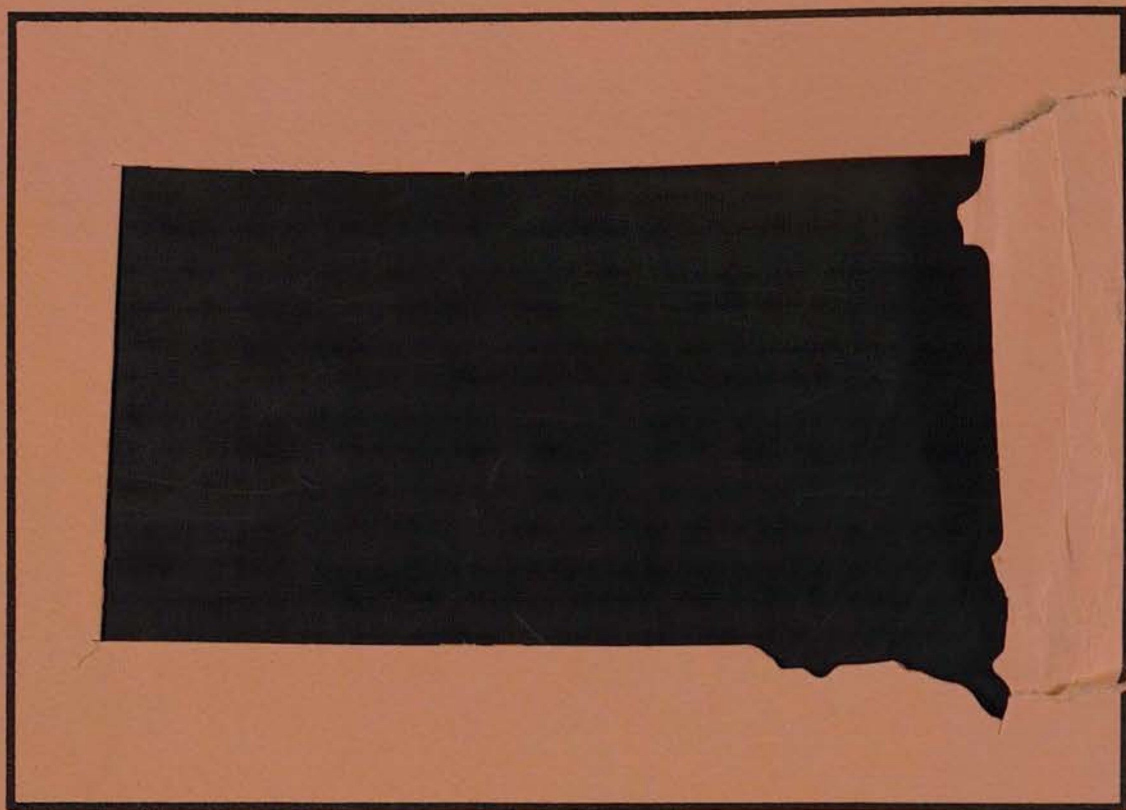

ECONOMICS DEPARTMENT

South Dakota State University
Brookings, South Dakota

Profitability and Nitrate Leaching Effects of Possible Farming Practice and System Changes over South Dakota's Big Sioux Aquifer: Case Farm No. 4 Summary

by

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CASE FARM NO. 4 SUMMARY

Introduction

The overall goal of the SARE/Water Quality project was to determine whether economic incentives offered by recent environmental provisions of the Federal farm program are sufficient to induce Western Corn Belt/Northern Great Plains farmers in environmentally sensitive areas to adopt sustainable farming practices and systems. To attain this goal, four case farms were chosen to be involved in this study based on their size, soil types, cropping systems, topography, and management in the Big Sioux Aquifer study area.

Description of the Case Farm

Baseline System: Before

Case Farm No. 4 is located in Brookings County and followed a continuous corn rotation prior to enrollment in the Water Quality Incentive Program (WQIP). It is an irrigated operation that uses a center-pivot system. Conventional tillage practices are used. The total operation consists of 838 acres, with 213 acres enrolled in the WQIP program. One hundred and fifty of those acres received irrigation management assistance. In one 73-acre field irrigated by a center-pivot system, 66 acres were assumed to be under the center-pivot system and the other 7 acres were assumed to be in the corners of the field where the center-pivot system could not reach. These 7 acres were designated as the set-aside acres for the baseline "before" scenario. This 73-acre field was focused on in our analyses. The majority of the soils in this field are a combination of coarse-textured (Fordville), and fine-textured (Marysland) soils. Both of these soils overlay a shallow drinking water aquifer.

All machinery operations, inputs, etc. used in the baseline system were entered into a program called CARE (Cost and Return Estimator) to generate crop budgets. The figures from these crop budgets were compiled into an economics summary spreadsheet to show economic performance before WQIP enrollment (Table 1). The first row shows the number of acres for each crop based on the rotation followed. The next line shows the yield for each crop. Net returns are calculated by subtracting operating costs, such as fertilizer, pesticide, fuel, labor, machinery, and other costs, from total receipts (crop revenue + deficiency payments). These operating costs include such costs as depreciation, interest on machinery, and family labor (i.e., certain "fixed" costs).

Baseline System: After

The WQIP program incorporates pest and nutrient management, crop selection and rotation, and conservation measures into a more comprehensive management program than is usually associated with the Agricultural Conservation Program[1]. Practices may include soil and tissue testing, field

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[1] The WQIP uses many different practices that are similar to the ones administered through the USDA's Agricultural Conservation Program (ACP).

scouting, cover crops, green manures, improved rotations, composting, and other techniques for reducing the use of agrichemicals.

