conservation Practice Profitability

In scenario two, the tenure parties are allowed to choose from all modeled crop management systems in maximizing 1985 before-tax net returns. Under this scenario, the CB rotation, with till-plant tillage and contouring on slopes C and steeper, is generally the most profitable crop-management system for all farm operators. The 50-50 tenant is very nearly indifferent as to selection of the till- or slot-plant tillage systems. The till-plant system requires less herbicides, but more diesel and machinery and repair costs than the slot-plant system (see Table 6 for a cost-returns breakdown for three rotations and the five tillage systems for SMU 120C2). Since the 50-50 tenant shares the herbicide costs with his landlord, his choice between the till- and slot-plant system depends on the relative costs of the shared and non-shared items mentioned above.

The cost savings of the till- and slot-plant systems over the conventional moldboard plow system allow both tenants to raise more acres of CB rotations than in scenario one. Still, the most erosive prone and

Table 6. Per acre soil loss, costs, and net returns on Tama silty clay loam, 5-9 percent slope, erosion phase 2, under 3 crop rotations

Rotation and Tillage System	Soil Loss	Cost of Short-term Capital[a]	Cost of Medium-term Capital[b]	Fuel Cost[c]	Pesticide Cost	Fertilizer Cost	Other Cost	Total Cost	Net Return
1. Corn-soybean									
- Fall Plow	46.94	9.56	16.98	20.90	18.45	30.69	71.79	168.37	213.57
- Chisel Plow	38.65	9.39	15.00	19.49	18.45	30.69	69.20	162.22	219.72
- Spring Disk	32.21	9.25	13.78	18.04	18.45	30.69	67.96	158.17	223.77
- Till-plant[d]	27.61	9.17	12.70	17.50	18.45	30.69	66.61	155.12	226.82
- Slot-plant[d]	8.28	9.51	11.67	17.00	23.95	30.69	65.27	158.09	223.85
2. Corn-oats-meadow-meadow-meadow									
- Fall Plow	4.60	7.27	18.98	16.58	5.73	42.65	65.81	157.02	194.87
- Chisel Plow	2.76	7.27	18.69	16.39	6.08	42.65	65.26	156.34	195.40
- Spring Disk	2.76	7.27	18.98	16.32	6.08	42.65	65.61	156.91	194.77
- Slot-plant[d]	1.56	7.37	17.45	16.12	8.28	42.65	63.93	155.80	196.17
3. Corn-soybean-corn-oat-meadow-meadow									
- Fall Plow	18.41	8.21	17.92	18.35	11.14	35.62	59.43	150.67	197.18
- Chisel Plow	14.72	8.15	17.00	17.71	11.44	35.62	58.21	148.13	199.72
- Spring Disk	12.88	8.11	16.83	17.16	11.44	35.62	58.13	147.29	200.57
- Till-plant[d]	8.28	8.06	15.77	16.94	11.44	35.62	56.80	144.63	203.22
- Slot-plant[d]	4.60	8.27	14.81	16.49	15.18	35.62	55.56	145.93	201.93

[a]Includes cost of capital for fuel, seed, fertilizer, pesticides, repairs, and other short-term items.

[b]Represents cost of capital for machinery.

[c]Includes diesel and LP gas costs--LP gas costs are the same for each rotation across tillage systems.

[d]Till-plant and slot-plant tillage systems are assumed to be on contour for this soil.

least productive soils are taken out of production or put into COMMM or pasture (moreso by the 100-65 tenant) by both tenants.

The CB rotations also are most profitable for both landlords under this scenario. The 50-50 landlord is generally indifferent to which tillage system is used except the slot-plant system since it requires more pesticides. In the solution summaries, it is assumed he chooses the tillage system (other than slot-plant) that is compatible with that most profitable to the tenant for the commonly selected rotations. The 0-35 landlord is totally indifferent to the tillage system since he pays no costs; he is also assumed to select the tillage system compatible with his tenant's selections in the solution summaries.

Given the ability and willingness to adopt conservation practices such as the till-and slot-plant tillage systems practiced on the contour on slopes C and greater, all tenure parties receive as great or greater net returns as under the strictly conventional fall plow system. Also, the increased surface residue left by these tillage systems greatly reduces the erosion levels on soils in a CB rotation (see Appendix C). The economies of the slot- and till-plant systems also allow a higher degree of lease party compatibility with respect to crop rotations.

In no cases does strip cropping or terracing enter these solutions in which soil erosion levels are not constrained.

Soil and Water Conservation Practice Selection Under T-Value Restrictions

In scenarios three and four, the operators and landlords may use all available crop management systems to maximize 1985 before-tax net returns subject to a constraint that soil erosion levels cannot exceed T-values. Scenario four assumes that all landowners and operators must pay 50 percent of terrace installation costs (the remainder is assumed to be subsidized by the other leasing party or the public) for any crop management systems selected that include terracing. The terrace maintenance costs are shared exactly as each party would share fertilizer and pesticide costs. Scenario three assumes the landowners must pay all terrace costs. This scenario is solved only for the landowners who selected terracing activities under the 50 percent subsidy in scenario four. Obviously landowners who do not use terracing when subsidized by 50 percent will not use terracing when they must pay all costs associated with it. Scenario three is also modeled for the 50-50 tenant only on the Jasper and Van Buren county farms. It is assumed that this tenant pays only terrace maintenance costs. No tenant solutions were solved for which the tenant pays no terracing costs, as he would select many terracing activities that the landlord would not find profitable.

Under T-value restrictions COMMM and corn-soybean-corn-oats-meadow-meadow (CBCOMM) rotations under slot-plant tillage and contouring on SMUs of C slope or steeper are the most profitable crop management systems for all operators and the 50-50 landlord. All E slope soils are taken out of production when all terracing costs must be paid by the landowner. The solutions for the 50-50 landlord are compatible with those of the 50-50 tenant except that it is more profitable for the landlord to have the COMMM rotations stripcropped under conventional tillage since this crop management system also achieves T-value and his herbicide costs are lower than for the slot-plant contour system. This presents no insurmountable problems in reality, as only half of the herbicide costs are involved.

Under T-value restrictions the parties of the 35-65 lease are very incompatible, reflecting the landlord's total disassociaton with costs. Continuous corn (C) under slot- or till-planting and contouring and corn-corn-oats-meadow-meadow (CCOMM) under slot-or till-planting and strip cropping on the more erosive soils are most profitable for the 0-35 landlord. The landlord's farm plans are much less profitable (or even unprofitable) to the 100-65 tenant than the more meadow-intensive rotations the tenant prefers to produce (see Appendix C).

Given a 50 percent subsidy for terrace installation costs, terracing is profitable to landowners on only SMU 24E2 on the Jasper County farm. On this SMU, terracing allows the landowner to raise COMMM with slot-planting on the contour at a "marginal" net return ($21.14/acre for the owner-operator) with the 50 percent subsidy. Even a 50 percent terrace installation subsidy will not allow a tenant to install terraces profitably. The model summaries for which the 50-50 tenant assumes terrace maintenance costs indicate that a tenant can profitably bear such costs on erosive soils that are fairly productive.

In all cases, the imposition of the T-value restrictions reduces net returns to the tenure party and/or the equivalent whole farm net returns for the selected farm plans as compared to the solutions of scenario two. The magnitude of the reduction varies in proportion to the amount of erosive soils on the farm; net returns are reduced by as much as 30 percent for tenure parties on the highly erosive Ida County farm. This is a result of the adoption of more meadow-intensive rotations under the herbicide intensive slot-plant tillage system and also taking more land out of production. It is clear that levels of cost-sharing higher than 50 percent on terrace installations are necessary to allow profitable production of corn-soybean rotations on most slopes C and steeper under T-value restrictions. Also, the slot-and till-plant systems in conjuction with contouring on slopes C and steeper are the most economical and effective systems in meeting these restrictions.

Soil Loss Taxes and Economics of Soil and Water Conservation Practices

In scenarios five, six, and seven, the tenure parties are assumed to maximize 1985 before-tax net returns subject to per acre soil loss taxes of \$.50, \$1.00, and \$3.00, respectively. All modeled crop management systems are available to the decisionmakers. These scenarios are modeled for the owner-operator on all farms and for the leasing parties on the Jasper and Van Buren county farms.

Under a \$.50 soil loss tax the decisionmakers generally use slot-planting (and contouring on slopes C and steeper) on SMUs under a CB rotation if soil loss is six tons (or more) less than that under the till-plant system (there is a trade-off between the tax and the herbicide costs which are about \$3.00 more for the slot-plant than the till-plant systems under the CB rotation). The 50-50 tenant needs little incentive to switch from till- to slot-plant systems on any of the SMUs (refer to sensitivity section). On some of the more erosive soils COMMM becomes more profitable than the CB rotation under the \$.50 tax as it has a lower soil erosion level and a fairly high net return. Again, the 0-35 landlord's desired farm plan diverges from that of his tenant; continuous corn rotations are more profitable for him under the \$.50 tax than the more meadow intensive rotations.

Under scenarios six and seven, all operators and the 50-50 landlord continue to adopt more meadow intensive rotations, generally under slot-plant tillage. On some SMUs, a chisel-plow system is more profitable for the 50-50 landlord than the slot-plant tillage system if the soil movement levels are similar, since his share of the herbicide costs are less under the former system. He and his tenant are otherwise compatible except that production on the most erosive slopes may be unprofitable for the tenant. Continuous corn rotations remain most profitable for the 0-35 landlord, until at the $3.00 tax the COMMM rotations become more profitable on his more erosive soils.

It is apparent (see Appendix A) that when the tenants or the 50-50 landlord are solely burdened with the entire soil loss tax, it is more profitable for them to adopt more meadow intensive rotations than the owner-operator does under the same tax rate.

Taxes are an effective means to reduce soil erosion levels; they also reduce net returns. As can be seen in Appendix C, the $.50 tax reduces soil movement from the levels of scenario two by 60 to 85 percent (depending on who is the decisionmaker) for the three more erosive farms. This tax generally reduces net returns and the counterpart's equivalent net returns (e.g., the landlord's net returns corresponding to the farm plan selected by his tenant) by three to eight percent from corresponding net returns in scenario two. The magnitude of the reduction corresponds to the erosiveness of the farm. The $3.00 soil movement tax generally reduces soil losses to T-values and reduces net returns by 15 percent or more for the more erosive farms. Taxing the tenant appears to result in farm plans more consistent with those of the owner-operator. On both the Jasper and Van Buren county farms, the landlord suffers no reduction in net returns from the tenant's farm plan in scenario two when the tenant is taxed at the $.50/ton rate.

Sensitivity of the Tenure Models

Tables showing the sensitivity of costs and prices for the tenure models under scenario two are given in Appendix B. These tables show the activity level, input cost (value appearing in the objective function for that activity) and the range of the input cost for which the level of that activity will remain unchanged in the solutions of scenario two. For example, the upper cost for an input (e.g., buy nitrogen) or a production activity (e.g., CB, till-plant, contour, 120C2) represents the largest negative value (since it is a cost) that can occur in the objective function without changing the level of the activity in the solution. In the selling activities, (e.g., sell corn grain) the "costs" are positive (negative costs) since they represent revenues. The upper cost, therefore, represents the lowest price, and the lower cost represents the highest price, that can occur in the objective function without changing the level of that selling activity.

Any narrow range of upper and lower costs or one of either costs very close in value to the input cost indicates that this activity is sensitive to costs and prices. Insensitive activities would indicate that the models are more applicable to a wide range of cost and price scenarios than if they are very sensitive.

In general, the owner-operator models indicate some degree of sensitivity between the till- and slot-plant systems, i.e., they generally differ in cost by about $3.00 for a corn-soybean rotation. The remaining tillage systems display even less sensitivity, e.g., approximately

$13.00 difference between conventional and till-plant systems and $8.00 difference between chisel-plow and till-plant systems. Most of the inputs display fairly moderate sensitivity, except, for example, diesel fuel on the Jasper County farm and medium term capital on the Van Buren County farm which appear to be more sensitive to prices. Also, output prices display fair insensitiveness except on the Van Buren county farm where the upper costs on corn and soybean selling activities are fairly close to the objective function values.

The 50-50 tenant's cropping practices, in general, are extremely sensitive to herbicide costs, diesel, and capital costs, reflecting the sensitivity between the till- and slot-plant tillage sytems. As mentioned previously, this is a result of the sharing of herbicide costs and the fact that the slot-plant system requires more herbicides and less diesel and machine and repair costs than the till-plant system. In general, the 50-50 tenant's cropping systems are as, or less, sensitive to other costs and output prices than the owner-operator solutions.

The apparent sensitivity of the production activities to costs in the 50-50 landlord models results from the fact that his costs are the same for all tillage systems except the slot-plant system. These model solutions appear to be no more sensitive to input and output prices than the owner-operator solutions.

In general, the 100-65 tenant's cropping systems appear no more sensitive to costs with respect to tillage systems than do those of the owner-operator, since this tenant also pays all costs. The COMMM, slot-plant, contour activity on SMU 24E2 on the Jasper County farm is very sensitive because the costs are identical to the same rotation and tillage activity under the strip cropping supporting practice. The tenant's model solutions are naturally more sensitive to output prices than are those of the owner-operator because the 100-65 tenant is receiving only 65 percent of the total product.

Conclusions

Several studies have associated higher levels of soil erosion with leased land. This study indicates that, given certain assumptions on cost and returns sharing, in many instances it may be profitable for a tenant to farm in a less erosive manner than an owner-operator.

The least intensive tillage systems are most profitable for tenants as well as owner-operators. On the more erosive soils analyzed, tenants may also have higher net returns from meadow-intensive rotations than from the CB rotations which are most profitable to an owner-operator. Under the customary cost and returns sharing arrangements in Iowa, production on the most erosive soils may be unprofitable for a tenant. Of course farmers would not be inclined to rent highly erosive soils unless they come in a package with less erosive soils.

This analysis indicates that terracing, even when subsidized at the 50 percent level, is seldom profitable for an owner-operator. It is no more profitable for the landlord as an individual, and extremely unprofitable for a tenant alone. Adopting less erosive rotations are generally more profitable for tenants under T-value restrictions or soil loss taxes. It may, however, be profitable for tenants to share some terracing costs on fairly productive soils.

Of course, under ideal leasing arrangements which satisfy the previously mentioned conditions, the subsidy necessary to induce adoption of terracing by the leasing parties would match that of the owner-operator. This study indicates that cost-sharing above the 50 percent level is necessary to make terracing a profitable activity for any landowner and/or operator on most erosive soils.

CHAPTER IV. EFFECTS OF CAPITAL CONSTRAINTS AND COSTS ON USE OF SOIL AND WATER CONSERVATION PRACTICES

Borrowing has long been an important source of capital for farmers (Brake and Melichar, 1977). Because of increases in prices of land and conventional farm inputs and the adoption of new labor saving technologies, liabilities of the farming sector increased from $53 billion in 1970 to $174.6 billion in 1981, an increase of 229 percent (USDA, 1982).

The models of the previous chapter assumed that the owner-operator and leasing parties could borrow unlimited amounts of capital at a 15 percent annual interest rate under an environment of "certainty". There are many instances in reality in which a landowner or operator may for some reason use levels of non-real estate capital lower than levels used in the previous chapters.

Basically there are two reasons why a farmer may not borrow or use an amount of capital that would approximately equate its marginal costs with marginal returns (Heady, 1952). The first is the degree of risk aversion inherent in the individual and the rate of discount he psychologically attributes to future returns based upon his perceptions of risk and uncertainty. Restricted capital usage resulting from a farmer's risk averseness or other choice criteria is called internal capital rationing. The second reason is that capital may be rationed to the farmer by credit firms or sources, referred to as external capital rationing. External capital rationing generally reflects the risk response of the credit firm to the same risks and uncertainties that the farmer faces, in addition to risk associated with the farmer as a manager and borrower. It may also result from unavailability of capital in the money markets at the bank level.

Baker (1968), and Barry and Baker (1971) have developed the "credit reserve" concept as one explanation of why farmers internally ration capital. They have described a credit reserve as the difference between capital limits imposed by external credit rationing and the amount actually borrowed by the individual farmer. Such credit reserves are viewed by farmers as a source of liquidity and play a role very similar to insurance in managing farm business risk. Like insurance, a credit reserve has costs and benefits associated with it. The costs are the expected benefits foregone by not utilizing the credit which is maintained as a reserve. The benefits are the liquidity the reserve provides to the firm.

Recently, the original Barry and Baker portfolio-analysis model has been expanded to account for credit risks, such as variability in interest rates and loan fund availability at rural banks, that farmers have been subjected to from the mid-70s to the present (Barry, Baker, and Sanint, 1981). These authors conclude that credit risk, in the same manner as commodity price and yield risks, in most circumstances leads a risk-averse farmer to less debt usage than when his credit availability and costs are certain.