Enrollment in the WQIP program began in 1993 for Case Farm No. 4. Crop rotation did not change after enrolling in the WQIP program, but the seeding rate was increased and the preplant dry fertilizer was eliminated. These changes increased profitability in the baseline "after" by nearly $18/acre compared to the baseline "before". Case Farm No. 4 received incentive payments to help pay for crop consulting. The total projected payment was $3,145 for the first year and $2,995 for the last two years, or $9,135 for the 3-year contract. Average payment per year was $3,045. The average annual incentive payment for all 213 acres enrolled in the WQIP was approximately $14.30. This includes $10/acre received on 150 of the contract acres for irrigation water management. Practices that are being followed but are not receiving incentive payments are nutrient management, pesticide management, conservation tillage, and crop residue. The economic summary spreadsheet for the baseline "after" system is shown in Table 2. Costs for the crop consultant and irrigation water management were considered "pass-throughs" and neither consultant/irrigation management costs nor WQIP payments were included on the economic summary spreadsheet.

Major Simulated Changes

Description of Practice Changes

In this study, we also performed profitability analyses for possible additional **practice** changes. These are "what if" scenarios that are not actually being used at this time, but that are possible additional management alternatives for this case farm. The key in Table 3 shows a complete list of the different alternatives analyzed for Case Farm No. 4.

The practice changes for Case Farm No. 4 involved splitting the nitrogen application into two operations (Alternative #4), use of a nitrogen inhibitor (Alternative #5), use of alternatives to atrazine (Alternative #11), and eliminating moldboard plow use (Alternative #13). Alternatives #11 and #13 are discussed in a later section of this paper.

Description of System Changes

Additional **systems** with more diverse crop rotations were analyzed to compare economic and environmental results with the results from the baseline "before" and "after" scenarios. The diverse rotations include switching to a corn/soybean rotation (Alternative #7) and a rotation in which alfalfa is clear-seeded and harvested for two years after the establishment year, followed by corn, soybeans, corn, and soybeans (Alternative #8). Table 4 shows the yield estimates for the baseline "before", the baseline "after", and the alternative practices and systems under different climate scenarios. Table 5 shows net irrigation application depths (inches) and frequency of application for different crops and climates.

Input Expenditure Summary Comparisons

Input expenditure comparisons were made between the baseline systems and the alternatives with practice or system changes for the "typical" climate scenario. These comparisons were categorized into fertilizer, pesticide, fuel, labor, machinery, irrigation, and other (seed cost, trucking, etc.) expenses and were put into individual bar charts (Figures 1-7). There was a dramatic difference between fertilizer expenditures for the "before" and "after" systems. This can be attributed to the exclusion of dry preplant fertilizer in the "after" system. Also, the alternative systems with the more diverse rotations used considerably lower amounts of fertilizer compared to the "after" system. The inclusion of legumes in these diverse rotations was the primary reason for the lower fertilizer costs. The inclusion of alfalfa in Alternative #8 led to higher machinery and labor costs for this system, but it also dropped pesticide costs. Irrigation costs did not vary greatly between the baselines, the alternative practices, and the alternative systems, except they were a little higher for Alternative #8 (due to alfalfa in that system). Alternative #11 (continuous corn rotation with no atrazine used) had substantially greater pesticide expenditures because the pesticides used to replace the atrazine were more expensive than atrazine.

Nitrate Leaching Comparisons

The nitrate leaching estimates were made using the computer model NLEAP (Nitrogen Leaching and Economic Analysis Package). This is a general model designed for use by land owners/operators/managers to help in deciding which farm management practices may impact ground water quality (nitrates) under various rotational cropping systems over several years of simulation.

Case Farm No. 4 had two different soil types that were analyzed with the computer model. The "whole-farm" nitrate leaching is dependent upon how many acres of each soil were covered in the analysis. As an example, if there were 10#/Ac nitrate leached on 40 acres of a coarse-textured soil out of a 100 acre parcel, and 20#/Ac on 60 acres of a fine-textured soil, the whole-farm nitrate leaching would be 16#/Ac ((10*40/100) + (20*60/100) = 16). **The nitrogen leaching amounts given in pounds/Ac (Figures 8-10) are whole-farm leaching annual averages.** The whole-farm averages result not only from the different soil types, but also from the different crops on each of the different soil types. The set-aside acres were not included in the whole-farm leaching averages on this farm because the nitrogen leached could not be calculated for the crop planted on the set-aside acres (sudan grass). The nitrogen leaching values should not be compared to those for any other case farms, since soils, crop practices, and systems may be quite different. The nitrate leaching values can be used as indicators of what the magnitude and variability of nitrate leaching might be on typical farms in the Big Sioux Aquifer area.

Profitability/N Leaching Results

Three different precipitation situations (typical, wet, and dry) were examined to see how the different alternatives would be affected economically and environmentally under different moisture conditions. Each alternative was based on the average 6-year rotation with the simulated climate the same for all years. These different conditions had varying effects on the economic and environmental results for the different alternatives. The results were put into charts with increasing economic returns extending vertically up the left side of the chart and increased nitrogen leaching extending horizontally to the right along the bottom of the chart. Points were plotted for each alternative based on the economic and environmental results (stated in annual averages), illustrating tradeoffs and complements for each precipitation situation (Figures 8-10).

In the "typical" year (Figure 8), profitability was slightly greater for the alternative practice of splitting the nitrogen application ($89.85/acre) when compared to the baseline "after" scenario ($81.17/acre). Using a nitrogen inhibitor (N-Serve) was also examined but was not included in the graphs. Profitability for this alternative practice was also slightly greater than the baseline "after". The alternative systems had lower economic returns ($74.61/acre for the corn/soybean rotation and $53.82/acre for the A,A,C,S,C,S rotation) than the baseline "after" system and the alternative practices. Environmental results for using a nitrogen inhibitor (34 lbs/acre) and splitting nitrogen application (33 lbs/acre) showed slight decreases in the amount of nitrogen leached when compared to the baseline "after" scenario (36 lbs/acre). The alternative systems showed a more significant decrease (26 lbs/acre for the corn/soybean rotation and 25 lbs/acre for the A,A,C,S,C,S rotation) in the amount of nitrogen leached than the alternative practices.

In the "wet" year (Figure 9), the profitability rankings remained the same as in the "typical" year. Environmental results showed that the baseline systems had the highest levels of nitrogen leaching (43 lbs/ac).