Research has also been done on factors influencing external capital rationing. In general a farmer's creditworthiness, based on such things as asset values, income and repayment potential, management and personal characteristics, as well as lender preferences (e.g., equipment vs. livestock loans) and overall capital availability in the financial markets, determine the extent of external credit rationing imposed upon the farmer by lending institutions. Such financial factors are often translated into "rule-of-thumb" credit limits such as lenders' willingness to loan up to 75 percent of farmland's current market value, to loan up to 75 percent of a crop's expected sale value, and to aim for an overall debt-equity ratio not to exceed 1.0. Also, the orders in which loans for particular types of items and from different sources are obtained are important in determining the amount of credit a farmer may obtain (Irwin and Baker, 1962). For example, the farmer can generally obtain more credit if cattle are financed before machinery, and also by going to the Production Credit Association (PCA) before merchants and dealers. Sonka, Dixon, and Jones (1980), using a lender survey-case study approach, found that the borrower's net worth and income-generating potential are major determinants of credit-generating capacity. They also found that short-term equity (current assets minus current liabilities) and the farmer's leverage ratio (debt/net worth) also are determinants, but that the degree to which these factors affect credit-generating capacity depend on the degree of "conservatism" or "liberalism" inherent in the lender. Barry, Baker, and Sanint (1981) also used a lender survey analysis to study credit risks that farmers may be subjected to by lenders. They found that operating credit appears more stable than capital credit, but that reduction in availability of operating credit may lead to farmer responses such as reductions in operating inputs or changes in enterprises in order to remain viable operations. They also report that capital credit availability is strongly linked to business performance (at least in the previous year), and that restricting capital credit rather than charging higher loan interest rates is a favored means of financial control for lenders.

It is fairly obvious that many factors can cause an operator or a landlord to contribute less capital (either borrowed or equity) to the farm enterprises than the amount that would equate its marginal cost with marginal revenues. Whether the restriction results from a risk response of the individual, an external credit limitation, a household-firm conflict (e.g., buying a car vs. investing in a no till-planter), or some combination of the above, in reality the above mentioned equation is seldom attained. The focus of the analysis in this chapter will be on how short-term and total capital constraints affect the selection of crop-management systems by the farm operators and thus their effects on soil erosion. Also, effects of short-term capital constraints on the 50-50 landlord's crop management selections will be modeled. Because the 0-35 landlord contributes no operating capital, and since terracing did not enter solutions voluntarily in chapter three scenarios, total capital is not constrained for either landlord.

It was shown in an earlier study that the landlord and tenant under a crop-share lease can reach agreement on a farm plan in absence of livestock production activities if each party has roughly the same relative capital limitations (Heady, Dean, and Egbert, 1956). For purposes of this study the various types of capital were constrained within the LP models at arbitrary percentages of the capital levels utilized in the model solutions of scenario two. The focus of the analysis is more on effects of the capital constraints on economics of the soil and water conservation practices rather than the lease party compatibility.

The first scenario (scenario eight in Appendix A) assumes that the operator or landlord maximizes 1985 before-tax net returns subject to a constraint on the amount of short-term capital available to him (short-term capital is requried for such inputs as seed, fuels, pesticides, fertilizers, repairs, etc.). The operator or landlord may choose his farm plan using any combination of rotations, tillage systems, and supporting practices. The following restrictions based on percentage of short-term capital used in scenario two by the respective operator or landlord are modeled and solved: (1) 90 and 80 percent of the short-term capital used by the owner-operator in scenario two are available to the owner-operator in scenarios 8A1 and 8A2, respectively; (2) 85 percent for the 50-50 tenant; (3) 85 percent (scenario 8D1) and

The 50-50 tenant, when rationed on short-term capital, also puts his less productive soils in COMMM and pasture rotations or takes them out of production entirely. However, the slot-plant tillage system is always the most profitable system for this tenant on the meadow-intensive rotation. As pointed out in Chapter II, his sharing the pesticide costs with the landlord often makes the slot-plant system his most profitable tillage system.

COMMM rotations are also most profitable for the 50-50 landlord when his short-term capital is limited. However, he would generally prefer that the tenant use conventional tillage rather than slot-planting because the former requires less pesticides than any of the other tillage systems on this crop rotation. Such discrepancy in the choice of tillage systems between the 50-50 lease parties results from the landlord's dis-association with fuel and other machine costs.

The 100-65 tenant reacts similarly to the owner-operator in his rotation and tillage system selection when his short-term capital is limited. The main difference is that pasture is often more profitable for him than COMMM on many soils of C slope or greater when his short-term capital is limited. Also production on many of the E slope soils may be unprofitable for him.

In scenario nine, in which the operators are allowed to maximize 1985 net returns subject to total (non-real estate) capital constraints and the availability of all crop-management systems, the owner-operator and 100-65 tenant solutions are very much like those in scenario two.

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The only difference is that some land is taken out of production because of the lack of capital. The corn-soybean till-plant system, on the contour on slopes C and greater, remains the most profitable crop-management system. Although the till-plant system requires slightly more capital than the slot-plant system, net returns are enough higher that it is still the most profitable system for the farm as a whole.

When total non-real estate capital is a constraint, corn-soybean production and not producing on less productive soils are most profitable for the 50-50 tenant. However, since he shares the pesticide costs with his landlord and the slot-plant system requires less total capital per acre than the till-plant system, the slot-plant system is most profitable for his whole farm plan.

It is interesting to see what happens to income and soil movement (assuming land taken out of production has zero soil movement) when the total capital is constrained for each operator based on the total capital he used in scenario two. Looking at Table 7, we can see that for the two most erosive farms (in Jasper and Ida counties), reducing total capital available to the owner-operator by 10 percent and the tenants by 15 percent reduces net returns by 5.3 and 6.6 or less, respectively. This decrease in net returns is a direct result of taking very erosive soils with very low returns out of production. Also, taking these erosive soils out of row-crop production substantially reduces whole farm soil movement levels, assuming zero soil movement on idle land.

Table 7. Income and soil movement changes under non-real estate capital restrictions

		Farm							
		Boone		Van Buren		Jasper		Ida	
Scenario	Capital	Net Returns[a]	Soil Loss[b]	Net Returns	Soil Loss	Net Returns	Soil Loss	Net Returns	Soil Loss
2A		68,754	497	35,587	5,084	71,366	11,658	35,650	18,456
9A		62,361	319	35,567	4,656	67,595	8,706	34,135	12,348
% reduction	(10)	(9.3)	(35.8)	(0.1)	(8.6)	(5.3)	(25.3)	(4.2)	(33.1)
2B		25,161	372	11,675	4,134	25,852	9,735	9,747	5,851
9B		22,313	96	10,516	992	24,514	2,497	9,379	2,455
% reduction	(15)	(11.3)	(74.2)	(9.9)	(76.0)	(5.2)	(74.4)	(3.8)	(58.0)
2D		27,637	497	12,470	4,134	28,327	9,067	9,206	8,337
9D		23,848	319	10,897	3,100	26,470	7,918	8,717	3,650
% reduction	(15)	(13.7)	(35.8)	(11.9)	(25.0)	(6.6)	(12.7)	(5.3)	(56.2)

[a]Net returns over fixed costs other than land.

[b]Total tons of soil loss for the farm.

The net returns for the Boone county farm are reduced almost equivalently to the percentage reduction in capital availability because all these soils are very productive and provide high net returns per acre. Similarly, on the Van Buren farm the owner-operator's net returns fall only slightly when total capital is constrained because he has taken a low net return SMU (65E2) out of production. The capital restriction merely eliminates the need for the capital he was using to produce pasture under scenario two. The tenants used no capital on SMU 65E2 in scenario two, so constraining their total capital by the selected method used in scenario nine had a much greater effect on their net returns than for the owner-operator. Generally the highly erosive soils have very low net returns potential, yet do require substantial capital for production. The significance of this will be expanded in the policy implication chapter.

Effects of Capital Costs on Soil and Water Conservation Practice Use

In general, the owner-operator and 100-65 tenant models are fairly insensitive to capital costs (see Appendix B). The model solutions indicate that at very high short-term interest rates and very low medium-term interests rates, COMMM rotations would begin to enter the solutions for scenario two. Since such an occurrence is unlikely (interest rates generally move together), it appears that normal ranges of interest rates will not affect soil erosion significantly. The 50-50 tenant solutions are similar in that slightly higher short-term and slightly lower medium term interest rates make the till-plant tillage system for a given rotation more profitable than the slot-plant tillage system, and vice versa.

Summary

Under situations in which short-term capital is constrained, these models indicate that most farm plans would utilize more meadow-intensive rotations such as COMMM under either chisel-plow or slot-plant tillage and no supporting practices. The amount of COMMM that could actually be expected to be raised by farmers is most likely over-estimated in these model results for three reasons: (1) the COMMM rotations require substantially greater amounts of medium-term capital than corn-bean rotations, (2) these models do not allow for different levels of fertilization on the various rotations, and (3) market effects of the increased meadow production are not accounted for. In actuality, farmers may be more inclined to reduce fertilization levels on certain soils in the corn-soybean rotation than to adopt so much meadow production. Also, meadow production implies that a livestock production enterprise exists that will utilize this roughage feed, a rather bold assumption.

Scenario nine perhaps gives a more realistic example of what operators might do under internal or external capital constraints. The operators generally take their least productive soils out of production, and the most profitable cropping system is still the corn-soybean rotation using till-planting on the contour on SMUs of slope C and steeper. This last scenario gives an approximation of the effect capital rationing has on farm size, which will be further discussed in the following chapter.

In conclusion, capital constraints cause less intensive crop rotations and conservation tillage systems such as the till- and slot-plant systems to be even more economically attractive than when capital is unlimited. Although terracing is not economical under unlimited capital, capital restrictions obviously make it even less attractive. Capital costs do not appear to substantially affect soil and water conservation practices.

CHAPTER V. EFFECTS OF FARM SIZE ON SOIL AND WATER CONSERVATION PRACTICES

Farm numbers in the United States have been declining for over the past four decades, accompanied by a greater concentration of farming in larger units. The reasons for this transformation are numerous. Some of them are: (1) greater employment and income opportunities off the farm; (2) tax rules encouraging firm growth; (3) government price support and supply restriction policies favoring larger producers; (4) price incentives for farmers to substitute capital goods for labor and the concurring enterprise specialization; (5) the encouragement of firm growth caused by inflation and expectations of further inflation in the 1970s; (6) the accumulation of wealth during this period enabling individuals to expand into larger farm units; (7) farm credit policies; (8) developments in machinery technology, and (9) cost efficiencies associated with farm size. Although there is no guarantee that such factors encouraging larger farms will continue into the future, and although the annual decrease in number of farms has declined from 3.5 percent in the early 60s to 0.7 percent in the late 70s (Schertz and Wunderlich, 1982), many people believe the past trend will continue. One recent study estimates that the total number of farms in the year 2000 is expected to be 1.75 million, down from the 2.5 million farms existing in 1980 (Lin, Coffman, and Penn, 1980).

Many issues have been raised concerning the consequences to society of declining farm numbers and the simultaneous growth in average farm size. Past research has shown that larger and fewer farms can be expected to stagnate or depress rural economies, raise individual farm incomes, lower total farm income, and benefit consumers through lower commodity prices (Sonka and Heady, 1974). Other issues such as equal distribution of farm wealth and political objectives of agriculture and the rural community may hinge on the farm size/number situation.

Although the issue has existed for some years, the effects farm size have on use of soil and water conservation practices has recently regained public interest. Held and Timmons (1958) in a study of erosion on Western Iowa farms, found that larger farms had lower levels of soil movement than smaller farms. In the most recent study of this series, Hauser (1976) reaffirmed this relationship.

More recently, using data from the land ownership survey (Lewis, 1980) mentioned earlier, Lee (1980) and Otte (1982) both found that high farm income was related to low soil loss. Baron (1981), using the same data, found a positive relation between conservation investment and both size of land holding and farm income.

Such results by no means assure that with large size farms must come more conservation practices and less soil erosion. It is the intent in this chapter to merely point out some economic reasons why and why not larger farms may be expected to be less erosive than smaller farms. Today it is becoming more and more difficult to define a farm. Are the several 160-acre tracts that a doctor owns and leases out at various locations outside the city a farm? How should the 500 acres the farmer rents, in addition to the 1000 acres he owns, be classified? This study refers to a farm unit as all land farmed under one management with a specific machinery and equipment complement. This analysis begins by discussing economic theory relating to determination of the "optimal" size of firm.

Theory of Farm Size, Efficiency

One of the most important determinants of farm size in a static context (i.e. prices and technologies are given) is the shape of the long run average cost curve, or envelope curve, and the position of the minimum long run average cost on that curve.

The long run is defined as a time period in which no factors of production are fixed; the short-run is a period in which at least one factor is fixed. The long run average cost curve is simply the curve tangent to the family of short-run average cost curves representing minimum average costs per unit of output for various "plant sizes" representing different amounts of the fixed resource(s), given a set of prices and technologies. A typical U-shaped short run average cost curve (SAC) is illustrated in Figure 1. The downward sloping part represents fuller utilizaton of the fixed plant, or resource, and spreading of the fixed costs over more and more output. The rising portion of the curve results from having to apply larger and larger proportions of variable inputs to the fixed resource to gain additional units of output (this assumes diminishing marginal productivity).

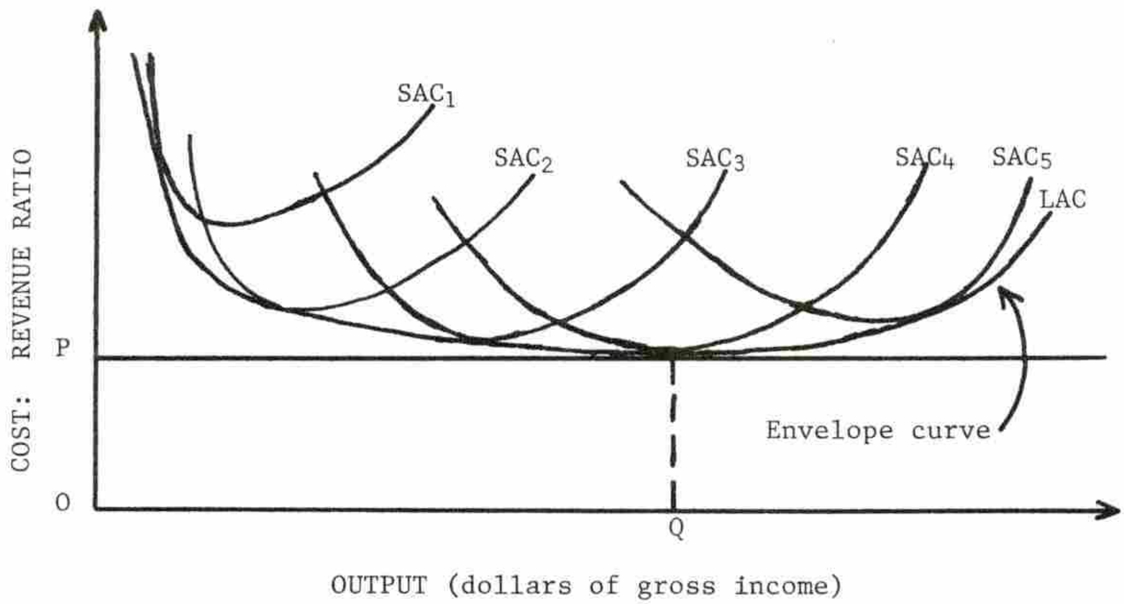

Figure 3. Theoretical illustration of short-run average cost curves and envelope curve

Given the long-run average cost curve illustrated in Figure 1, it would appear that a short-run plant (or farm) of the size represented by SAC4 is capable of achieving the lowest average costs per unit of output (i.e., is the most cost efficient size), since it is tangent to the lowest point on the long-run average cost curve.

Of course in reality cost efficiency is not the only factor influencing farm size. Many things in fact tend to restrict the size that many growing farm units actually achieve. The above theoretical case supposes a competitive environment and many other assumptions (perfect knowledge, mobility and homogeneity of resources, ease of entry into the industry, etc.). In reality, knowledge is not perfect--farmers are uncertain of prices, labor availability, weather conditions, economic conditions in general, capital availability, and many other things. In addition, the indivisibility of some resources, such as a large tractor or a tract of land, or unavailability of land in local real estate markets, may prevent a farmer's reaching the most cost efficient size. Also, even though larger scale may mean more technical and pecuniary economies than those realized in the average size farms, managerial ability may impose limitations on the size a farm may attain.

Literature Review Relating to Farm Size Theory

Much research has been done in attempts to determine the relationship between farm size and cost efficiency for many types of farms, and also the role this possible efficiency may play in promoting farm growth. Several studies on this topic are Seckler and Young (1978), Bailey (1973), Stanton (1978), Hall and LeVeen (1978), Miller, Rodewald and McElroy (1981), Chan, Heady, and Sonka (1976), Heady and Krenz (1962), Ihnen and Heady (1964), and Madden and Partenheimer (1972). The general concensus of the authors of these studies is that the long-run average cost curve for midwest grain farms, whether it includes land and labor charges or not, tends to be L-shaped, i.e., production costs decline rapidly with initial increase in size and then level off or decline at a very low rate. Little evidence is found of increasing costs as farm sizes get very large. Stanton (1978) stated that "It has been easier to identify what makes this cost curve fall than to discover evidence or demonstrate economic logic that shows long-run costs rising after some point" (pg. 730). Heady and Krenz (1962) incorporated costs associated with reduced yields resulting from untimeliness of operations in a farm size-efficiency study analyzing different sets of machine complements in Iowa. They found that the envelope curve developed for their assumed technology and production functions exhibited rapidly increasing per-unit costs at farm sizes above 800 crop acres. Of course, there have been phenomenal increases in machine size and technology since that study. Seckler and Young sum up the farm size-efficiency topic as follows: "Increasing average farm size does not necessarily imply the presence of economies of size; it only implies the absense of significant diseconomies of size" (p. 581).

The general conclusion presented in several of the above studies is that most all of the efficiencies associated with farm size can be attained in a fully mechanized one-man farm in which the maximum acreage of crops, subject to the capability of the man and his machinery complement, is produced. Bailey (1973) states that "the technically optimum one-man farm is larger, requires more capital, and demands a higher level of managerial talent than is found on most one-man farms today in the United States" (p. v).