In the "dry" year (Figure 10), the profitability rankings were the same as in the "typical" and "wet" years. However, nitrogen leaching rankings changed, with the A,A,C,S,C,S rotation having the highest level of nitrogen leaching (9 lbs/ac).

In all of the climate scenarios, the alternative practices increased profits <u>and</u> decreased the amount of nitrogen leaching. The alternative systems generally were able to reduce the amount of nitrogen leaching, but they also suffered a decrease in profits when compared to the baseline "after" system.

The profitability figures for the "wet" and "dry" scenarios were influenced by yield estimates based on how "wet" or "dry" conditions were assumed to affect different crops for each alternative on the different soils on this case farm. Nitrogen leaching estimates were determined by running the nitrogen leaching model with appropriate precipitation levels for the "wet" and "dry" scenarios.

Selected Other "Practice"" and/or "System" Changes

There were other alternative practices examined that were not discussed in the above paragraphs. These practices included a continuous corn (C,C) system with no atrazine (Alternative #11), and using a chisel plow only, instead of a moldboard plow (Alternataive #13). In all climate situations (typical, wet, and dry), profitability was increased using the "chisel plow only" alternative when compared to the baseline "after". The amount of nitrogen leached for this alternative practice was the same as the baseline "after" in all of the climate scenarios.

The continuous corn system with no atrazine was analyzed only for profitability effects. In all climate situations, this alternative decreased profitability when compared to the baseline "after" system.

Sensitivity Analyses

Selected analyses were conducted to explore policy alternatives to green payments to induce more diverse rotations. A "free market" policy and a "normal crop acreage" policy were examined. In the "free market" scenario, set-aside acres and price supports (i.e., deficiency payments) would be dropped and crop mixes would be more influenced by market prices. In the "normal crop acreage" scenario, the deficiency payments were decoupled from the crops grown (i.e., a flat payment equivalent to that in the "after" baseline was assumed) and overall set-aside acreage was left the same as in the "after" baseline scenario (for all practices and systems). These analyses were done only for the "after" baseline and alternatives with a rotational change, to determine the relative profitability of different systems under these policy options, compared to provisions of the Federal farm program in 1993.

For Case Farm No. 4, both policy alternatives changed the profitability ranking of the systems. Under the 1993 farm program scenario, the baseline "after" system (continuous corn) was the most profitable. By substituting either the "free market" or the "normal crop acreage" scenario, the corn/soybean rotation became the most profitable system (Figure 11). Neither the "free market" nor the "normal crop acreage" scenario made the diverse rotation with alfalfa as profitable as continuous corn or corn/soybeans, under irrigation, however.

Methodological Notes

In some situations, we were unable to model both economic and environmental implications of an alternative. For Case Farm No. 4, there was not enough information to enable us to model nitrogen leaching on the set-aside acres (sudan grass). Profitability was measured by taking the estimated AUM's available from the sudan grass and multiplying that number by the value for AUM's in the CARE data base. The set-aside acres were assumed to be in the corners of the field where the center-pivot system cannot reach.

Table 1. CARE Budget Spreadsheet: Case Farm #4 - Before Program

	Corn-hvy.	Corn-lgt.	Set aside	WHOLE FARM
Units	Bushels	Bushels	AUM's*	
Acres	16	50	7	73.00
Yield/ac	135	135	3	
Defc. Pmts./ac	$41.50	$41.50	$0.00	
Total Receipts ($/acre)	$311.50	$311.50	$43.50	
Operating Costs ($/acre)	$242.89	$243.05	$27.31	
Net Returns ($/acre)	$68.61	$68.45	$16.19	
********* *********	*********	*********	*********	*********
Total Crop Returns ($/crop)	$1,097.76	$3,422.50	$113.33	$4,633.59
			$/ac =	$63.47

*-AUM's were used to calculate a value for sudan grass

Table 2. CARE Budget Spreadsheet: Case Farm #4 - After Program

	Corn-hvy.	Corn-lgt.	Set aside	WHOLE FARM
Units	Bushels	Bushels	AUM's*	
Acres	16	50	7	73.00
Yield/ac	135	135	3	
Defc. Pmts./ac	$41.50	$41.50	$0.00	
Total Receipts ($/acre)	$311.50	$311.50	$43.50	
Operating Costs ($/acre)	$225.42	$222.81	$27.31	
Net Returns ($/acre)	$86.08	$88.69	$16.19	
********* *********	*********	*********	*********	*********
Total Crop Returns ($/crop)	$1,377.28	$4,434.50	$113.33	$5,925.11
			$/ac =	$81.17

*-AUM's were used to calculate a value for sudan grass

Table 3. Baseline Systems and Other Possible Practice and System Changes, Case Farm No. 4

Key #	Alternative Description
1	Baseline (Before)
2	Baseline (After)
4	Splitting N application
5	Using N-Serve
7	C,S rotation*
8	A,A,C,S,C,S rotation**
11	C,C rotation no atrazine
13	Chisel plow only, no moldboard plow

*-Corn,Soybean rotation
**-Alfalfa,Alfalfa,Corn,Soybean,Corn,Soybean rotation

Table 4. Yield Estimates for Various Management Practices with different Climates for Case Farm #4.

System, field rotation and	Corn Yields in Bu/Ac.			Soybean Yields in Bu/Ac.			Alfalfa Yld. Tons/ac-Establish			Alfalfa Ylds in Tons/Ac.		
soils	Average	Dry	Wet	Average	Dry	Wet	Average	Dry	Wet	Average	Dry	Wet
"Before" (baseline) - Cont. corn												
Corn-Maryland soil	135	135	125									
Corn- Fordville soil	135	135	130									
"After"												
Corn-Marysland soil	135	135	125									
Corn- Fordville soil	135	135	130									
Corn-Soybean rotation												
Marysland soil												
Corn, Soybeans rotation	155	155	145	35	35	32						
Fordville soil												
Corn, Soybeans rotation	155	155	150	35	35	37						
Alf-est.A,C,S,C,S rotation												
Marysland soil												
Alf-est.A,C,S,C,S rotation	155	155	145	35	35	32	1.5	1.5	1.5	6	6	6
Fordville soil												
Alf-est.A,C,S,C,S rotation	155	155	150	35	35	37	1.5	1.5	1.5	5	5	5.5
Splitting N applications												
Marysland soil												
C,C rotation Split app. of												
anhydrous ammonia.	140	140	130									
Fordville soil												
C,C rotation Split app. of												
anhydrous ammonia.	140	140	135									
N application w/N-inhibitor												
Marysland soil												
C,C rotation:N-inhibitor w/												
1 application of anhydrous amm	140	140	130									
Fordville soil												
C,C rotation Split app. of												
1 application of anhydrous amm	140	140	135									
Tillage Change:MP to Chisel Plo												
Marysland soil												
C,C rotation Chisel Plow	135	135	125									
Fordville soil												
C,C rotation Chisel Plow	135	135	130									

Table 5. Net Irrigation Application Depths (Inches) and Frequency of Application for Different Crops and Climates.

	CLIMATES					
	Average		Wet		Dry	
	Depth (in.)	(Freq.)	Depth (in.)	(Freq.)	Depth (in.)	(Freq.)
Corn	5.6	9	0	0	9.6	16
Soybeans	3.6	6	0	0	6.6	11
Alfalfa (Est.)	9.6	16	0	0	13.8	23
Alfalfa (new seeding)	3.0	5	0	0	4.2	7

The irrigations were simulated to provide adequate moisture to the crop, and were varied depending upon the climate. The application efficiency was assumed to be 80%.

Figure 1.

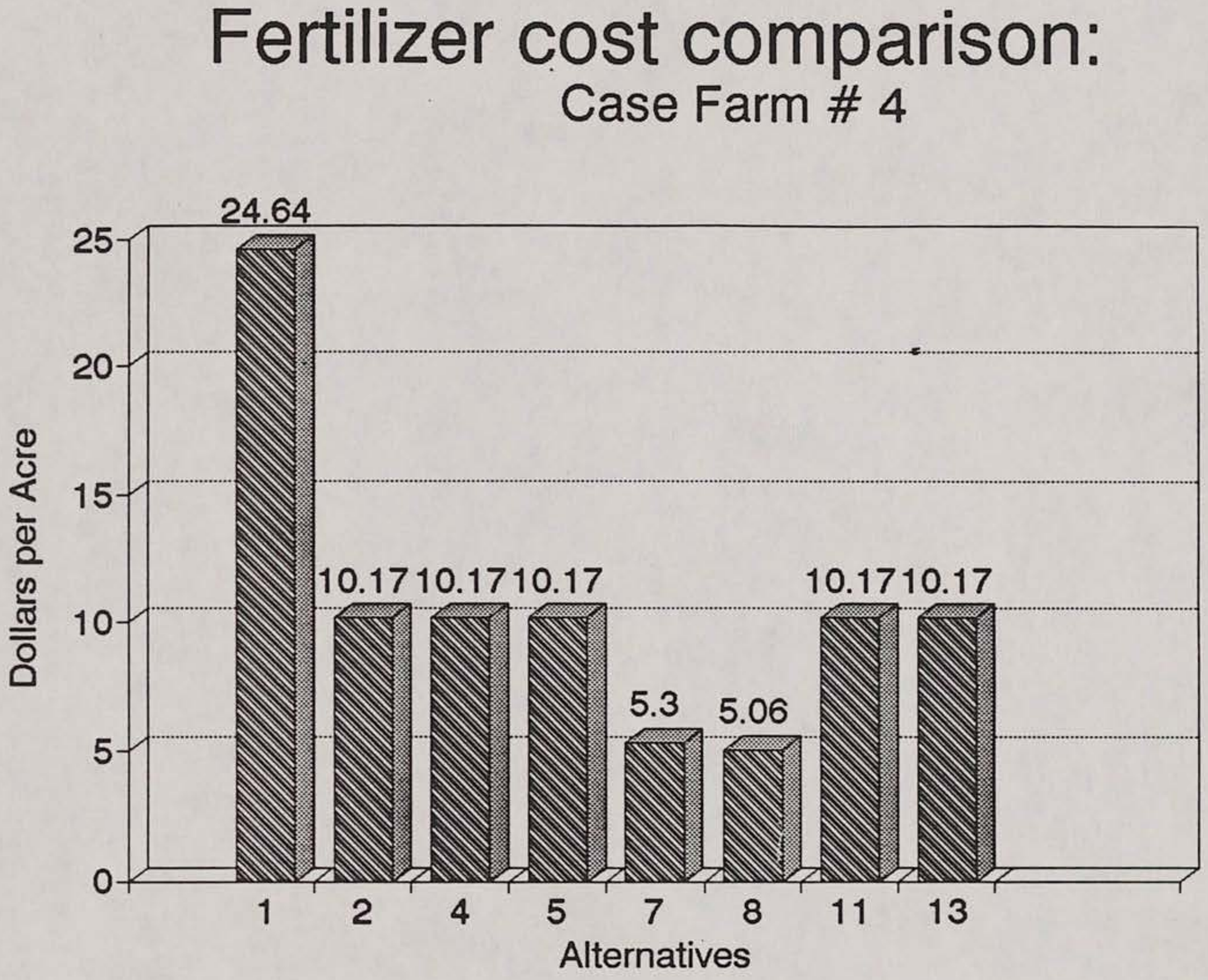
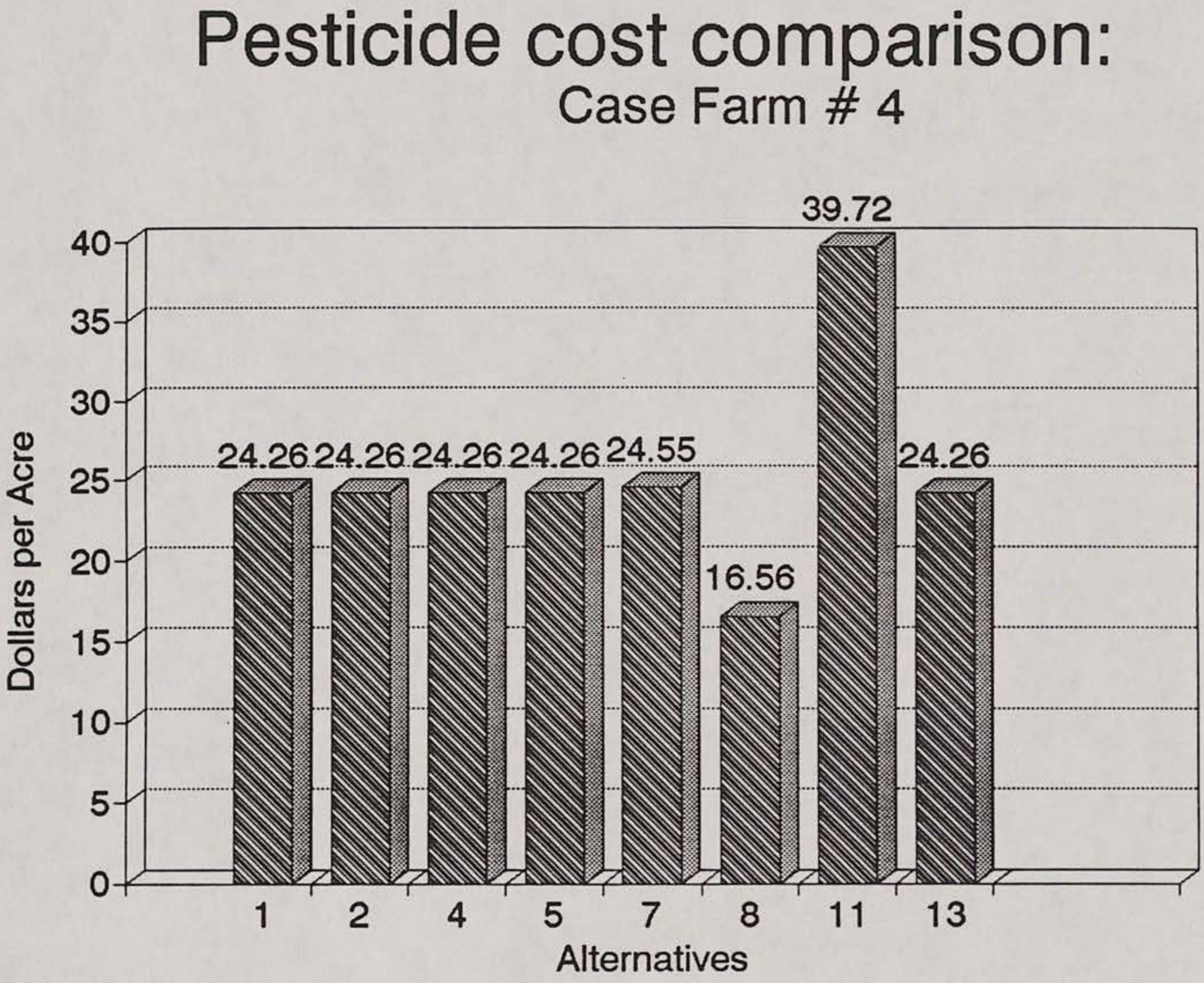