Any slight additional cost efficiencies that are realized on farms of larger size appear to result from better management, large farms having access to higher-quality resources, and slightly (if any) greater market access and availability of premium prices (Hall and LeVeen, 1978).

The main reasons associated with farms increasing in size above this range in which most economies can be realized are the desires to increase income, enlarge the bundle of resources that the operator or family controls, and gain increased prestige in the community. The main factors restricting the frequency of growth to very large farm sizes are: limitations in managerial and coordinating abilities; uncertainties associated with commodity and resource prices, weather, crop disasters, and labor supply; limited availability of capital or internal capital rationing because of risks; and unavailability of land in local areas.

Discussion

The main point that can be extracted from the above studies and applied to how farm size may affect use of soil and water conservation practices is that about costs per unit of output. There is no evidence that there are significant cost differences between "average" farm sizes such as are modeled in this study and those of much larger farms.

Even smaller farms do not have to incur much higher costs per unit of output if they can hire the cropping activities done on a custom basis (Hall and LeVeen, 1978).

Further analysis of per acre crop production costs can provide additional support to the argument in progress. In crop farming, most of the variable costs such as seed, fertilizer, and pesticides are the same per acre and per unit of output regardless of farm size. The costs that do vary according to farm size are the "fixed" costs of the machine and equipment set that is used on the farm. The above discussion, which demonstrates the relatively flat long-run average cost curve, suggests that it is possible to fit machine sets to varying farm sizes to approximate relatively equal per acre or per unit of output machine costs on farms of varying sizes, save for the very smallest farms. In the context of our study, if in fact larger farms do realize lower average levels of soil movement, it could be the result of more superior or conscientious management that has adopted the more economical till and slot-plant systems for their farm operations. In addition to having higher returns to land, labor, and management, these two tillage systems always require less labor than the conventional fall mold-board plow, chisel-plow, and spring-disk tillage systems on the various rotations. Also, these systems require much less time in the critical spring planting period on the corn-soybean rotation, as no pre-plant field preparation is required.

As for the adoption of terracing or other structures that appear to be non-profitable in a short-run context, there is also no reason a priori that a large farmer should implement such soil and water conservation practices any more frequently than a smaller farmer.

As mentioned in the previous chapter, a larger asset base may give a larger farmer access to more funds. In addition, investments in soil and water conservation practices such as terracing may be slightly more attractive to a person in a higher tax bracket. However, large farm size (measured in either acres or net farm income) is not a reliable indicator of a farmer's financial situation. For example, large farmers can be in low equity, tight cash flow situations, and small farmers may have an off-farm job or somehow have acquired wealth. One exception must be made to the above statement. Theoretically, as the acreage of the farm increases, any costs and benefits of externalities associated with soil loss and delivery to streams from the farms are increasingly internalized to the farm firm. This internalizaton becomes more important as the farm expands contiguously. Since land markets infrequently allow such expansion, this factor associated with farm size probably has a limited influence on adoption of soil and water conservation practices in reality.

Other factors may actually inhibit the adoption of soil and water conservation practices on large farms. It is conceivable that the use of tillage equipment 60 feet in width may be incompatible with such practices as contouring and terracing. It is important to note that terracing is fairly effective in reducing soil movement, yet as our models indicate, is quite unprofitable or has high opportunity costs in a short-run analysis. Contouring, although an assumed activity in our models for the till- and slot-plant tillage systems on SMUs of slope C or steeper, is only slightly or moderately effective in curbing soil movement on most SMUs of C or steeper slope as measured by the Universal Soil Loss Equation. Therefore, the possible machine-supporting practice incompatiblity would not result in erosion levels significantly greater on larger farms than for the moderatly sized farms modeled in this study.

Conclusions

It appears that if larger farms actually are less erosive than small and average sized farms in general, the main causal factor is management. More skillful management may realize and take advantage of the cost economies offered by the reduced tillage systems. Operating most cost efficiently may also give a farmer with high management skills an advantage in acquiring less erosive, more productive lands. Finally, a larger asset base may give a farmer access to more funds than the average farmer, which could enable him to invest more heavily in soil and water conserving structures.

CHAPTER VI. STUDY LIMITATIONS, POLICY IMPLICATIONS

There are several limitations of this study that must be understood to adequately interpret the results and in giving consideration to policy implications. Many deal with lack of sufficient data--others deal with the many assumptions that were made in the model construction.

It was assumed that farm owners and/or operators are solely maximizers of single-period net returns. Many landowners and farmers have much longer planning horizons and may satisfy other choice criteria such as net worth (wealth), cash flows, after tax net income, or household utility. For a discussion of economics of soil and water conservation practices under longer planning horizons, see Bhide, Pope, and Heady (1982).

The Universal Soil Loss Equation (USLE) was used as a measurement device for average annual soil loss. This equation approximates soil movement or displacement caused by rainfall, and in many cases overestimates soil loss from the field or farm boundaries. Soil erosion caused by wind is not accounted for in the models.

Only terracing, strip cropping, and contouring are included in the models. Other supporting practices such as catch basins, ridge planting or listing, and catch crops bordering streams may be effective ways to reduce soil erosion and/or sediment delivery. Also, there are many other variations in tillage methods and crop rotations used in Iowa. Only the more popular tillage systems and crop rotations representing different erosiveness levels were modeled.

Sufficient data are not available to accurately predict long-term effects of soil loss on productivity. These single-period models therefore attribute no reductions to productivity from soil erosion, which may bias slightly the profitability of terracing. More research is necessary in ascertaining the effects of soil losses on the future productivity potentials for many soil types.

In these models, is it assumed that all coefficients (resource constraints, prices, technical production, soil loss, etc.) are known with certainty. In reality most of these coefficients are variable, so an attempt is made to use the average values or best estimates for these coefficients based on historical data. The model solutions for scenario two appear to be moderately sensitive to input and output prices. However, much of the sensitivity is between the till- and slot-plant tillage systems rather than crop rotations (see the sensitivity section of Chapter III). Large variations in relative prices could undoubtedly alter the uses of soil and water conservation practices from those of the model solutions of scenario two.

Also, since conclusive evidence to the contrary does not exist, it is assumed that yields do not differ across tillage systems and supporting practices. If yield differences between tillage systems do exist on certain soils for some technical reason or lack of managerial ability, the solution results might also change (see Pope, Bhide, and Heady, 1982c).

This analysis ignores the effects of livestock on the economics of soil and water conservation practices. The landowners and/or operators are given markets for alfalfa, oats, straw, and pasture. Silage is not sold as it is seldom grown as a cash crop in Iowa. If a tenant or an owner-operator who rents additional land has a livestock enterprise in addition to his cash crop enterprise, his use of soil and water conservation practices may differ according to the type of livestock raised and the most profitable ration fed to the livestock. For example, if an owner-operator who rents additional land feeds steers using a silage ration, he may be inclined to raise the erosive silage rotations on the landlord's farm if so allowed. For a discussion of the effects of livestock and dairy enterprises on the economics of soil and water conservation practices, see Krog, Bhide, Pope, and Heady (1982).

Under soil loss restrictions and short-run capital limitations the owner-operators and tenant-operators may produce much more meadow and pasture. Since the modeled market prices reflect current market conditions, large quantities of alfalfa and pasture production would surely not support these price levels, i.e. there are not enough roughage consuming animals in local markets to utilize such high production.

In linear programming models, production activities represent one mix of inputs and outputs in fixed proportions. Because of the large data requirements, only one resource mix considered to be technically "optimal" was included in the models for the activity consisting of a rotation, tillage system, and supporting practice. Under certain leasing arrangements or when resources such as capital are a constraint, different resource mixes (e.g., using less fertilizer on a corn-soybean rotation) may be more profitable overall for the operator or the owner than the "optimal" cropping system that is modeled.

Also, these models include annual machinery ownership and variable costs for the machine complements based on time required for field operations. Costs involved in switching from one tillage system to another are not accounted for. For example, although most modern row-crop planters can economically be adapted to till- or slot-planting, the farmer may find that the opportunity costs (or reservation prices) of his moldboard and chisel plows are very low, possibly salvage value. Other costs such as managerial training may be involved in adopting the new tillage systems. Of course, potential benefits such as more leisure time are also not accounted for.

Policy Implications

It is evident that in many areas of Iowa soil erosion is occurring at very high levels. Although data are not yet present to accurately estimate the relationship between soil erosion and soil productivity, enough evidence exists today to assure that at some point soil loss reduces potential soil productivity. For the time being, soil scientists have assumed that T-values represent a "safe" soil loss level. The major objective of soil and water conservation policies is to encourage and help farmers to approach these soil loss goals in a manner least costly to farmers and society. Policy alternatives include education and technical assistance, cost-sharing and subsidies, disincentives such as taxes or fines on soil erosion, and direct regulation of the cultural pratices that farmers may use. Policy formulation must also account for effects that tenure arrangements, capital restrictions, and farm size may have in influencing the attractiveness to farmers of various soil and water conservation practices.

Results of this study indicate that use of reduced tillage systems such as the till- and slot-plant systems can actually increase net returns to operators and substantially reduce soil erosion levels from corresponding levels under conventional tillage systems. Farmers should be encouraged to adopt such practices through the extension of information concerning the cost and time-saving advantages of these systems, and also through the provision of technical assistance. Also more intensive yield research is necessary to assure that reduced tillage systems will not lead to reduced yields on erosive-prone Iowa soils. There is no indication that such policy need differ with respect to tenure of operator or his capital availability, or farm size. The cost economies of the till- and slot-plant tillage systems are at least as attractive to tenants as to owner-operators. Also, these tillage systems require less capital than conventional systems utilizing moldboard and chisel plows, field cultivators, disks, and other tillage equipment.

On many Iowa soils, supporting practices such as terracing and strip-cropping, and meadow-intensive rotations are required in addition to reduced tillage systems to reduce soil erosion levels to T-values. This study indicates that an owner-operator with unlimited capital would have to be subsidized at levels greater than 50 percent to find terracing profitable on many of the SMUs analyzed if regulated to T-levels. If cost-sharing on structural investments between leasing parties is successfully promoted, there will be no need to subsidize the tenant and landlord to any greater degree. Also, guarantees for unexhausted investments and/or longer leases should be encouraged to make longer term investments such as terracing and meadow rotations more attractive to lease parties.

Given markets for meadow and pasture, crop-share tenants appear to adopt less erosive rotations more readily on the highly erosive soils. Policies and programs which aid marketing of hay and pasture should be given consideration by policymakers. However, it is very likely that policies supporting extensive hay and pasture production could prove to be costly to farmers and/or society. The large acreages of these crops that are necessary to bring soil losses in Iowa to T-values would surely depress market prices, burdening farmers if unsubsidized or society if subsidies are granted to farmers for production of these crops.

Terracing, even when used in conjunction with reduced tillage practices, does not reduce the slope and slope length of many soils enough to constrain soil losses to T-values when corn and soybeans are grown in rotation on them. Research should be devoted to developing more economically and technically effective soil erosion reducing practices that create and/or maintain structures on a continuous basis via field operations. Practices such as till- and slot-planting and cultivating on ridges and the contour could prove very useful in reducing soil losses in row crop production.

Based on past research findings, it appears that policies to restrict farm size cannot be justified on soil erosion issues.

Solutions from the capital constraint analysis emphasize the fact that many of the most erosive soils analyzed produce low net returns. On many of these soils net returns from meadow rotations are close to or higher than returns from corn-soybean rotations. It makes little sense to invest public funds on terracing soils for which expected returns will not cover the structure costs. These soils could be targeted for set-aside lands or wildlife areas if meadow and pasture rotations cannot contain soil erosion on them.

CHAPTER VII. SUMMARY AND CONCLUSIONS

The current levels of soil erosion in Iowa are contaminating streams and lakes, harming wildlife, and reducing future soil productivity potentials. Past studies have attempted to associate such variables as tenure, capital availability, and farm size to soil erosion levels using cross sectional data from farmer and landowner surveys. This study analyzes how the above variables may be expected to affect the economics of soil and water conservation practices utilized by Iowa farmers that greatly determine soil erosion levels.

The framework of the analysis consists of linear-programming models representing four cash crop farms in Iowa that vary in erosiveness class, land resource area, watershed, and principal soil association. These models incorporate various crop management systems consisting of five tillage systems, three supporting practices, and eight crop rotations, representing popular soil and water conservation practices used in Iowa and a wide range of erosiveness levels. The five modeled tillage systems include conventional fall moldboard plow, chisel plow, spring disk, till-plant, and slot-plant. The three supporting practices include terracing, strip cropping, and contouring. Also, grass waterways are assumed to be used where necessary. Crop rotations including several combinations of corn-grain, soybeans, oats, meadow, and pasture are modeled. Crop yields are assumed to be equal across tillage systems and supporting practices, and they are not reduced to reflect decreased productivity resulting from soil erosion. Soil losses are approximated for each crop management system using the Universal Soil Loss Equation.

These models are solved to maximize 1985 before tax net returns to an owner-operator, and to the landlords and tenants of two crop share leases used in Iowa. Solutions are obtained for scenarios representing various assumptions about farmers' willingness and ability to use certain soil and water conservation practices, capital constraints, soil loss restrictions, and soil loss taxes.

Conclusions

In all modeled scenarios, the owner operator and both leasing parties generally raise as much corn and soybeans in rotation on most SMUs as constraints will allow. However, on some very erosive soils on which meadow and pasture rotations are more productive, these forages may provide higher net returns than the corn-soybean rotation. This is true even more so for crop-share tenants. The more variable costs the tenant must assume, the more marginal land he will put into meadow and pasture rotations or take out of production, and the more incompatible he will become with his landlord in farm planning. As a result, the crop-share tenants appear to be less erosive cash crop farmers than owner-operators when only short-run profits are considered.

Given the willingness and ability to use all soil and water conservation practices, reduced tillage systems such as the till- and slot-plant systems are more profitable than conventional tillage systems for all farm operators. Corn and soybean rotations raised with these tillage systems on the contour on slopes C and steeper are most profitable on most Iowa soils. These tillage systems allow greater net returns and lower soil erosion levels for most rotations than do conventional tillage systems.

When soil loss taxes or restrictions are imposed upon farmers, more lands are put into meadow and pasture rotations or taken out of production entirely rather than terraced to allow production. Such restrictions and penalties also lower net returns. The results of this analysis indicate that many landowners will have to be subsidized at levels greater than 50 percent to find terracing a profitable enterprise when restrained to T-values (soil loss levels that allow maintenance of soil productivity). Also, tenants may find it economically beneficial to share terracing costs on more productive, erosive soils if constrained to T-values.

This analysis indicates that low capital availability can result in lower levels of soil erosion, either by making meadow intensive rotations more economical or by forcing unproductive, erosive soils out of production. Any capital provided to farmers for erosion control purposes should be targeted at encouraging adoption of reduced tillage systems or terracing on soils that warrant such costs.

Survey studies have associated lower soil erosion levels with larger farms. If this is a true relationship, it is most likely caused by better management of crop systems. To a lesser degree, greater capital availability and possibly higher tax brackets may make structural investments more possible or attractive for larger farmers. Also, larger farmers may control less erosive soils than smaller farmers.

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APPENDIX A: TENURE MODEL SOLUTIONS FOR VARIOUS SCENARIOS

Table A.1. Boone County tenure summaries

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
				conventional tillage					
1A[a]	107A1	144	28,293	196.48	0	0	CB	conv	none
	55A1	80	17,598	219.98	0	0	CB	conv	none
	138B1	74	14,621	197.58	542	7.33	CB	conv	none
	138C2	22	3,868	175.86	540	24.55	CB	conv	none
Farm Total		**320**	**64,382**	**201.19**	**1,082**	**3.38**			
1B[b]	107A1	144	9,024	62.67	0	0	CB	conv	none
	55A1	80	5,936	74.20	0	0	CB	conv	none
	138B1	74	4,678	63.22	542	7.33	CB	conv	none
	138C2	22	1,151	52.33	540	24.55	CB	conv	none
Farm Total		**320**	**20,789**	**64.97**	**1,082**	**3.38**			
1C[c]	107A1	144	19,270	133.82	0	0	CB	conv	none
	55A1	80	11,662	145.78	0	0	CB	conv	none
	138B1	74	9,943	134.36	542	7.33	CB	conv	none
	138C2	22	2,718	123.53	540	24.55	CB	conv	none
Farm Total		**320**	**43,593**	**136.23**	**1,082**	**3.38**			
1D[d]	107A1	144	10,038	69.71	0	0	CB	conv	none
	55A1	80	6,711	83.89	0	0	CB	conv	none
	138B1	74	5,240	70.81	542	7.33	CB	conv	none
	138C2	22	1,280	58.18	53	2.41	COMMM	conv	none
Farm Total		**320**	**23,269**	**72.72**	**595**	**1.86**			
1E[e]	107A1	144	18,255	126.77	0	0	CB	conv	none
	55A1	80	10,887	136.09	0	0	CB	conv	none
	138B1	74	9,381	126.77	542	7.33	CB	conv	none
	138C2	22	2,595	117.97	540	24.55	CB	conv	none
Farm Total		**320**	**41,118**	**128.49**	**1,082**	**3.38**			

[a]"A" represents owner-operator solutions.
[b]"B" represents 50-50 tenant solutions.
[c]"C" represents 50-50 landlord solutions.
[d]"D" represents 100-65 tenant solutions.
[e]"E" represents 0-35 landlord solutions.