Fertilizer cost comparison:
Case Farm # 4
24.64
10.17
10.17
10.17
5.3
5.06
10.17
10.17
25
20
15
10
5
0
Dollars per Acre
1
2
4
5
7
8
11
13
Alternatives

Figure 2.



Pesticide cost comparison:
Case Farm # 4
40
35
30
25
20
15
10
5
0
Dollars per Acre
24.26
24.26
24.26
24.26
24.55
16.56
39.72
24.26
1
2
4
5
7
8
11
13
Alternatives

Figure 3.

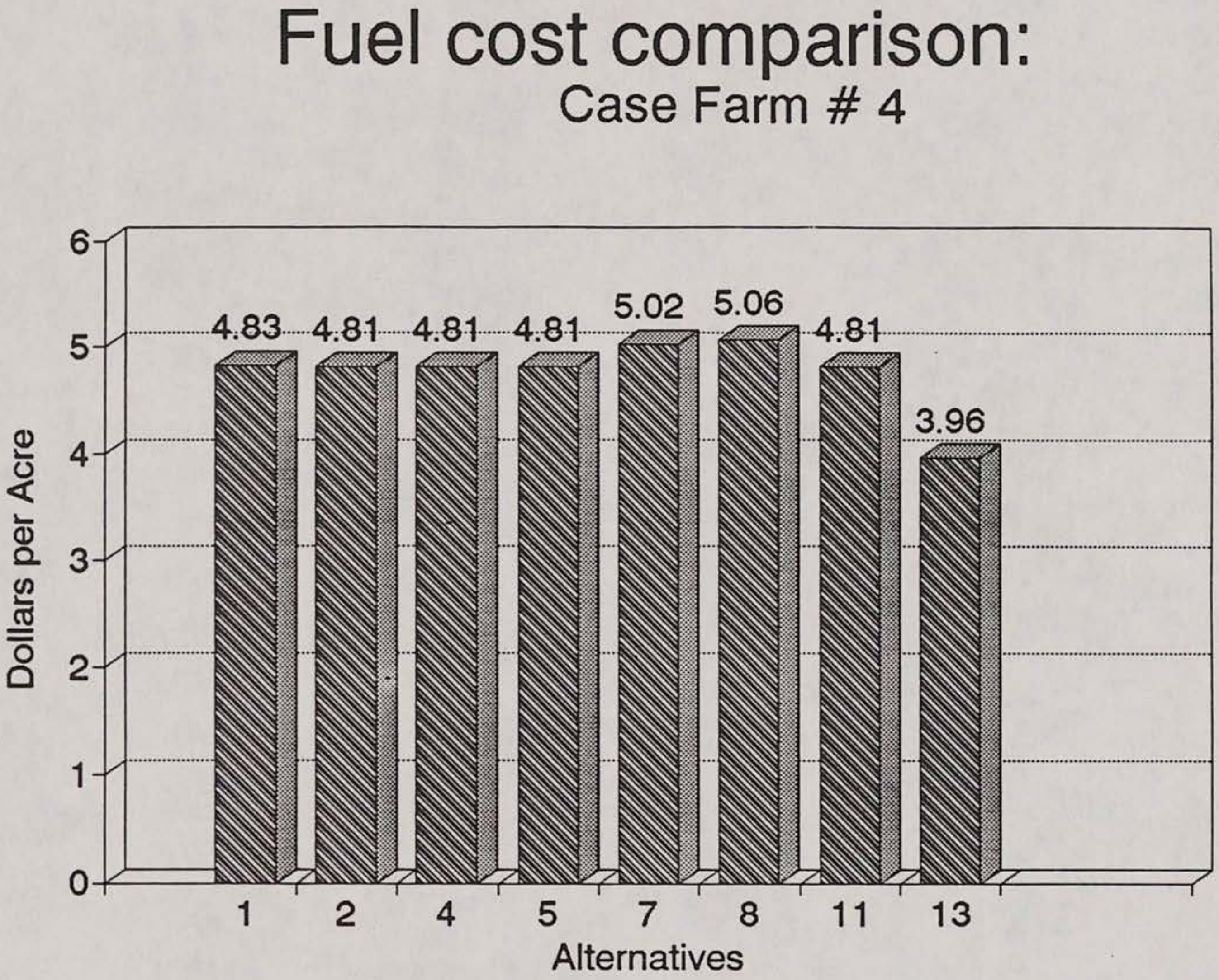

Fuel cost comparison:
Case Farm # 4
Dollars per Acre
0
1
2
3
4
5
6
4.83
4.81
4.81
4.81
5.02
5.06
4.81
3.96
1
2
4
5
7
8
11
13
Alternatives

Figure 4.

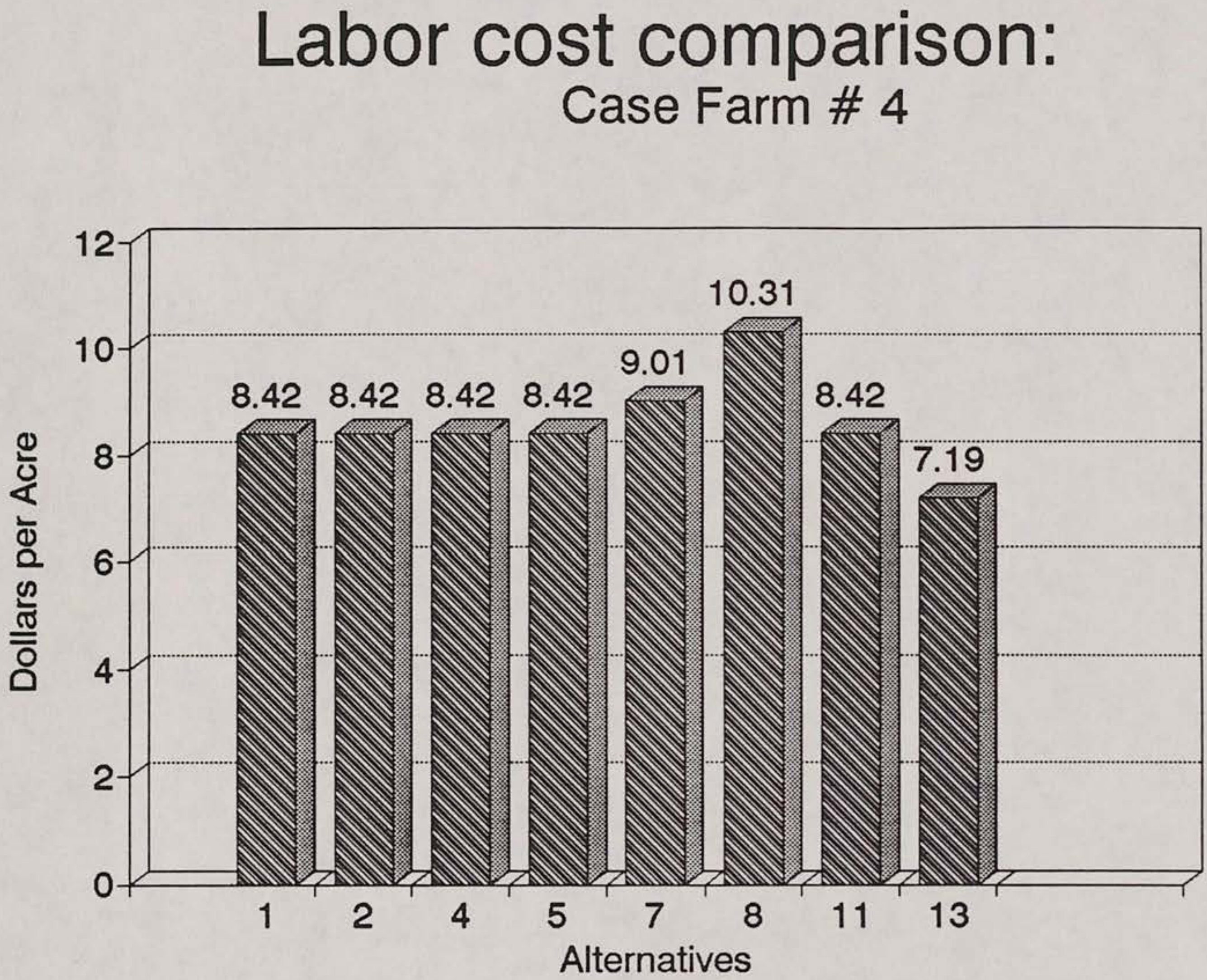
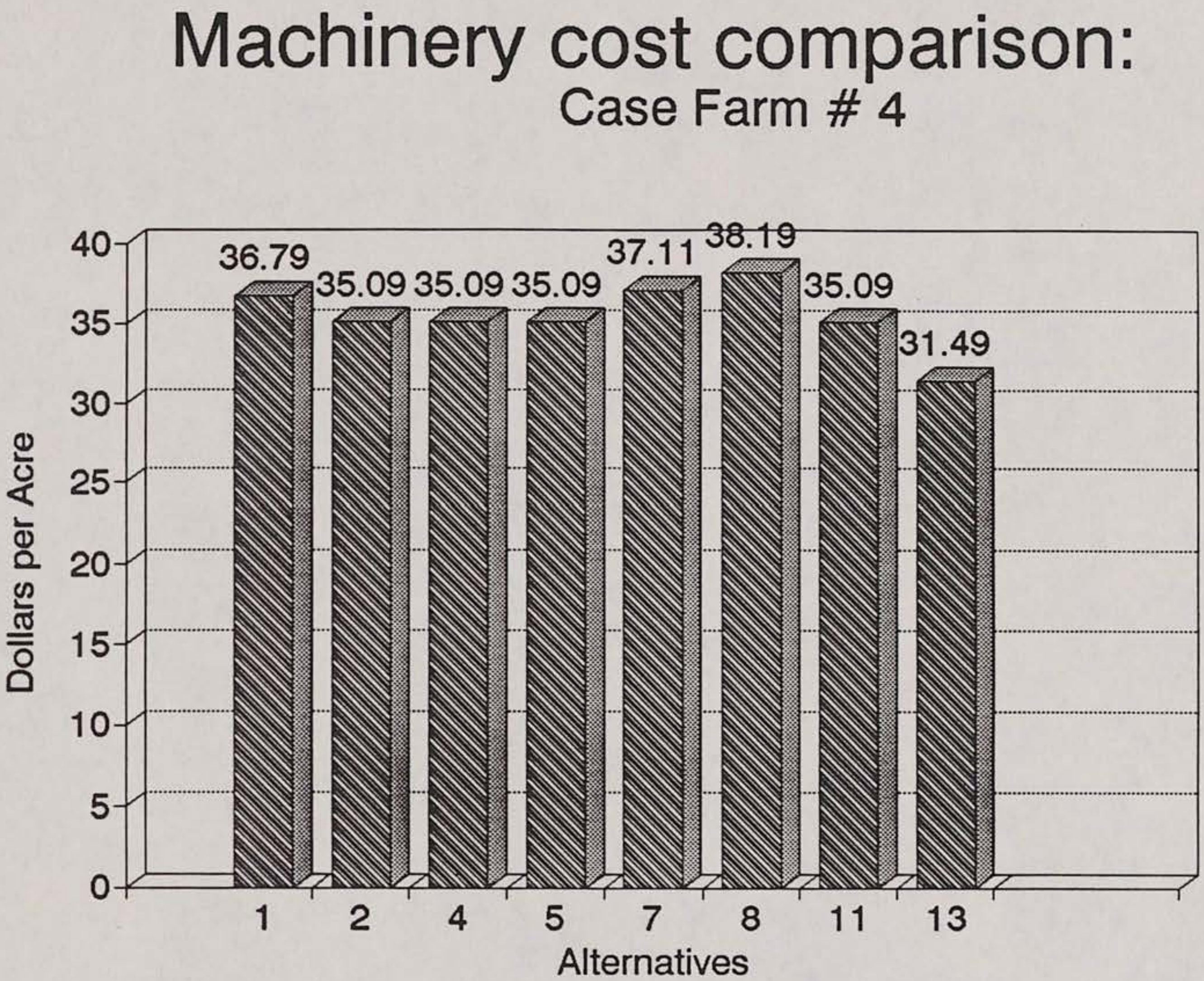