Table A.1. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
				-all soil and water conservation practices-					
2A	107A1	144	30,263	210.16	0	0	CB	till	none
	55A1	80	18,693	233.66	0	0	CB	till	none
	138B1	74	15,633	211.25	319	4.31	CB	till	none
	138C2	22	4,166	189.35	178	8.09	CB	till	contour
Farm Total		**320**	**68,754**	**214.86**	**497**	**1.55**			
2B	107A1	144	10,993	76.34	0	0	CB	till	none
	55A1	80	7,030	87.87	0	0	CB	till	none
	138B1	74	5,690	76.89	319	4.31	CB	till	none
	138C2	22	1,448	65.83	53	2.43	CB	slot	contour
Farm Total		**320**	**25,161**	**78.63**	**372**	**1.16**			
2C	107A1	144	19,270	133.82	0	0	CB	till	none
	55A1	80	11,662	145.78	0	0	CB	till	none
	138B1	74	9,943	134.36	319	4.31	CB	till	none
	138C2	22	2,718	123.53	178	8.09	CB	till	contour
Farm Total		**320**	**43,593**	**136.23**	**497**	**1.55**			
2D	170A1	144	12,008	83.39	0	0	CB	till	none
	55A1	80	7,806	97.57	0	0	CB	till	none
	138B1	74	6,252	84.49	319	4.31	CB	till	none
	138C2	22	1,571	71.39	178	8.09	CB	till	contour
Farm Total		**320**	**27,637**	**86.37**	**497**	**1.55**			
2E	107A1	144	18,255	126.77	0	0	CB	till	none
	55A1	80	10,887	136.09	0	0	CB	till	none
	138B1	74	9,381	126.77	319	4.31	CB	till	none
	138C2	22	2,595	117.97	178	8.09	CB	till	contour
Farm Total		**320**	**41,118**	**128.49**	**497**	**1.55**			

Table A.1. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - T-values, 50 percent subsidy on terrace installation costs - - - - - - - - - -									
3A[f] & 4A	107A1	144	30,263	210.16	0	0	CB	till	none
	55A1	80	18,693	233.66	0	0	CB	till	none
	138B1	74	15,601	210.83	172	2.33	CB	till	contour
	138C2	22	4,101	186.41	53	2.43	CB	slot	contour
Farm Total		**320**	**68,657**	**214.55**	**225**	**0.71**			
4B	107A1	144	10,993	76.34	0	0	CB	till	none
	55A1	80	7,030	87.87	0	0	CB	till	none
	138B1	74	5,687	76.85	96	1.30	CB	slot	none
	138C2	22	1,448	65.83	53	2.43	CB	slot	contour
Farm Total		**320**	**25,158**	**78.62**	**149**	**0.47**			
4C	107A1	144	19,270	133.81	0	0	CB	till	none
	55A1	80	11,662	145.78	0	0	CB	till	none
	138B1	74	9,943	134.36	172	2.33	CB	till	contour
	138C2	22	2,653	120.58	53	2.43	CB	slot	contour
Farm Total		**320**	**43,528**	**136.03**	**225**	**0.70**			
4D	107A1	144	12,008	83.39	0	0	CB	till	none
	55A1	80	7,806	97.57	0	0	CB	till	none
	138B1	74	6,220	84.06	172	2.33	CB	till	contour
	138C2	22	1,506	68.44	53	2.43	CB	slot	contour
Farm Total		**320**	**27,540**	**86.06**	**225**	**0.70**			
4E	107A1	144	18,255	126.77	0	0	CB	till	none
	55A1	80	10,887	136.09	0	0	CB	till	none
	138B1	74	9,381	126.77	172	2.33	CB	till	contour
	138C2	22	2,595	117.97	53	2.43	CB	slot	contour
Farm Total		**320**	**41,118**	**128.49**	**225**	**0.70**			

[f] No subsidy on terracing in scenario 3A.

Table A.1. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - soil loss taxes - - -									
5A	107A1	144	30,263	210.16	0	0	CB	till	none
($.50/ton)	55A1	80	18,693	233.66	0	0	CB	till	none
	138B1	74	15,515	209.66	172	2.33	CB	till	contour
	138C2	22	4,077	185.31	178	8.09	CB	till	contour
Farm Total		**320**	**68,547**	**214.21**	**350**	**1.09**			
6A	107A1	144	30,263	210.16	0	0	CB	till	none
($1.00/ton)	55A1	80	18,693	233.66	0	0	CB	till	none
	138B1	74	15,429	208.50	172	2.33	CB	till	contour
	138C2	22	4,048	183.98	53	2.43	CB	slot	contour
Farm Total		**320**	**68,432**	**213.85**	**225**	**0.71**			
7A	107A1	144	30,263	210.16	0	0	CB	till	none
($3.00/ton)	55A1	80	18,693	233.66	0	0	CB	till	none
	138B1	74	15,227	205.77	52	0.70	CB	slot	contour
	138C2	22	3,941	179.13	53	2.43	CB	slot	contour
Farm Total		**320**	**68,123**	**212.88**	**105**	**0.33**			
- - - short-term capital constraints - - -									
8A1	107A1	144	30,263	210.16	0	0	CB	till	none
(10% of 2A)	55A1	62.9	12,696	201.85	0	0	COMMM	slot	none
	55A1	17.1	3,996	233.66	0	0	CB	till	none
	138B1	74	13,458	181.87	18	0.24	COMMM	slot	none
	138C2	22	3,539	160.87	32	1.44	COMMM	chisel	none
Farm Total		**320**	**63,952**	**199.85**	**50**	**0.16**			
8A2	107A1	128	22,115	172.77	0	0	COMMM	slot	none
(20% of 2A)	107A1	16	3,363	210.16	0	0	CB	till	none
	55A1	80	16,148	201.85	0	0	COMMM	slot	none
	138B1	74	13,458	181.87	18	0.24	COMMM	slot	none
	138C2	22	3,539	160.87	32	1.44	COMMM	chisel	none
Farm Total		**320**	**58,623**	**183.20**	**50**	**0.16**			

Table A.1. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - - - - - - - -short-term capital constraints - - - - - - - - - - - - - - - - - -									
8B	107A1	144	10,993	76.34	0	0	CB	till	none
(15% of 2B)	55A1	38.4	2,850	74.21	0	0	COMMM	slot	none
	55A1	41.6	3,655	87.87	0	0	CB	till	none
	138B1	74	4,769	64.45	18	0.24	COMMM	slot	none
	138C2	22	332	15.09	21	0.96	P	conv	none
Farm Total		**320**	**22,599**	**70.62**	**39**	**0.12**			
8C	107A1	136.8	15,616	114.15	0	0	COMMM	conv	none
(25% of 2C)	107A1	7.2	0	0	0	0	--	----	----
	55A1	80	10,321	129.01	0	0	COMMM	conv	none
	138B1	74	8,790	118.79	53	0.72	COMMM	conv	none
	138C2	22	0	0	----	----	--	----	----
Farm Total		**320**	**34,727**	**108.52**	**53**	**0.17**			
8D1	107A1	144	12,007	83.38	0	0	CB	till	none
(15% of 2D)	55A1	69.8	5,787	82.91	0	0	COMMM	slot	none
	55A1	10.2	995	97.57	0	0	CB	till	none
	138B1	74	5,287	71.45	18	0.24	COMMM	slot	none
	138C2	22	320	14.56	21	0.96	P	conv	none
Farm Total		**320**	**24,396**	**76.24**	**39**	**0.12**			
8D2	107A1	110.9	9,247	83.38	0	0	CB	till	none
(25% of 2D)	107A1	33.1	507	15.31	0	0	P	conv	none
	55A1	80	6,633	82.91	0	0	COMMM	slot	none
	138B1	74	5,287	71.45	18	0.24	COMMM	slot	none
	138C2	22	320	14.56	21	0.96	P	conv	none
Farm Total		**320**	**21,994**	**68.73**	**39**	**0.12**			

Table A.1. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - - - - - - - total capital constraints - - - - - - - - - - - - - - - - - -									
9A	107A1	133.4	28,035	210.16	0	0	CB	till	none
(10% of 2A)	107A1	10.6	0	0	----	----	--	----	----
	55A1	80.0	18,693	233.66	0	0	CB	till	none
	138B1	74.0	15,633	211.25	319	4.31	CB	till	none
	138C2	22.0	0	0	----	----	--	----	----
Farm Total		**320**	**62,361**	**194.88**	**319**	**1.00**			
9B	107A1	125.8	9,599	76.30	0	0	CB	slot	none
(15% of 2B)	107A1	18.2	0	0	0	0	--	----	----
	55A1	80	7,027	87.84	0	0	CB	slot	none
	138B1	74	5,687	76.85	96	1.30	CB	slot	none
	138C2	22	0	0	----	----	--	----	----
Farm Total		**320**	**22,313**	**69.73**	**96**	**0.30**			
9D	107A1	117.4	9,790	83.39	0	0	CB	till	none
(15% of 2D)	107A1	26.6	0	0	----	----	--	----	----
	55A1	80	7,806	97.57	0	0	CB	till	none
	138B1	74	6,252	84.49	319	4.31	CB	till	none
	138C2	22	0	0	----	----	--	----	----
Farm Total		**320**	**23,848**	**74.53**	**319**	**1.00**			

Table A.2. Van Buren County tenure summaries

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
conventional tillage									
1A[a]	65E2	144	45	0.31	950	6.60	P	conv	none
	131B1	108	18,673	172.90	1,290	11.94	CB	conv	none
	132C2	108	14,039	129.99	5,738	53.13	CB	conv	none
Farm Total		**360**	**32,756**	**90.99**	**7,978**	**22.16**			
1B[b]	65E2	144	0	0	----	----	--	----	----
	131B1	108	5,570	51.57	1,290	11.94	CB	conv	none
	132C2	108	3,275	30.32	5,738	53.13	CB	conv	none
Farm Total		**360**	**8,845**	**24.57**	**7,028**	**19.52**			
1C[c]	65E2	144	3,135	21.77	2,375	16.49	COMMM	conv	none
	131B1	108	13,104	121.33	1,290	11.94	CB	conv	none
	132C2	108	10,764	99.67	5,738	53.40	CB	conv	none
Farm Total		**360**	**27,003**	**75.01**	**9,403**	**26.12**			
1D[d]	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,137	56.82	1,290	11.94	CB	conv	none
	132C2	108	3,508	32.48	563	5.21	COMMM	conv	none
Farm Total		**360**	**9,645**	**26.79**	**1,853**	**5.15**			
1E[e]	65E2	144	4,303	29.88	3,799	26.38	COMMM	conv	none
	131B1	108	12,537	116.08	1,290	11.94	CB	conv	none
	132C2	108	10,636	98.48	5,738	53.13	CB	conv	none
Farm Total		**360**	**27,476**	**76.32**	**10,827**	**30.08**			

[a] "A" represents owner-operator solutions.
[b] "B" represents 50-50 tenant solutions.
[c] "C" represents 50-50 landlord solutions.
[d] "D" represents 100-65 tenant solutions.
[e] "E" represents 0-35 landlord solutions.

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
			-all soil and water conservation practices-						
2A	65E2	144	45	0.31	950	6.60	P	conv	none
	131B1	108	20,099	186.10	759	7.03	CB	till	none
	132C2	108	15,444	143.00	3,375	31.25	CB	till	contour
Farm Total		**360**	**35,587**	**98.85**	**5,084**	**14.12**			
2B	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,995	64.77	759	7.03	CB	till	none
	132C2	108	4,680	43.33	3,375	31.25	CB	till	contour
Farm Total		**360**	**11,675**	**32.43**	**4,134**	**11.48**			
2C	65E2	144	3,135	21.77	2,375	16.49	COMMM	conv	none
	131B1	108	13,104	121.33	759	7.03	CB	till	none
	132C2	108	10,764	99.67	3,375	31.25	CB	till	contour
Farm Total		**360**	**27,003**	**75.01**	**6,509**	**18.08**			
2D	65E2	144	0	0	----	----	--	----	----
	131B1	108	7,562	70.02	759	7.03	CB	till	none
	132C2	108	4,808	44.52	3,375	31.25	CB	till	contour
Farm Total		**360**	**12,370**	**34.36**	**4,134**	**11.48**			
2E	65E2	144	4,303	29.88	808	5.61	COMMM	slot	contour
	131B1	108	12,537	116.08	409	3.79	CB	till	contour
	132C2	108	10,636	98.48	3,375	31.25	CB	till	contour
Farm Total		**360**	**27,476**	**76.32**	**4,592**	**12.76**			

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - - **T-values, 50% subsidy on terrace installation costs** - - - - - - - - - - - - -									
3A[f] & 4A	65E2	144	0	0	----	----	--	----	----
	131B1	108	19,771	183.06	228	2.11	CB	slot	none
	132C2	**108**	**12,585**	**116.53**	**191**	**1.77**	**COMMM**	**slot**	**contour**
Farm Total		**360**	**32,356**	**89.88**	**419**	**1.94**			
3B[g] & 4B	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,987	64.69	228	2.11	CB	slot	none
	132C2	**108**	**3,487**	**32.29**	**191**	**1.77**	**COMMM**	**slot**	**contour**
Farm Total		**360**	**10,474**	**29.09**	**419**	**1.16**			
4C	65E2	144	0	0	----	----	--	----	----
	131B1	108	12,784	118.37	228	2.11	CB	slot	none
	132C2	**108**	**9,246**	**85.61**	**112**	**1.04**	**COMMM**	**conv**	**strip**
Farm Total		**360**	**22,030**	**61.19**	**340**	**0.94**			
4D	65E2	144	0	0	----	----	--	----	----
	131B1	108	7,234	66.98	228	2.11	CB	slot	none
	132C2	**108**	**3,636**	**33.67**	**191**	**1.77**	**COMMM**	**slot**	**contour**
Farm Total		**360**	**10,870**	**30.19**	**419**	**1.16**			
4E	65E2	144	0	0	----		--	----	----
	131B1	108	12,537	116.08	228	2.11	CB	slot	none
	132C2	**108**	**9,077**	**84.05**	**169**	**1.56**	**CCOMM**	**till**	**strip**
Farm Total		**360**	**21,614**	**60.04**	**397**	**1.10**			

[f]No subsidy on terracing in scenario 3A.
[g]This tenant pays only maintenance costs for terracing.

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns		Tons Soil Loss		Rotation	Tillage System	Supporting Practice
			Per SMU	Per Acre	Per SMU	Per Acre			
-$.50/ton soil loss tax									
5A	65E2	144	0	0	----	----	--	----	----
	131B1	108	19,850	183.80	410	3.79	CB	till	contour
	132C2	108	14,617	135.34	1,013	9.38	CB	slot	contour
Farm Total		**360**	**34,467**	**95.74**	**1,423**	**6.58**			
5B	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,884	63.74	123	1.14	CB	slot	contour
	132C2	108	4,172	38.63	1,013	9.38	CB	slot	contour
Farm Total		**360**	**11,056**	**30.71**	**1,136**	**3.16**			
5C	65E2	144	2,534	17.60	807	5.61	COMMM	slot	strip
	131B1	108	12,899	119.43	410	3.79	CB	till	contour
	132C2	108	9,939	92.03	1,013	9.38	CB	slot	contour
Farm Total		**360**	**25,372**	**70.48**	**2,230**	**6.19**			
5D	65E2	144	0	0	----	----	--	----	----
	131B1	108	7,314	67.72	410	3.79	CB	till	contour
	132C2	108	3,981	36.86	1,013	9.38	CB	slot	contour
Farm Total		**360**	**11,295**	**31.38**	**1,423**	**3.95**			
5E	65E2	144	3,900	27.08	808	5.61	COMMM	slot	strip
	131B1	108	12,475	115.51	123	1.14	CB	slot	contour
	132C2	108	10,129	93.79	1,013	9.38	CB	slot	contour
Farm Total		**360**	**26,504**	**73.62**	**1,944**	**5.40**			

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - -	- - - - - -	- - - - -	- - - - -	**$1.00/ton soil loss tax**	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
6A	65E2	144	0	0	----	----	--	----	----
	131B1	108	19,645	181.90	410	3.79	CB	till	contour
	132C2	108	14,111	130.65	1,013	9.38	CB	slot	contour
Farm Total		**360**	**33,756**	**93.77**	**1,423**	**6.58**			
6B	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,822	63.17	123	1.14	CB	slot	contour
	132C2	108	3,666	33.94	1,013	9.38	CB	slot	contour
Farm Total		**360**	**10,488**	**29.13**	**1,136**	**3.16**			
6C	65E2	144	2,131	14.80	807	5.61	COMMM	slot	strip
	131B1	108	12,694	117.54	410	3.79	CB	till	contour
	132C2	108	9,432	87.34	1,013	9.38	CB	slot	contour
Farm Total		**360**	**24,257**	**67.38**	**2,230**	**6.19**			
6D	65E2	144	0	0	----	----	--	----	----
	131B1	108	7,109	65.82	410	3.79	CB	till	contour
	132C2	108	3,599	33.32	38	0.35	COMMM	slot	strip
Farm Total		**360**	**10,708**	**29.74**	**448**	**1.24**			
6E	65E2	144	3,495	24.27	808	5.61	COMMM	slot	contour
	131B1	108	12,414	114.94	123	1.14	CB	slot	contour
	132C2	108	9,895	91.62	338	3.13	C	slot	contour
Farm Total		**360**	**25,804**	**71.68**	**1,269**	**3.53**			