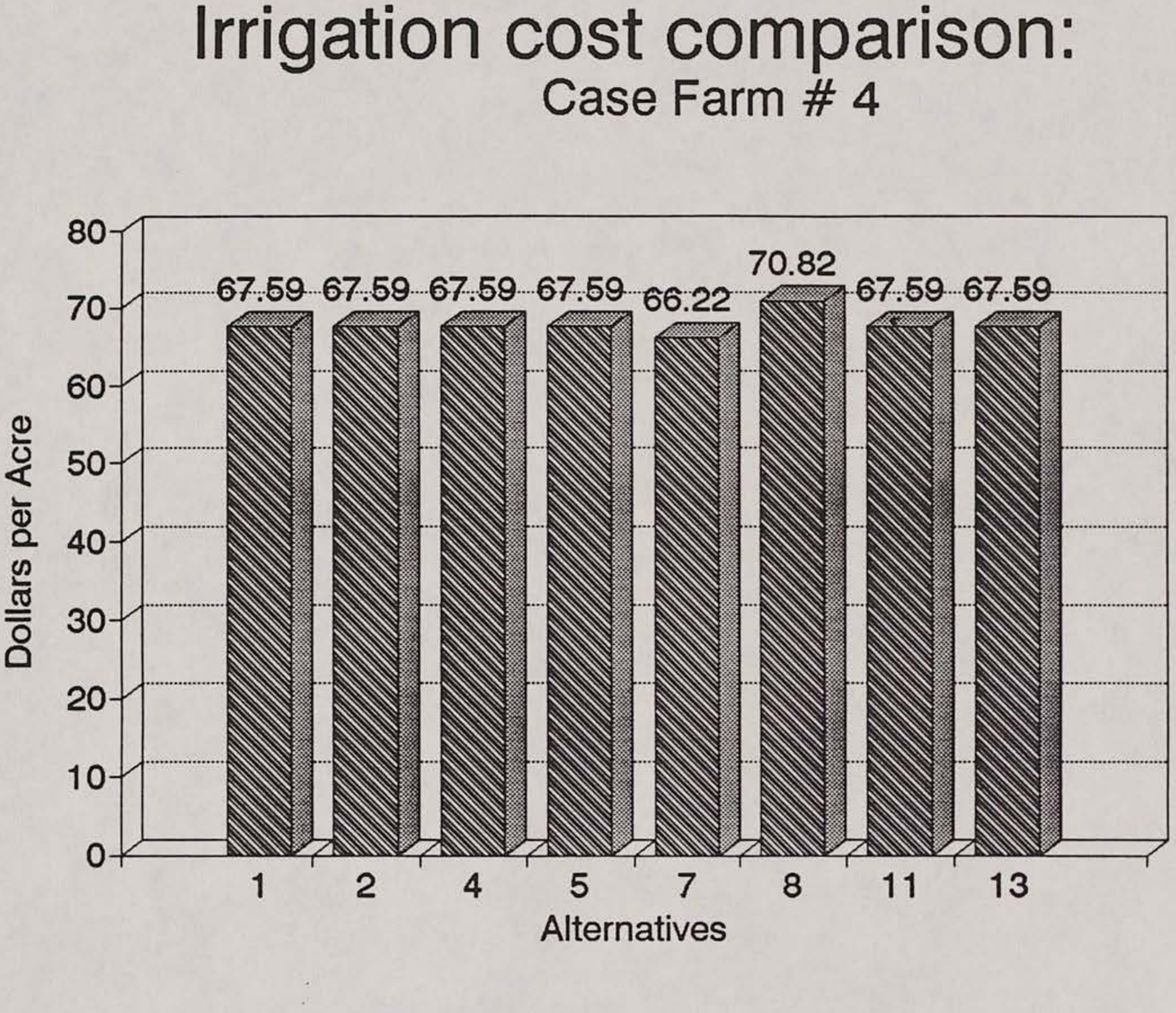