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
$3.00/ton soil loss tax									
7A	65E2	144	0	0	----	----	--	----	----
	131B1	108	19,361	179.27	123	1.14	CB	slot	contour
	132C2	108	12,470	115.46	38	0.35	COMMM	slot	strip
Farm Total		**360**	**31,831**	**88.42**	**161**	**0.45**			
7B	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,576	60.89	123	1.14	CB	slot	contour
	132C2	108	3,372	31.22	38	0.35	COMMM	slot	strip
Farm Total		**360**	**9,948**	**27.63**	**161**	**0.45**			
7C	65E2	144	516	3.58	807	5.61	COMMM	slot	strip
	131B1	108	12,416	114.96	123	1.14	CB	slot	contour
	132C2	108	9,023	83.55	68	0.63	COMMM	chisel	strip
Farm Total		**360**	**21,955**	**60.99**	**998**	**2.78**			
7D	65E2	144	0	0	----	----	--	----	----
	131B1	108	6,825	63.19	123	1.14	CB	slot	contour
	132C2	108	3,522	32.61	38	0.35	COMMM	slot	strip
Farm Total		**360**	**10,347**	**28.74**	**161**	**0.45**			
7E	65E2	144	1,881	13.06	808	5.61	COMMM	slot	contour
	131B1	108	12,168	112.67	123	1.14	CB	slot	contour
	132C2	108	9,221	85.38	338	3.13	C	slot	contour
Farm Total		**360**	**23,270**	**64.64**	**1,269**	**3.53**			

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - -	- - - - - -	- - - - - -	**short-term capital constraints**	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -	- - - - - -
8A1	65E2	144	0	0	----	----	--	----	----
(10% of 2A)	131B1	108	20,099	186.10	759	7.03	CB	till	none
	132C2	43	4,981	115.83	135	3.13	COMMM	chisel	none
	132C2	65	9,295	143.00	2,031	31.25	CB	till	contour
Farm Total		**360**	**34,375**	**95.49**	**2,925**	**8.13**			
8A2	65E2	144	0	0	----	----	--	----	----
(20% of 2A)	131B1	108	20,099	186.10	759	7.03	CB	till	none
	132C2	96.1	11,136	115.83	301	3.13	COMMM	chisel	none
	132C2	11.9	273	23.03	25	2.08	P	conv	none
Farm Total		**360**	**31,508**	**87.52**	**1,085**	**3.01**			
8B	65E2	144	0	0	----	----	--	----	----
(15% of 2B)	131B1	108	6,995	64.77	759	7.03	CB	till	none
	132C2	74.1	3,209	43.33	2,315	31.25	CB	till	contour
	132C2	33.9	335	9.86	71	2.08	P	conv	none
Farm Total		**360**	**10,539**	**29.28**	**3,145**	**8.74**			
8C	65E2	144	0	0	----	----	--	----	----
(25% of 2C)	131B1	108	13,104	121.33	409	3.79	CB	till	contour
	132C2	6.2	528	85.61	32	5.21	COMMM	conv	none
	132C2	101.8	10,149	99.67	3,182	31.25	CB	till	contour
Farm Total		**360**	**23,781**	**66.06**	**3,623**	**10.06**			
8D1	65E2	144	0	0	----	----	--	----	----
(15% of 2D)	131B1	108	7,562	70.02	759	7.03	CB	till	none
	132C2	71	3,161	44.52	2,219	31.25	CB	till	contour
	132C2	37	264	7.13	77	2.09	P	conv	none
Farm Total		**360**	**10,987**	**30.52**	**3,055**	**8.47**			

Table A.2. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - short term capital constraints - - -									
8D2	65E2	144	0	0	----	----	--	----	----
(25% of 2D)	131B2	108	7,562	70.02	759	7.03	CB	till	none
	132C2	46.3	2,061	44.52	1,448	31.25	CB	till	contour
	132C2	61.7	439	7.13	129	2.09	P	conv	none
Farm Total		**360**	**10,062**	**27.95**	**2,336**	**6.49**			
- - - total capital constraints - - -									
9A	65E2	77.6	24	0.31	512	6.60	P	conv	none
(10% of 2A)	65E2	66.4	0	0	----	----	--	----	----
	131B1	108	20,099	186.10	759	7.03	CB	till	none
	132C2	108	15,444	143.00	3,375	31.25	CB	till	contour
Farm Total		**360**	**35,567**	**98.80**	**4,646**	**12.91**			
9B	65E2	144	0	0	----	----	--	----	----
(15% of 2B)	131B1	108	6,987	64.69	228	2.11	CB	slot	none
	132C2	81.5	3,529	43.32	764	9.38	CB	slot	contour
	132C2	26.5	0	0	----	----	--	----	----
Farm Total		**360**	**10,516**	**29.21**	**992**	**2.76**			
9D	65E2	144	0	0	----	----	--	----	----
(15% of 2D)	131B1	108	7,562	70.02	759	7.03	CB	till	none
	132C2	74.9	3,335	44.52	2,341	31.25	CB	till	contour
	132C2	33.1	0	0	----	----	--	----	----
Farm Total		**360**	**10,897**	**30.30**	**3,100**	**8.61**			

Table A.3. Jasper County tenure summaries

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
				conventional tillage					
1A[a]	120C2	204	43,569	213.57	9,575	46.94	CB	conv	none
	162D2	68	11,958	175.85	5,574	81.97	CB	conv	none
	119A1	34	8,820	259.41	0	0	CB	conv	none
	24E2	34	2,607	76.69	458	13.46	COMMM	conv	none
Farm Total		**340**	**66,954**	**196.92**	**15,607**	**45.90**			
1B[b]	120C2	204	14,494	71.05	9,575	46.94	CB	conv	none
	162D2	68	3,574	52.56	5,574	81.97	CB	conv	none
	119A1	34	3,195	93.97	0	0	CB	conv	none
	24E2	34	362	10.64	458	13.46	COMMM	conv	none
Farm Total		**340**	**21,625**	**63.60**	**15,607**	**45.90**			
1C[c]	120C2	204	29,074	142.52	9,576	46.94	CB	conv	none
	162D2	68	8,384	123.29	5,574	81.97	CB	conv	none
	119A1	34	5,625	165.43	0	0	CB	conv	none
	24E2	34	2,431	71.50	4,670	137.34	CB	conv	none
Farm Total		**340**	**45,514**	**133.86**	**19,820**	**58.29**			
1D[d]	120C2	204	16,298	79.89	9,575	46.94	CB	conv	none
	162D2	68	3,953	58.13	546	8.04	COMMM	conv	none
	119A1	34	3,648	107.28	0	0	CB	conv	none
	24E2	34	344	10.13	458	13.46	COMMM	conv	none
Farm Total		**340**	**24,243**	**71.30**	**10,579**	**31.11**			
1E[e]	120C2	204	27,271	133.68	9,575	46.94	CB	conv	none
	162D2	68	8,022	117.97	5,574	81.97	CB	conv	none
	119A1	34	5,172	152.12	0	0	CB	conv	none
	24E2	34	2,586	76.06	4,669	137.34	CB	conv	none
Farm Total		**340**	**43,051**	**126.62**	**19,818**	**58.29**			

[a]"A" represents owner-operator solutions.
[b]"B" represents 50-50 tenant solutions.
[c]"C" represents 50-50 landlord solutions.
[d]"D" represents 100-65 tenant solutions.
[e]"E" represents 0-35 landlord solutions.

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
-all soil and water conservation practices-									
2A	120C2	204	46,271	226.82	5,632	27.61	CB	till	contour
	162D2	68	12,859	189.10	3,279	48.22	CB	till	contour
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	2,967	87.26	2,747	80.79	CB	till	contour
Farm Total		**340**	**71,366**	**209.90**	**11,658**	**34.29**			
2B	120C2	204	17,197	84.30	5,632	27.61	CB	till	contour
	162D2	68	4,475	65.81	3,279	48.22	CB	till	contour
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	536	15.77	824	24.24	CB	slot	contour
Farm Total		**340**	**25,852**	**76.04**	**9,735**	**28.63**			
2C	120C2	204	29,074	142.52	5,632	27.61	CB	till	contour
	162D2	68	8,384	123.29	3,279	48.22	CB	till	contour
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	2,431	71.50	2,747	80.79	CB	till	contour
Farm Total		**340**	**45,514**	**133.86**	**11,658**	**34.29**			
2D	120C2	204	19,001	93.14	5,632	27.61	CB	till	contour
	162D2	68	4,837	71.13	3,279	48.22	CB	till	contour
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	392	11.54	156	4.58	COMMM	slot	contour
Farm Total		**340**	**28,327**	**83.31**	**9,067**	**26.67**			
2E	120C2	204	27,271	133.68	5,632	27.61	CB	till	contour
	162D2	68	8,022	117.97	3,279	48.22	CB	till	contour
	119A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	2,586	76.06	2,747	80.79	CB	till	contour
Farm Total		**340**	**43,051**	**126.62**	**11,658**	**34.29**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - -T-values, no terrace installation subsidy- - - - - - -									
3A	120C2	204	41,193	201.93	939	4.60	CBCOMM	slot	contour
	162D2	68	10,986	161.56	186	2.73	COMMM	slot	contour
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**61,448**	**180.73**	**1,125**	**3.31**			
3B[f]	120C2	204	16,618	81.46	963	4.72	CB	slot	terrace
	162D2	68	3,686	54.21	186	2.73	COMMM	slot	contour
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	333	9.78	82	2.40	COMMM	slot	terrace
Farm Total		**340**	**24,281**	**71.41**	**1,231**	**3.62**			
3C	120C2	204	26,155	128.21	939	4.60	CBCOMM	slot	contour
	162D2	68	7,394	108.73	164	2.41	COMMM	conv	strip
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**39,174**	**115.22**	**1,103**	**3.24**			
3E	120C2	204	26,504	129.92	563	2.76	C	slot	contour
	162D2	68	7,042	103.56	131	1.93	CCOMM	slot	strip
	119A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**38,718**	**113.88**	**694**	**2.04**			

[f] This tenant pays only maintenance costs for terracing.

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - - T-values, 50% subsidy on terrace installation costs - - - - - - - - - - - - -									
4A	120C2	204	41,193	201.93	939	4.60	CBCOMM	slot	contour
	162D2	68	10,986	161.56	56	0.82	COMMM	slot	strip
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	719	21.14	82	2.40	COMMM	slot	terrace
Farm Total		**340**	**62,167**	**182.84**	**1,077**	**3.16**			
4B	120C2	204	15,037	73.71	939	4.60	CBCOMM	slot	contour
	162D2	68	3,686	54.21	186	2.73	COMMM	slot	contour
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**22,367**	**65.79**	**1,125**	**3.31**			
4C	120C2	204	26,155	128.21	939	4.60	CBCOMM	slot	contour
	162D2	68	7,394	108.73	164	2.41	COMMM	conv	strip
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	607	17.86	82	2.40	COMMM	slot	terrace
Farm Total		**340**	**39,781**	**117.00**	**1,185**	**3.49**			
4D	120C2	204	16,355	80.17	939	4.60	CBCOMM	slot	contour
	162D2	68	4,041	59.43	186	2.73	COMMM	slot	contour
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	0	0	----	----	----	----	----
Farm Total		**340**	**24,493**	**72.04**	**1,125**	**3.31**			
4E	120C2	204	26,504	129.92	563	2.76	C	slot	contour
	162D2	68	7,043	103.58	219	3.21	CCOMM	till	strip
	119A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	380	11.16	82	2.40	COMMM	slot	terrace
Farm Total		**340**	**39,099**	**115.00**	**864**	**2.54**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
-$.50 soil loss tax									
5A	120C2	204	44,821	219.71	1,690	8.28	CB	slot	contour
	162D2	68	12,165	178.90	984	14.46	CB	slot	contour
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	2,577	75.81	156	4.58	COMMM	slot	contour
Farm Total		**340**	**68,832**	**202.45**	**2,830**	**8.32**			
5B	120C2	240	16,351	80.15	1,690	8.28	CB	slot	contour
	162D2	68	3,982	58.56	984	14.46	CB	slot	contour
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	378	11.13	156	4.58	COMMM	slot	contour
Farm Total		**340**	**24,355**	**71.63**	**2,830**	**8.32**			
5C	120C2	204	27,626	135.42	1,690	8.28	CB	slot	contour
	162D2	68	7,691	113.10	984	14.46	CB	slot	contour
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	2,121	62.39	156	4.58	COMMM	slot	contour
Farm Total		**340**	**43,063**	**126.66**	**2,830**	**8.32**			
5D	120C2	204	17,550	86.03	1,690	8.28	CB	slot	contour
	162D2	68	4,143	60.93	984	14.46	CB	slot	contour
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	315	9.25	156	4.58	COMMM	slot	contour
Farm Total		**340**	**26,105**	**76.78**	**2,830**	**8.32**			
5E	120C2	204	26,426	129.54	1,690	8.28	CB	slot	contour
	162D2	68	7,541	110.90	328	4.82	C	slot	contour
	119A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	2,353	69.22	275	8.08	C	slot	contour
Farm Total		**340**	**41,492**	**122.04**	**2,293**	**6.74**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - -$1.00 soil loss tax- - - -									
6A	120C2	204	43,976	215.57	1,690	8.28	CB	slot	contour
	162D2	68	11,673	171.67	984	14.46	CB	slot	contour
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	2,500	73.52	156	4.58	COMMM	slot	contour
Farm Total		**340**	**67,418**	**198.29**	**2,830**	**8.32**			
6B	120C2	204	15,504	76.00	1,690	8.28	CB	slot	contour
	162D2	68	3,631	53.39	56	0.82	COMMM	slot	strip
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	301	8.84	156	4.58	COMMM	slot	contour
Farm Total		**340**	**23,080**	**67.88**	**1,902**	**5.59**			
6C	120C2	204	26,781	131.28	1,690	8.28	CB	slot	contour
	162D2	68	7,282	107.09	98	1.45	COMMM	chisel	strip
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	2,043	60.10	156	4.58	COMMM	slot	contour
Farm Total		**340**	**41,731**	**122.74**	**1,944**	**5.72**			
6D	120C2	204	16,706	81.89	1,690	8.28	CB	slot	contour
	162D2	68	3,985	58.61	56	0.82	COMMM	slot	strip
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	237	6.96	156	4.58	COMMM	slot	contour
Farm Total		**340**	**25,025**	**73.60**	**1,902**	**5.59**			
6E	120C2	204	25,941	127.16	563	2.76	C	slot	contour
	162D2	68	7,377	108.49	328	4.82	C	slot	contour
	19A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	2,216	65.18	275	8.08	C	slot	contour
Farm Total		**340**	**40,706**	**119.72**	**1,166**	**3.43**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- $3.00 soil loss tax -									
7A	120C2	204	40,597	199.01	1,690	8.28	CB	slot	contour
	162D2	68	10,819	159.10	56	0.82	COMMM	slot	strip
	119A1	34	9,269	272.61	0	0	CB	till	none
	24E2	34	2,188	64.36	156	4.58	COMMM	slot	contour
Farm Total		**340**	**62,873**	**184.92**	**1,902**	**5.59**			
7B	120C2	204	14,315	70.17	64	0.31	COMMM	slot	strip
	162D2	68	3,519	51.75	56	0.82	COMMM	slot	strip
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**21,478**	**63.17**	**120**	**0.35**			
7C	120C2	204	25,416	124.59	113	0.55	COMMM	chisel	strip
	162D2	68	7,133	104.90	56	0.82	COMMM	slot	strip
	119A1	34	5,625	165.43	0	0	CB	till	none
	24E2	34	1,732	50.95	156	4.58	COMMM	slot	contour
Farm Total		**340**	**39,906**	**117.37**	**325**	**0.96**			
7D	120C2	204	15,983	78.35	64	0.31	COMMM	slot	strip
	162D2	68	3,874	56.97	56	0.82	COMMM	slot	strip
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**23,954**	**70.45**	**120**	**0.35**			
7E	120C2	204	24,813	121.63	563	2.76	C	slot	cvontour
	162D2	68	6,778	99.67	56	0.82	COMMM	slot	strip
	119A1	34	5,172	152.12	0	0	CB	till	none
	24E2	34	1,796	52.83	156	4.58	COMMM	slot	contour
Farm Total		**340**	**38,559**	**113.41**	**775**	**2.28**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns		Tons Soil Loss		Rotation	Tillage System	Supporting Practice
			Per SMU	Per Acre	Per SMU	Per Acre			
- - - short-term capital constraints - - -									
8A1	120C2	204	46,271	226.82	5,632	27.61	CB	till	contour
(10% of 2A)	162D2	38.7	6,223	160.79	187	4.82	COMMM	chisel	none
	162D2	29.3	5,541	189.10	1,413	48.22	CB	till	contour
	119A1	34	9,269	272.61	0	0.0	CB	till	none
	24E2	34	505	14.86	183	5.39	P	conv	none
Farm Total		**340**	**67,809**	**199.44**	**7,415**	**21.81**			
8A2	120C2	130.4	25,480	195.40	360	2.76	COMMM	chisel	none
(20% of 2A)	120C2	73.6	16,694	226.82	2,032	27.61	CB	till	contour
	162D2	68	10,934	160.79	328	4.82	COMMM	chisel	none
	119A1	34	9,269	272.61	0	0.0	CB	till	none
	24E2	34	505	14.86	183	5.39	P	conv	none
Farm Total		**340**	**62,882**	**184.95**	**2,903**	**8.54**			
8B	120C2	21.4	1,525	71.11	33	1.56	COMMM	slot	contour
(15% of 2B)	120C2	182.6	15,389	84.30	5,040	27.61	CB	till	contour
	162D2	68	3,686	54.21	186	2.73	COMMM	slot	contour
	119A1	34	3,644	107.17	0	0	CB	till	none
	24E2	34	198	5.83	183	5.39	P	conv	none
Farm Total		**340**	**24,442**	**71.89**	**5,442**	**16.01**			
8C	120C2	204	25,792	126.43	939	4.60	COMMM	conv	none
(25% of 2C)	162D2	60	6,524	108.73	145	2.41	COMMM	conv	strip
	162D2	8	0	0	----	----	--	----	----
	119A1	34	4,901	144.14	0	0	COMMM	conv	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**37,217**	**109.46**	**1,084**	**3.19**			

Table A.3. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
8D1	120C2	204	19,001	93.14	5,632	27.61	CB	till	contour
(15% of 2D)	162D2	46.6	2,769	59.43	38	0.82	COMMM	slot	strip
	162D2	21.4	292	13.65	69	3.21	P	conv	none
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**26,159**	**76.94**	**5,739**	**16.88**			
8D2	120C2	9	707	78.53	25	2.76	COMMM	chisel	none
(25% of 2D)	120C2	195	18,162	93.14	5,384	27.61	CB	till	contour
	162D2	68	928	13.65	218	3.21	P	conv	none
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**23,894**	**70.28**	**5,627**	**16.55**			
- - - - - - - -	- - - -	- - - -	- - - **Total**	**capital**	**constraints**	- - - -	- - - -	- - - -	- - - -
9A	120C2	204	46,271	226.82	5,632	27.61	CB	till	contour
(10% of 2A)	162D2	63.7	12,055	189.10	3,074	48.22	CB	till	contour
	162D2	4.3	0	0	----	----	--	----	----
	119A1	34	9,269	272.61	0	0.0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**67,595**	**198.81**	**8,706**	**25.61**			
9B	120C2	204	17,195	84.29	1,689	8.28	CB	slot	contour
(15% of 2B)	162D2	55.9	3,678	65.80	808	14.46	CB	slot	contour
	162D2	12.1	0	0	----	----	--	----	----
	119A1	34	3,641	107.09	0	0	CB	slot	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**24,514**	**72.1**	**2,497**	**7.34**			
9D	120C2	204	19,001	93.14	5,632	27.61	CB	till	contour
(15% of 2D)	162D2	47.4	3,372	71.13	2,286	48.22	CB	till	contour
	162D2	20.6	0	0	----	----	--	----	----
	119A1	34	4,097	120.49	0	0	CB	till	none
	24E2	34	0	0	----	----	--	----	----
Farm Total		**340**	**26,470**	**77.85**	**7,918**	**23.29**			

Table A.4. Ida County tenure summaries

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - - - - - - - - -conventional tillage - - - - - - - - - - - - - - - - - - -									
1A[a]	1D3	47	3,907	83.14	4,257	90.57	CB	conv	none
	1E3	93	3,995	42.95	17,202	184.97	CB	conv	none
	10C2	56	8,083	144.33	2,162	38.61	CB	conv	none
	10D2	52	5,356	102.99	4,039	77.68	CB	conv	none
	12C1	62	10,648	171.74	2,681	43.25	CB	conv	none
Farm Total		**310**	**31,989**	**103.19**	**30,341**	**97.88**			
1B[b]	1D3	47	443	9.43	417	8.88	COMMM	conv	none
	1E3	93	453	4.87	675	7.25	P	conv	none
	10C2	56	2,097	37.44	2,162	38.61	CB	conv	none
	10D2	52	893	17.18	4,039	77.68	CB	conv	none
	12C1	62	3,162	51.00	2,681	43.24	CB	conv	none
Farm Total		**310**	**7,048**	**22.74**	**9,974**	**32.17**			
1C[c]	1D3	47	3,552	75.58	4,257	90.57	CB	conv	none
	1E3	93	5,124	55.10	17,202	184.97	CB	conv	none
	10C2	56	5,986	106.89	2,162	38.61	CB	conv	none
	10D2	52	4,463	85.82	4,039	77.68	CB	conv	none
	12C1	62	7,486	120.74	2,681	43.25	CB	conv	none
Farm Total		**310**	**26,611**	**85.84**	**30,341**	**97.87**			
1D[d]	1D3	47	416	8.85	417	8.88	COMMM	conv	none
	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,239	39.99	2,162	38.61	CB	conv	none
	10D2	52	908	17.47	396	7.62	COMMM	conv	none
	12C1	62	3,483	56.18	2,681	43.25	CB	conv	none
Farm Total		**310**	**7,046**	**22.73**	**5,656**	**18.25**			
1E[e]	1D3	47	3,713	78.99	4,257	90.57	CB	conv	none
	1E3	93	5,807	62.44	17,202	184.97	CB	conv	none
	10C2	56	5,844	104.35	2,162	38.61	CB	conv	none
	10D2	52	4,538	87.27	4,039	77.68	CB	conv	none
	12C1	62	7,165	115.56	2,681	43.25	CB	conv	none
Farm Total		**310**	**27,067**	**87.31**	**30,341**	**97.87**			

[a]"A" represents owner-operator solutions.
[b]"B" represents 50-50 tenant solutions.
[c]"C" represents 50-50 landlord solutions.
[d]"D" represents 100-65 tenant solutions.
[e]"E" represents 0-35 landlord solutions.

Table A.4. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
-all soil and water conservation practices-									
2A	1D3	47	4,509	95.93	2,504	53.28	CB	till	contour
	1E3	93	5,185	55.75	10,119	108.81	CB	till	contour
	10C2	56	8,641	154.30	1,484	26.50	CB	disk	none
	10D2	52	5,874	112.96	2,772	53.31	CB	disk	none
	12C1	62	11,441	184.54	1,577	25.44	CB	till	contour
Farm Total		**310**	**35,650**	**111.50**	**18,456**	**61.32**			
2B	1D3	47	957	20.36	2,504	53.28	CB	till	contour
	1E3	93	453	4.87	675	7.25	P	conv	none
	10C2	56	2,818	50.33	382	6.81	CB	slot	contour
	10D2	52	1,563	30.06	713	13.71	CB	slot	contour
	12C1	62	3,956	63.80	1,577	25.44	CB	till	contour
Farm Total		**310**	**9,747**	**31.44**	**5,851**	**18.87**			
2C	1D3	47	3,552	75.58	3,347	71.22	CB	till	contour
	1E3	93	5,124	55.10	10,119	108.81	CB	till	contour
	10C2	56	5,986	106.89	1,483	26.49	CB	disk	none
	10D2	52	4,463	85.82	2,783	53.51	CB	disk	none
	12C1	62	7,486	120.74	1,577	25.44	CB	till	contour
Farm Total		**310**	**26,611**	**85.84**	**19,309**	**62.29**			
2D	1D3	47	796	16.94	2,504	53.28	CB	till	contour
	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,797	49.95	1,484	26.50	CB	disk	none
	10D2	52	1,336	25.69	2,772	53.31	CB	disk	none
	12C1	62	4,277	68.98	1,577	25.44	CB	till	contour
Farm Total		**310**	**9,206**	**29.70**	**8,337**	**26.89**			
2E	1D3	47	3,713	78.99	2,504	53.28	CB	till	contour
	1E3	93	5,807	62.44	10,119	108.81	CB	till	contour
	10C2	56	5,844	104.35	1,484	26.50	CB	disk	none
	10D2	52	4,538	87.27	2,772	53.31	CB	disk	none
	12C1	62	7,165	115.56	1,577	25.44	CB	till	contour
Farm Total		**310**	**27,067**	**87.31**	**8,456**	**59.54**			

Table A.4. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - - - - - - - T-values, 50% subsidy on terrace installation costs - - - - - - - - - - - -									
3A & 4A	1D3	47	3,520	74.90	142	3.01	COMMM	slot	contour
	1E3	93	0	0	----	----	--	----	----
	10C2	56	7,313	130.60	212	3.78	CBCOMM	slot	contour
	10D2	52	4,680	90.00	135	2.59	COMMM	slot	contour
	12C1	62	9,539	153.86	263	4.24	CBCOMM	slot	contour
Farm Total		**310**	**25,053**	**80.82**	**752**	**2.42**			
4B	1D3	47	560	11.91	142	3.02	COMMM	slot	contour
	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,179	38.92	212	3.79	CBCOMM	slot	contour
	10D2	52	1,003	19.28	135	2.59	COMMM	slot	contour
	12C1	62	3,119	50.31	263	4.24	CBCOMM	slot	contour
Farm Total		**310**	**6,861**	**22.13**	**752**	**2.43**			
4C	1D3	47	3,025	64.36	125	2.66	COMMM	conv	strip
	1E3	93	0	0	----	----	--	----	----
	10C2	56	5,134	91.68	212	3.79	CBCOMM	slot	contour
	10D2	52	3,749	72.10	119	2.28	COMMM	conv	strip
	12C1	62	6,420	103.55	263	4.24	CBCOMM	slot	contour
Farm Total		**310**	**18,328**	**59.12**	**719**	**2.32**			
4D	1D3	47	468	9.96	142	3.02	COMMM	slot	contour
	1E3	93	0	0	----	----	--	----	---
	10C2	56	2,195	39.19	212	3.79	CBCOMM	slot	contour
	10D2	52	968	18.61	135	2.59	COMMM	slot	contour
	12C1	62	3,270	52.74	263	4.24	CBCOMM	slot	contour
Farm Total		**310**	**6,901**	**22.26**	**752**	**2.43**			
4E	1D3	47	3,158	67.19	167	3.55	CCOMM	till	strip
	1E3	93	0	0	----	----	--	----	----
	10C2	56	5,634	100.61	127	2.27	C	slot	contour
	10D2	52	4,369	84.01	238	4.57	C	slot	contour
	12C1	62	6,904	111.36	158	2.54	C	slot	contour
Farm Total		**310**	**20,065**	**64.73**	**690**	**2.23**			

[f]No subsidy on terracing in scenario 3A.

Table A.4. Ida County tenure summaries

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - soil loss taxes - - -									
5A	1D3	47	3,992	84.93	751	15.98	CB	slot	contour
($.50/ton)	1E3	93	3,786	40.71	573	6.17	COMMM	slot	contour
	10C2	56	8,448	150.86	381	6.81	CB	slot	contour
	10D2	52	5,516	106.07	713	13.71	CB	slot	contour
	12C1	62	11,018	177.71	473	7.63	CB	slot	contour
Farm Total		310	32,760	105.68	2,891	9.33			
6A	1D3	47	3,616	76.94	751	15.98	CB	slot	contour
($1.00/ton)	1E3	93	3,500	37.63	573	6.17	COMMM	slot	contour
	10C2	56	8,257	147.45	381	6.81	CB	slot	contour
	10D2	52	5,159	99.22	713	13.71	CB	slot	contour
	12C1	62	10,782	173.90	473	7.63	CB	slot	contour
Farm Total		310	31,313	101.01	2,891	9.33			
7A	1D3	47	3,393	72.18	43	0.91	COMMM	slot	strip
($3.00/ton)	1E3	93	2,353	25.30	573	6.17	COMMM	slot	contour
	10C2	56	7,494	133.82	382	6.81	CB	slot	contour
	10D2	52	4,559	87.67	40	0.78	COMMM	slot	strip
	12C1	62	9,835	158.63	473	7.63	CB	slot	contour
Farm Total		310	27,633	89.14	1,511	4.87			
- - - short-term capital constraints - - -									
8A1	1D3	47	4,509	95.93	2,504	53.28	CB	till	contour
(10% of 2A)	1E3	82.1	3,544	43.16	893	10.88	COMMM	chisel	none
	1E3	10.9	0	0	----	----	--	----	----
	10C2	56	8,641	154.30	1,484	26.50	CB	disk	none
	10D2	52	5,874	112.96	2,772	53.31	CB	disk	none
	12C1	62	11,441	184.54	1,577	25.44	CB	till	contour
Farm Total		310	34,009	109.71	9,230	29.77			

Table A.4. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
- - - - - - short-term capital constraints - - - - - -									
8A2	1D3	47	4,509	95.93	2,504	53.28	CB	till	contour
(20% of 2A)	1E3	34.4	1,486	43.16	375	10.88	COMMM	chisel	none
	1E3	58.6	0	0	----	----	--	----	----
	10C2	56	8,641	154.30	1,484	26.50	CB	disk	none
	10D2	52	5,874	112.96	2,772	53.31	CB	disk	none
	12C1	62	11,441	184.54	1,577	25.44	CB	till	contour
Farm Total		**310**	**31,951**	**103.07**	**8,712**	28.10			
8B	1D3	12.3	250	20.36	654	53.28	CB	till	contour
(15% of 2B)	1D3	34.7	0	0	----	----	--	----	----
	1E3	93	453	4.87	675	7.25	P	conv	none
	10C2	56	2,818	50.33	382	6.81	CB	slot	contour
	10D2	52	1,563	30.06	713	13.71	CB	slot	contour
	12C1	62	3,956	63.80	1,577	25.44	CB	till	contour
Farm Total		**310**	**9,040**	**29.16**	**4,001**	**12.91**			
8C	1D3	47	3,025	64.36	125	2.66	COMMM	conv	strip
(25% of 2C)	1E3	41	1,986	48.44	743	18.13	COMMM	conv	none
	1E3	52	0	0	----	----	--	----	----
	10C2	56	5,986	106.89	1,483	26.49	CB	disk	none
	10D2	52	3,749	72.10	119	2.28	COMMM	conv	none
	12C1	62	7,486	120.74	1,577	25.44	CB	till	contour
Farm Total		**310**	**22,232**	**71.71**	**4,047**	**13.05**			
8D1	1D3	12	203	16.94	638	53.27	CB	till	contour
(15% of 2D)	1D3	35	0	0	----	----	--	----	----
	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,797	49.95	1,484	26.50	CB	disk	none
	10D2	52	1,336	25.69	2,772	53.31	CB	disk	none
	12C1	62	4,277	68.98	1,577	25.44	CB	till	contour
Farm Total		**310**	**8,613**	**27.78**	**6,471**	**20.87**			

Table A.4. (continued)

Scenario	SMU Code	Net Acres	Net Returns Per SMU	Net Returns Per Acre	Tons Soil Loss Per SMU	Tons Soil Loss Per Acre	Rotation	Tillage System	Supporting Practice
8D2	1D3	47	0	0	----	----	--	----	----
(25% of 2D)	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,797	49.95	1,484	26.50	CB	disk	none
	10D2	41	1,055	25.69	2,190	53.31	CB	disk	none
	10D2	11	0	0	----	----	--	----	----
	12C1	62	4,277	68.98	1,577	25.44	CB	till	contour
Farm Total		**310**	**8,129**	**26.22**	**5,251**	**16.94**			
- - - - - -	- - -	- - -	- - -	- - **total capital constraints** - -			- - -	- - -	- - -
9A	1D3	47	4,509	95.93	2,504	53.28	CB	till	contour
(10% of 2A)	1E3	65.9	3,674	55.75	7,172	108.81	CB	till	contour
	1E3	27.1	0	0	----	----	--	----	----
	10C2	56	8,639	154.26	382	6.81	CB	slot	contour
	10D2	52	5,872	112.92	713	13.71	CB	slot	contour
	12C1	62	11,441	184.54	1,577	25.44	CB	till	contour
Farm Total		**310**	**34,135**	**110.11**	**12,348**	**39.83**			
9B	1D3	47	954	20.30	751	15.98	CB	slot	contour
(15% of 2B)	1E3	18.8	92	4.87	136	7.25	P	conv	none
	1E3	74.2	0	0	----	----	--	----	----
	10C2	56	2,818	50.33	382	6.81	CB	slot	contour
	10D2	52	1,563	30.06	713	13.71	CB	slot	contour
	12C1	62	3,952	63.74	473	7.63	CB	slot	contour
Farm Total		**310**	**9,379**	**30.25**	**2,455**	**7.92**			
9D	1D3	18.4	311	16.94	978	53.27	CB	till	contour
(15% of 2D)	1D3	28.6	0	0	----	----	--	----	----
	1E3	93	0	0	----	----	--	----	----
	10C2	56	2,795	49.91	382	6.81	CB	slot	contour
	10D2	52	1,334	25.65	713	13.71	CB	slot	contour
	12C1	62	4,277	68.98	1,577	25.44	CB	till	contour
Farm Total		**310**	**8,717**	**28.12**	**3,650**	**11.77**			

APPENDIX B: RANGE ANALYSES FOR SELECTED ACTIVITIES FOR TENURE MODELS UNDER SCENARIO TWO

Table B.1. Range analysis for selected activities on the Boone County farm for owner-operator, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
CB, till-plant, none, 107A1	144	-65.51	-68.50	∞
CB, slot-plant, none, 107A1	0	-64.16	- ∞	-61.17
CB, conventional, none, 107A1	0	-70.68	- ∞	-57.01
CB, chisel-plow, none, 107A1	0	-68.10	- ∞	-60.58
C, till-plant, none, 107A1	0	-78.87	- ∞	-24.40
CB, till-plant, none, 55A1	80	-66.33	-66.70	∞
CB, till-plant, none, 138B1	74	-65.51	-65.93	-65.17
CB, till-plant, none, 138C2	22	-64.76	-65.07	-57.17
CB, conventional, terrace, 138C2	0	-69.94	- ∞	-36.03
CB, chisel-plow, terrace, 138C2	0	-67.36	- ∞	-39.81
Buy herbicides	5,904	-1.00	-1.34	-0.60
Buy diesel	2,025	-1.30	-3.04	0.09
Buy LP gas	3,948	-0.69	-4.42	0.05
Borrow short-term capital	38,330	-0.075	-0.21	0.0
Borrow medium term capital	26,894	-0.15	-0.31	-0.04
Buy nitrogen	24,731	-0.14	-0.53	0.01
Buy phosphorus	15,111	-0.27	-1.47	0.02
Buy potash	16,824	-0.12	-0.85	0.01
Sell corn	23,681	2.56	1.93	3.34
Sell soybeans	7,788	7.30	6.17	9.05
Sell alfalfa hay	0	57.73	- ∞	65.71
Sell oats	0	1.56	-0.75	2.64
Sell pasture	0	8.00	- ∞	29.99

Table B.2. Range analysis for selected activities on the Van Buren County farm for owner-operator, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
P, conventional, none, 65E2	144	-7.76	-8.06	∞
CB, till-plant, none, 131B1	108	-64.23	-67.64	∞
CB, slot-plant, none, 131B1	0	-62.89	- ∞	-59.48
CB, conventional, none, 131B1	0	-69.41	- ∞	-56.21
CB, chisel-plow, none, 131B1	0	-66.83	- ∞	-59.53
CB, till-plant, contour, 132C2	108	-62.74	-65.71	-61.60
CB, slot-plant, contour, 132C2	0	-61.39	- ∞	-58.42
Buy herbicides	3,985	-1.00	-1.20	-0.65
Buy diesel	1,316	-1.30	-5.00	-0.91
Buy LP gas	2,226	-0.69	-0.87	-0.05
Borrow short-term capital	25,355	-0.075	-0.11	0.00
Borrow medium term capital	27,691	-0.150	-0.154	-0.10
Buy nitrogen	13,354	-0.14	-0.21	-0.01
Buy phosphorus	8,997	-0.27	-0.36	-0.20
Buy potash	9,959	-0.12	-0.21	-0.11
Sell corn	13,354	2.56	2.52	2.98
Sell soybeans	4,386	7.30	7.21	8.57
Sell alfalfa hay	0	57.73	- ∞	58.12
Sell oats	0	1.56	- ∞	3.77
Sell pasture	373	8.00	7.88	25.52

Table B.3. Range analysis for selected activities on the Jasper County farm for owner-operator, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
CB, till-plant, contour, 120C2	204	-66.61	-69.58	∞
CB, till-plant, contour, 162D2	68	-65.21	-68.18	∞
CB, slot-plant, contour, 162D2	0	-63.87	- ∞	-60.90
CB, conventional, terrace, 162D2	0	-70.39	- ∞	-56.51
CB, till-plant, none, 119A1	34	-68.05	-71.09	∞
CB, till-plant, contour, 24E2	34	-61.76	-61.76	-53.41
P, conventional, none, 24E2	0	-8.49	- ∞	63.91
Buy herbicides	6,273	-1.00	-1.38	-0.46
Buy diesel	2,224	-1.30	-8.48	0.10
Buy LP gas	4,149	-0.69	-2.78	0.05
Borrow short-term capital	40,619	-0.075	-0.45	0.00
Borrow medium term capital	28,498	-0.15	-0.58	-0.05
Buy nitrogen	24,888	-0.14	-0.36	0.01
Buy phosphorus	15,830	-0.27	-2.10	0.02
Buy potash	17,592	-0.12	-1.77	0.00
Sell corn	24,888	2.56	2.21	3.37
Sell soybeans	8,122	7.30	6.66	116.66
Sell alfalfa hay	0	57.73	- ∞	62.18
Sell oats	0	1.56	-0.75	2.36
Sell pasture	0	8.00	0	19.01

Table B.4. Range analysis for selected activities on the Ida County farm for owner-operator, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, contour, 1D3	47	-61.14	-64.06	∞
COMMM, slot-plant, contour, 1D3	0	-43.05	-∞	-36.96
P, conventional, none, 1D3	0	-3.95	-∞	29.90
CB, till-plant contour, 1E3	93	-59.79	-59.90	-55.05
COMMM, slot-plant, contour, 1E3	0	-42.36	-42.42	-42.32
P, conventional, none, 1E3	0	-1.94	-20.97	20.04
CB, spring-disk, none, 10C2	56	-64.58	-64.59	∞
CB, till-plant, contour, 10C2	0	-63.24	-∞	63.23
CB, spring-disk, none, 10D2	52	-63.16	-63.16	∞
CB, till-plant, contour, 10D2	0	-61.81	-∞	61.81
CB, slot-plant, contour, 10D2	0	-60.47	-∞	-60.43
CB, till-plant, countour 12C1	62	-64.16	-67.07	∞
CB, spring-disk, none, 12C1	0	-65.53	-∞	-62.59
Buy herbicides	5,719	-1.00	-1.29	-1.00
Buy diesel	1,892	-1.30	-1.32	-0.61
Buy LP gas	2,600	-0.69	-3.99	0.05
Borrow short-term capital	32,180	-0.075	-0.51	-0.07
Borrow medium term capital	25,299	-0.15	-0.15	-0.07
Buy nitrogen	15,596	-0.14	-0.26	0.01
Buy phosphorus	9,948	-0.27	-2.70	0.02
Buy potash	11,072	-0.12	-2.04	0.01
Sell corn	15,596	2.56	2.01	3.39
Sell soybeans	5,124	7.30	6.28	18.63
Sell alfalfa hay	0	57.73	-∞	65.48
Sell oats	0	1.56	-0.75	2.84
Sell pasture	0	8.00	-∞	21.53

Table B.5. Range analysis for selected activities on the Boone County farm for 50-50 tenant, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, none, 107A1	144	-65.51	-65.54	∞
CB, slot-plant, none, 107A1	0	-64.16	− ∞	-64.13
COMMM, slot-plant, none, 107A1	0	-45.29	− ∞	-28.94
CB, till-plant, none, 55A1	80	-66.33	-66.37	∞
CB, slot-plant, none, 55A1	0	-64.99	− ∞	-64.95
CB, till-plant, none, 138B1	74	-65.51	-65.54	∞
CB, spring-disk, contour, 138B1	0	-66.85	− ∞	-62.90
CB, conventional, contour, 138B1	0	-70.68	− ∞	-56.38
CB, slot-plant, contour, 138C2	22	-63.42	-63.43	∞
CB, till-plant, contour, 138C2	0	-64.76	− ∞	-64.75
Buy herbicides	6,025	-1.00	-1.002	-0.987
Buy diesel	2,017	-1.30	-1.40	-1.28
Buy LP gas	3,948	-0.686	-4.10	0.05
Buy short-term capital	24,278	-0.075	-0.080	-0.055
Buy medium-term capital	26,742	-0.15	-0.155	-0.149
Buy nitrogen	24,731	-0.14	-0.50	0.01
Buy phosphorus	15,111	-0.27	-1.77	0.02
Buy potash	16,824	-0.12	-1.46	-0.009
Sell corn grain	23,681	2.56	1.99	3.62
Sell soybeans	7,788	7.30	6.26	113.72
Sell alfalfa hay	0	57.73	0	65.03
Sell oats	0	1.56	-0.75	2.83
Sell pasture	0	8.00	− ∞	16.83

Table B.6. Range analysis for selected activities on the Van Buren County farm for 50-50 tenant, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
P, conventional, none, 65E2	0	-7.76	$-\infty$	-7.31
CB, till-plant, none, 131B1	108	-64.23	-64.31	∞
CB, slot-plant, none, 131B1	0	-62.89	$-\infty$	-62.81
CB, till-plant, contour, 132C2	108	-62.74	-62.75	∞
CB, slot-plant, contour, 132C2	0	-61.39	$-\infty$	-61.38
Buy herbicides	3,985	-1.00	-2.62	-0.99
Buy diesel	1,306	-1.30	-1.34	0.10
Buy LP gas	2,226	-0.686	-3.86	0.05
Buy short-term capital	15,347	-0.075	-0.274	-0.067
Buy medium-term capital	17,602	-0.15	-0.152	-0.144
Buy nitrogen	13,354	-0.14	-0.51	0.01
Buy phosphorus	8,517	-0.27	-1.10	-0.003
Buy potash	9,479	-0.12	-0.86	0.009
Sell corn grain	13,354	2.56	2.03	3.40
Sell soybeans	4,386	7.30	6.24	11.26
Sell alfalfa hay	0	57.73	$-\infty$	65.28
Sell oats	0	1.56	-0.75	3.29
Sell pasture	0	8.00	0	8.34

Table B.7. Range analysis for selected activities on the Jasper County farm for 50-50 tenant, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
CB, slot-plant, contour, 120C2	0	-65.26	$-\infty$	-65.25
CB, till-plant, contour, 120C2	204	-66.61	-66.62	∞
CB, till-plant, contour, 162D2	68	-65.21	-65.22	∞
CB, slot-plant, contour, 162D2	0	-63.87	$-\infty$	-63.86
CB, till-plant, none, 119A1	34	-68.05	-68.13	∞
CB, slot-plant, none, 119A1	0	-66.71	$-\infty$	-66.63
CB, slot-plant, contour, 24E2	34	-60.42	-60.43	∞
CB, till-plant, contour, 24E2	0	-61.76	$-\infty$	-61.75
Buy herbicides	6,460	-1.00	-1.03	-0.996
Buy diesel	2,210	-1.30	-1.328	-1.279
Buy LP gas	4,149	-0.686	-1.762	0.05
Borrow short-term capital	25,807	-0.075	-0.080	-0.069
Borrow medium-term capital	28,264	-0.15	-0.152	-0.149
Buy nitrogen	24,888	-0.14	-0.25	0.01
Buy phosphorus	15,830	-0.27	-1.08	0.02
Buy potash	17,592	-0.12	-0.83	-0.06
Sell corn grain	24,888	2.56	2.38	3.54
Sell soybeans	8,122	7.30	6.97	143.02
Sell alfalfa hay	0	57.73	$-\infty$	60.02
Sell oats	0	1.56	-0.75	1.97
Sell pasture	0	8.0	0	12.26

Table B.8. Range analysis for selected activities on the Ida County farm for 50-50 tenant, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, contour, 1D3	47	-61.14	-61.20	∞
CB, slot-plant, contour, 1D3	0	-59.80	- ∞	-59.74
P, conventional, none, 1D3	0	-3.95	- ∞	16.90
P, conventional, None, 1E3	93	-1.94	-3.11	∞
CB, till-plant, contour, 1E3	0	-59.79	- ∞	-55.58
CB, slot-plant, contour, 10C2	56	-61.89	-63.34	∞
P, conventional, none, 10C2	0	-4.67	- ∞	39.47
CB, slot-plant, contour, 10D2	52	-60.47	-61.92	∞
COMMM, slot-plant, contour, 10D2	0	-43.39	- ∞	-41.79
CB, till-plant, contour, 12C1	62	-64.16	-64.21	∞
COMMM, slot-plant, contour, 12C1	0	-44.58	- ∞	-37.35
Buy herbicides	4,598	-1.00	-1.75	-0.98
Buy diesel	1,283	-1.30	-1.45	-1.12
Buy LP gas	2,039	-0.686	-3.92	-0.30
Buy short-term capital	15,194	-0.075	-0.39	-0.06
Buy medium-term capital	23,294	-0.15	-0.16	-0.05
Buy nitrogen	16,883	-0.14	-0.31	0.1
Buy phosphorus	8,432	-0.27	-1.67	-0.13
Buy potash	8,701	-0.12	-1.38	-0.03
Sell corn grain	12,233	2.56	2.02	2.62
Sell soybeans	4,030	7.30	6.32	7.49
Sell alfalfa hay	0	57.73	- ∞	65.36
Sell oats	0	1.56	-0.75	2.67
Sell pasture	337	8.00	7.36	17.37

Table B.9. Range analysis for selected activities on the Boone County farm for 50-50 landlord, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, none, 107A1	144	-31.15	-31.15	∞
CB, slot-plant, none, 107A1	0	-31.15	- ∞	-28.19
CBCOMM, till-plant, none, 107A1	0	-27.68	- ∞	-25.12
CB, till-plant, none, 55A1	80	-31.81	-31.81	∞
COMMM, conventional, none, 55A1	0	-23.34	- ∞	-23.28
CBCOMM, till-plant, none, 55A1	0	-28.12	- ∞	-27.96
CB, till-plant, none, 138B1	74	-31.15	-31.15	∞
CB, till-plant, contour, 138C2	22	-30.55	-30.55	∞
CB, till-plant, terrace, 138C2	0	-30.55	- ∞	61.46
COMMM, conventional, none, 138C2	0	-22.84	- ∞	-22.57
P, conventional, none, 138C2	0	-16.09	- ∞	-87.40
Buy herbicides	5,904	-1.00	-1.26	-0.88
Buy LP gas	3,948	-0.686	-1.95	0.05
Buy short-term capital	14,090	-0.075	-0.315	0.024
Buy nitrogen	24,731	-0.14	-0.57	0.01
Buy phosphorus	15,111	-0.27	-2.11	0.02
Buy potash	16,824	-0.12	-0.95	-0.04
Sell corn grain	23,681	2.56	2.35	3.00
Sell soybeans	7,788	7.30	6.69	7.84
Sell alfalfa hay	0	57.73	- ∞	60.40
Sell oats	0	1.56	- ∞	2.60
Sell pasture	0	8.00	0	36.12

Table B.10. Range analysis for selected activities on the Van Buren County farm for 50-50 landlord, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
COMMM, conventional, none, 65E2	144	-19.59	-19.59	∞
P, conventional, none, 65E2	0	-16.56	- ∞	4.46
CB, till-plant, none, 131B1	108	-30.06	-30.06	∞
COMMM, conventional, none, 131B1	0	-22.64	- ∞	-20.57
CBCOMM, conventional, none, 131B1	0	-26.94	- ∞	-26.31
CB, till-plant, terrace, 131B1	0	-30.06	- ∞	4.44
CB, till-plant, contour, 132C2	108	-28.86	-28.86	∞
CB, till-plant, terrace, 132C2	0	-28.86	- ∞	28.65
Buy herbicide	4,517	-1.00	-1.25	-0.26
Buy insecticide	293	-1.00	-4.88	0.075
Buy LP gas	2,226	-0.686	-1.19	0.05
Buy nitrogen	13,354	-0.14	-0.33	0.01
Buy phosphorus	11,498	-0.27	-2.37	-0.08
Buy potash	19,060	-0.12	-0.37	-0.09
Sell corn grain	13,354	2.56	2.47	2.86
Sell soybeans	4,386	7.30	7.04	13.18
Sell alfalfa hay	213	57.73	47.26	58.82
Sell oats	0	1.56	- ∞	3.92
Sell pasture	0	8.00	0	24.24

Table B.11. Range analysis for selected activities on the Jasper County farm for 50-50 landlord, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, contour, 120C2	204	-32.13	32.13	∞
CB, slot-plant, contour, 120C2	0	-32.13	- ∞	-29.17
CB, till-plant, contour, 162D2	68	-31.00	31.00	∞
CB, slot-plant, contour, 162D2	0	-31.00	- ∞	-28.04
CB, till-plant, terrace, 162D2	0	-31.00	- ∞	61.01
CB, till-plant, none, 119A1	34	-33.26	-33.26	∞
CB, till-plant, terrace, 24E2	0	-28.28	- ∞	75.24
CB, till-plant, contour, 24E2	34	-28.28	-28.28	∞
Buy herbicides	6,273	-1.00	-1.59	-0.40
Buy LP gas	4,149	-0.686	-2.68	0.05
Buy nitrogen	24,888	-0.14	-0.35	0.01
Buy phosphorus	15,830	-0.27	-1.71	0.02
Buy potash	17,592	-0.12	-1.57	-0.01
Sell corn grain	24,888	2.56	2.23	3.06
Sell soybeans	8,122	7.30	6.70	17.71
Sell alfalfa hay	0	57.73	- ∞	61.96
Sell oats	0	1.56	-0.75	2.32
Sell pasture	0	8.00	- ∞	34.82
Borrow short-term capital	14,871	-0.075	-0.58	∞

Table B.12. Range analysis for selected activities on the Ida County farm for 50-50 landlord, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
CB, till-plant, contour, 1D3	47	-27.60	-27.60	∞
COMMM, conventional, none, 1D3	0	-21.66	- ∞	-18.94
CBCOMM, conventional, none, 1D3	0	-25.31	- ∞	-23.93
CB, till-plant, terrace, 1D3	0	-27.60	- ∞	52.92
CB, till-plant, contour, 1E3	93	-26.54	-26.54	∞
CB, till-plant, terrace, 1E3	0	-26.54	- ∞	76.98
CB, spring-disk, none, 10C2	56	-29.26	-29.26	∞
CBCOMM, conventional, none, 10C2	0	-26.41	- ∞	-22.48
CB, spring-disk, none, 10D2	52	-28.13	-28.13	∞
COMMM, conventional, none, 10D2	0	-21.87	- ∞	-17.43
CB, till-plant, contour, 12C1	62	-29.99	-29.99	∞
CBCOMM, conventional, none, 12C1	0	-26.90	- ∞	-21.99
Buy herbicides	5,719	-1.00	-1.06	0.08
Buy LP gas	2,600	-0.686	-0.88	0.05
Buy short-term capital	11,214	-0.075	-0.12	1.0
Buy nitrogen	15,596	-0.14	-0.21	-0.02
Buy phosphorus	9,948	-0.27	-2.44	-0.18
Buy potash	11,072	-0.12	-1.01	-0.11
Sell corn grain	15,596	2.56	2.53	2.91
Sell soybeans	5,124	7.30	7.20	∞
Sell alfalfa hay	0	57.73	- ∞	58.2
Sell oats	0	1.56	- ∞	2.91
Sell pasture	0	8.00	- ∞	36.92

Table B.13. Range analysis for selected activities on the Boone County farm for 100-65 tenant, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, none, 107A1	144	-65.51	-68.50	∞
CB, slot-plant, none, 107A1	0	-64.16	- ∞	-61.17
COMMM, slot-plant, none, 107A1	0	-45.29	- ∞	-40.13
CB, till-plant, none, 55A1	80	-66.33	-67.63	∞
COMMM, slot-plant, none, 55A1	0	-45.80	- ∞	-44.50
CB, till-plant, none, 138B1	74	-65.51	-65.93	∞
CB, till-plant, contour, 138B1	0	-65.51	- ∞	-65.08
COMMM, slot-plant, none, 138B1	0	-45.36	- ∞	-44.89
CB, till-plant, contour, 138C2	22	-64.76	-67.71	∞
P, conventional, none, 138C2	0	-8.95	- ∞	47.88
COMMM, slot-plant, contour, 138C2	0	-44.96	- ∞	-35.34
Buy herbicides	5,904	-1.00	-1.38	-0.53
Buy diesel	2,025	-1.30	-3.24	0.10
Buy LP gas	3,948	-0.686	-2.11	0.05
Buy short-term capital	38,330	-0.075	-0.44	0.12
Buy medium-term capital	26,894	-0.15	-0.34	-0.05
Buy nitrogen	24,731	-0.14	-0.30	0.01
Buy phosphorus	15,111	-0.27	-1.69	0.02
Buy potash	16,824	-0.12	-1.38	-0.04
Sell corn grain	23,681	2.56	2.20	3.67
Sell soybeans	7,788	7.30	6.64	10.43
Sell alfalfa hay	0	57.73	- ∞	62.42
Sell oats	0	1.56	-0.75	2.40
Sel pasture	0	8.00	0	19.90

Table B.14. Range analysis for selected activities on the Van Buren County farm for 100-65 tenant, scenario two

			Range of costs where activity level remains unchanged	
Selected Activities	Activity Level	Input Cost	Upper Cost	Lower Cost
P, conventional, none, 65E2	0	-7.76	$-\infty$	-0.82
CB, till-plant, none, 131B1	108	-64.23	-64.64	∞
COMMM, slot-plant, contour, 131B1	0	-44.62	$-\infty$	-40.65
CB, till-plant, contour, 131B1	0	-64.23	$-\infty$	-63.83
CB, till-plant, contour, 132C2	108	-62.74	-65.71	∞
CB, slot-plant, contour, 132C2	0	-61.39	$-\infty$	-58.42
Buy herbicides	3,985	-1.00	-1.32	-0.46
Buy diesel	1,306	-1.30	-7.09	0.10
Buy LP gas	2,226	-0.686	-2.60	0.05
Buy short-term capital	23,938	-0.075	-0.46	0.36
Buy medium-term capital	17,602	-0.15	-0.58	-0.065
Buy nitrogen	13,354	-0.14	-0.34	0.01
Buy phosphorus	8,517	-0.27	-1.41	0.02
Buy potash	9,479	-0.12	-1.13	-0.01
Sell corn grain	13,354	2.56	2.06	3.71
Sell soybeans	4,386	7.30	6.41	12.00
Sell alfalfa hay	0	57.73	$-\infty$	64.05
Sell oats	0	1.56	-0.75	3.02
Sell pasture	0	8.00	0	12.12

Table B.15. Range analysis for selected activities on the Jasper County farm for 100-65 tenant, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, contour, 120C2	204	-66.61	-69.57	∞
CB, slot-plant, contour, 120C2	0	-65.26	- ∞	-62.30
CB, till-plant, contour, 162D2	68	-65.21	-68.18	∞
CB, till-plant, none, 119A1	34	-68.05	-71.09	∞
COMMM, slot-plant, contour, 24E2	34	-43.34	-43.34	∞
COMMM, chisel, none, 24E2	0	-44.90	- ∞	-44.05
CB, till-plant, contour, 24E2	0	-61.76	- ∞	-61.43
Pasture, conventional, none, 24E2	0	-8.49	- ∞	1.22
Buy herbicides	5,858	-1.00	-1.38	-0.97
Buy insecticide	69	-1.00	-1.17	0.08
Buy diesel	2,323	-1.30	-1.42	0.10
Buy LP gas	4,000	0.686	-2.42	-0.61
Buy short-term capital	39,782	-0.075	-0.22	-0.06
Buy medium-term capital	29,573	-0.15	-0.16	-0.05
Buy nitrogen	23,478	-0.14	-0.32	-0.13
Buy phosphorus	16,239	-0.27	-0.29	0.02
Buy potash	20,280	-0.12	-0.124	-0.02
Sell corn grain	23,995	2.56	2.12	2.58
Sell soybeans	7,631	7.30	6.50	7.34
Sell alfalfa hay	70	57.73	57.47	63.43
Sell oats	391	1.56	1.51	2.58
Sell straw	6	50.00	46.98	118.20
Sell pasture	0	8.00	0	11.21

Table B.16. Range analysis for selected activities on the Ida County farm for 100-65 tenant, scenario two

Selected Activities	Activity Level	Input Cost	Range of costs where activity level remains unchanged	
			Upper Cost	Lower Cost
CB, till-plant, contour, 1D3	47	-61.14	-64.06	∞
CB, slot-plant, contour, 1D3	0	-59.80	- ∞	-56.79
COMMM, slot-plant, contour, 1D3	0	-43.05	- ∞	-42.13
P, conventional, none, 1D3	0	-3.95	- ∞	19.40
CB, till-plant, contour, 1E3	0	-59.79	- ∞	-53.10
P, conventional, none, 1E3	0	-1.94	-19.61	1.48
CB, spring-disk, none, 10C2	56	-64.58	-64.59	∞
COMMM, slot-plant, contour, 10C2	0	-44.11	- ∞	-38.79
CB, till-plant, contour, 10C2	0	-63.24	- ∞	-63.23
CB, spring-disk, none, 10D2	52	-63.15	-63.16	∞
CB, till-plant, contour, 10D2	0	-61.81	- ∞	-61.80
CB, till-plant, contour, 12C1	62	-64.15	-67.10	∞
CB, spring-disk, none, 12C1	0	-65.50	- ∞	-62.59
Buy herbicides	4,004	-1.00	-1.46	-0.998
Buy diesel	1,357	-1.30	-1.32	-1.02
Buy LP gas	2,039	-0.686	-1.97	-0.37
Buy short-term capital	23,420	-0.075	-0.244	-0.072
Buy medium-term cpaital	18,221	-0.15	-0.151	-0.129
Buy nitrogen	12,233	-0.14	-0.28	-0.09
Buy phosphorus	7,812	-0.27	-0.85	-0.18
Buy potash	8,701	-0.12	-0.38	-0.04
Sell corn grain	12,233	2.56	2.23	2.65
Sell soybeans	4,030	7.30	6.68	7.55
Sell alfalfa hay	0	57.73	- ∞	62.55
Sell oats	0	1.56	-0.75	2.35
Sell pasture	0	8.0	- ∞	9.45

APPENDIX C: INCOME AND SOIL EROSION LEVELS BY TENURE FOR ALTERNATIVE SOIL EROSION RESTRICTION POLICIES

Table C.1. Boone County Farm: Income and soil erosion levels by tenure for alternative soil erosion restriction policies

Scenario	Net Returns	Percent Change From BASE[a]	Counter-Part Net Returns[b]	Percent Change From BASE[a]	Whole Farm Net Returns[c]	Percent Change From BASE[a]	Total Soil Loss	Percent Change From BASE[a]
1A	64,382	-6.36	----	---	----	---	1,082	+117.71
2A	68,754	0	----	---	----	---	497	0
3A	68,657	-0.14	----	---	----	---	225	-54.73
4A	68,657	-0.14	----	---	----	---	225	-54.73
5A	68,547	-0.30	----	---	----	---	350	-29.58
6A	68,432	-0.47	----	---	----	---	225	-54.73
7A	68,123	-0.92	----	---	----	---	105	-78.87
1B	20,789	-17.38	43,593	+0.15	64,382	-6.27	1,082	+190.86
2B	25,161	0	43,529	0	68,690	0	372	0
4B	25,158	-0.01	43,310	-0.50	68,468	-0.32	149	-59.95
1C	43,593	0	20,789	-17.38	64,382	-6.36	1,082	+117.71
2C	43,593	0	25,161	0	68,754	0	497	0
4C	43,528	-0.15	25,130	-0.12	68,658	-0.14	225	-54.73
1D	23,269	-15.80	40,770	-0.84	64,039	-6.86	595	+19.72
2D	27,637	0	41,117	0	68,754	0	497	0
4D	27,540	-0.35	41,117	0	68,657	-0.14	225	-54.73
1E	41,118	0	23,264	-15.82	64,382	-6.36	1,082	+117.71
2E	41,118	0	27,636	0	68,754	0	497	0
4E	41,118	0	27,540	-0.35	68,657	-0.14	225	-54.73

[a]BASE represents scenario 2.

[b]Net returns that the other lease party would receive for same solution.

[c]Whole farm net returns for same solution.

Table C.2. Van Buren County Farm: Income and soil erosion levels by tenure for alternative soil erosion restriction policies

Scenario	Net Returns	Percent Change From BASE[a]	Counter-Part Net Returns[b]	Percent Change From BASE[a]	Whole Farm Net Returns[c]	Percent Change From BASE[a]	Total Soil Loss	Percent Change From BASE[a]
1A	32,756	-7.96	----	---	----	---	7,978	+56.92
2A	35,587	0	----	---	----	---	5,084	
3A	32,356	-9.08	----	---	----	---	419	-91.76
4A	32,356	-9.08	----	---	----	---	419	-91.76
5A	34,467	-3.15	----	---	----	---	1,423	-72.01
6A	33,756	-5.15	----	---	----	---	1,423	-72.01
7A	31,831	-10.55	----	---	----	---	161	-96.83
1B	8,845	-24.24	23,867	0	32,712	-7.97	7,028	+70.00
2B	11,675	0	23,868	0	35,543	0	4,134	0
4B	10,474	-10.29	21,882	-8.32	32,356	-8.97	419	-89.86
5B	11,056	-5.30	23,228	-2.68	34,284	-3.54	1,136	-72.52
6B	10,488	-10.17	23,228	-2.68	33,716	-5.14	1,136	-72.52
7B	9,948	-14.79	21,883	-8.32	31,831	-10.44	161	-96.11
1C	27,003	0	4,314	-39.62	31,317	-8.29	9,403	+44.46
2C	27,003	0	7,145	0	34,148	0	6,509	0
4C	22,030	-18.42	10,123	+41.68	32,153	-5.84	340	-94.78
5C	25,372	-6.04	7,497	+4.93	32,869	-3.75	2,230	-65.74
6C	24,257	-10.17	7,497	+4.93	31,754	-7.01	2,230	-65.74
7C	21,955	-18.69	6,023	-15.70	27,978	-18.07	998	-84.67
1D	9,645	-22.03	21,484	-7.29	31,129	-12.42	1,853	-55.18
2D	12,370	0	23,173	0	35,543	0	4,134	0
4D	10,870	-12.13	21,485	-7.29	32,355	-8.97	419	-89.86
5D	11,295	-8.69	23,172	0	34,467	-3.03	1,423	-65.58
6D	10,708	-13.44	21,484	-7.29	32,192	-9.43	448	-89.16
7D	10,347	-16.35	21,484	-7.29	31,831	-10.44	161	-96.11
1E	27,476	0	3,841	-37.87	31,317	-6.96	10,827	+135.78
2E	27,476	0	6,182	0	33,658	0	4,592	0
4E	21,614	-21.33	9,810	+58.69	31,424	-6.64	397	-91.35
5E	26,504	-3.54	6,182	0	32,686	-2.89	1,944	-57.67
6E	25,804	-6.09	1,042	-83.14	26,846	-20.24	1,269	-72.36
7E	23,270	-15.31	1,038	-83.21	24,308	-27.78	1,269	-72.36

[a]BASE represents scenario 2.

[b]Net returns that the other lease party would receive for same solution.

[c]Whole farm net returns for same solution.

Table C.3. Jasper County Farm: Income and soil erosion levels by tenure for alternative soil erosion restriction policies

Scenario	Net Returns	Percent Change From BASE[a]	Counter-Part Net Returns[b]	Percent Change From BASE[a]	Whole Farm Net Returns[c]	Percent Change From BASE[a]	Total Soil Loss	Percent Change From BASE[a]
1A	66,954	-6.18	----	----	----	----	15,607	+33.87
2A	71,366	0	----	----	----	----	11,658	0
3A	61,448	-13.90	----	----	----	----	1,125	-90.35
4A	62,167	-12.89	----	----	----	----	1,077	-90.76
5A	68,832	-3.55	----	----	----	----	2,830	-75.72
6A	67,418	-5.53	----	----	----	----	2,830	-75.72
7A	62,873	-11.90	----	----	----	----	1,902	-83.69
1B	21,625	-16.35	45,329	-0.19	66,954	-6.05	15,607	+60.32
2B	25,852	0	45,414	0	71,266	0	9,735	0
3B	24,281	-6.08	23,652	-47.92	47,933	-32.74	1,231	-87.35
4B	22,367	-13.48	39,082	-13.94	61,449	-13.78	1,125	-88.44
5B	24,355	-5.79	44,476	-2.07	68,831	-1.43	2,830	-70.93
6B	23,080	-10.72	43,593	-4.01	66,673	-3.78	1,902	-80.46
7B	21,478	-16.92	38,436	-15.37	59,914	-15.42	120	-98.77
1C	45,514	0	21,341	-17.45	66,855	-6.32	19,820	+70.01
2C	45,514	0	25,852	0	71,366	0	11,658	0
3C	39,174	-13.93	22,139	-14.36	61,313	-14.09	1,103	-90.54
4C	39,781	-12.60	22,251	-13.93	62,032	-13.08	1,185	-89.84
5C	43,063	-5.39	25,768	-0.32	68,831	-3.55	2,830	-75.72
6C	41,731	-8.31	24,802	-4.06	66,533	-6.77	1,944	-83.32
7C	39,906	-12.32	21,754	-15.85	61,660	-13.60	325	-97.21
1D	24,243	-14.42	41,651	-2.52	65,894	-7.26	10,579	+16.68
2D	28,327	0	42,727	0	71,054	0	9,067	0
4D	24,493	-13.53	36,955	-13.51	61,448	-13.52	995	-89.03
5D	26,105	-7.84	42,726	0	68,831	-3.13	2,830	-68.79
6D	25,025	-11.66	41,648	-2.53	66,673	-6.17	1,902	-79.02
7D	23,954	-15.44	35,960	-15.84	59,914	-15.68	120	-98.68
1E	43,051	0	23,804	-13.15	66,855	-5.11	19,818	+69.99
2E	43,051	0	27,407	0	70,458	0	11,658	0
3E	38,718	-10.06	14,064	-48.68	52,782	-25.09	694	-94.05
4E	39,099	-9.18	14,429	-47.35	53,528	-24.03	864	-92.59
5E	41,492	-3.62	22,275	-18.73	63,767	-9.50	2,293	-80.33
6E	40,706	-5.45	10,689	-61.00	51,229	-27.29	1,166	-90.00
7E	38,559	-10.43	15,172	-44.64	53,731	-23.74	775	-93.35

[a]BASE represents scenario 2.

[b]Net returns that the other lease party would receive for same solution.

[c]Whole farm net returns for same solution.

Table C.4. Ida County Farm: Income and soil erosion levels by tenure for alternative soil erosion restriction policies

Scenario	Net Returns	Percent Change From BASE[a]	Counter-Part Net Returns[b]	Percent Change From BASE[a]	Whole Farm Net Returns[c]	Percent Change From BASE[a]	Total Soil Loss	Percent Change From BASE[a]
1A	31,989	-10.27	----	----	----	----	30,341	+64.40
2A	35,650	0	----	----	----	----	18,456	0
3A	25,053	-29.73	----	----	----	----	752	-95.93
4A	25,053	-29.73	----	----	----	----	752	-95.93
5A	32,760	-8.11	----	----	----	----	2,891	-84.34
6A	31,313	-12.17	----	----	----	----	2,891	-84.34
7A	27,633	-22.49	----	----	----	----	1,511	-91.81
1B	7,048	-27.69	21,133	-0.97	28,181	-9.35	9,974	+70.47
2B	9,747	0	21,340	0	31,087	0	5,851	0
4B	6,861	-29.61	18,192	-14.75	25,053	-19.41	752	-87.15
1C	26,611	0	5,378	-40.50	31,989	-10.27	30,341	+57.13
2C	26,611	0	9,039	0	35,650	0	19,309	0
4C	18,328	-31.13	6,547	-27.57	24,875	-30.22	719	-96.28
1D	7,046	-23.46	19,773	-6.99	26,819	-11.97	5,656	-32.16
2D	9,206	0	21,259	0	30,465	0	8,337	0
4D	6,901	-25.04	18,152	-14.61	25,053	-17.76	752	-90.98
1E	27,067	0	4,922	-42.65	31,989	-10.27	30,341	+64.40
2E	27,067	0	8,583	0	35,650	0	18,456	0
4E	20,065	-25.87	-56	-100.65	20,009	-43.87	690	-96.26

[a]BASE represents scenario 2.

[b]Net returns that the other lease party would receive for same solution.

[c]Whole farm net returns for same solution.