Labor cost comparison:
Case Farm # 4
Dollars per Acre
0
2
4
6
8
10
12
8.42
8.42
8.42
8.42
9.01
10.31
8.42
7.19
1
2
4
5
7
8
11
13
Alternatives

Figure 5.



Machinery cost comparison:
Case Farm # 4
40
35
30
25
20
15
10
5
0
Dollars per Acre
36.79
35.09
35.09
35.09
37.11
38.19
35.09
31.49
1
2
4
5
7
8
11
13
Alternatives

Figure 6.



Irrigation cost comparison:
Case Farm # 4
80
70
60
50
40
30
20
10
0
Dollars per Acre
67.59
67.59
67.59
67.59
66.22
70.82
67.59
67.59
1
2
4
5
7
8
11
13
Alternatives

Figure 7.

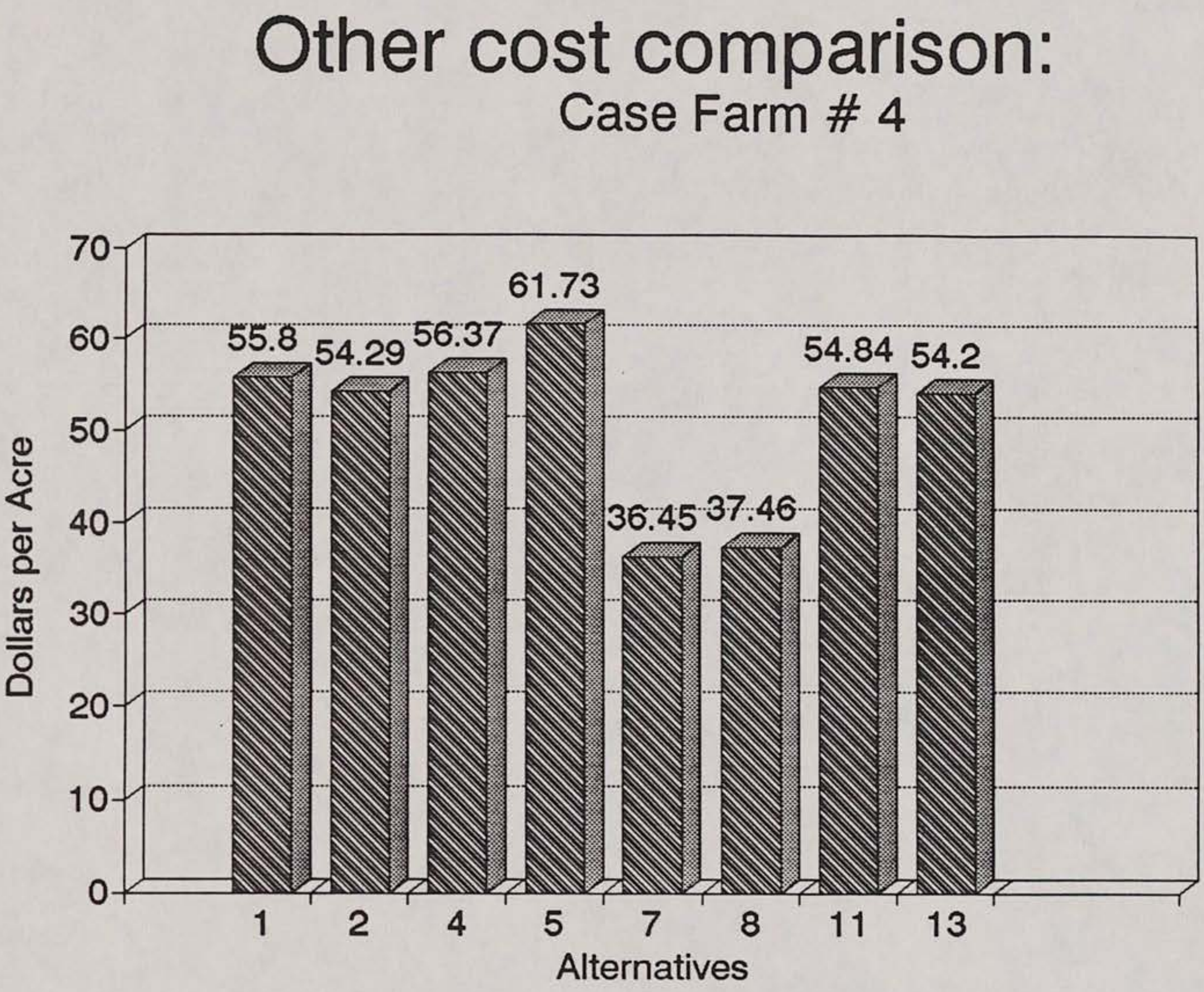

Other cost comparison:
Case Farm # 4
70
60
50
40
30
20
10
0
Dollars per Acre
55.8
54.29
56.37
61.73
36.45
37.46
54.84
54.2
1
2
4
5
7
8
11
13
Alternatives

Figure 8.

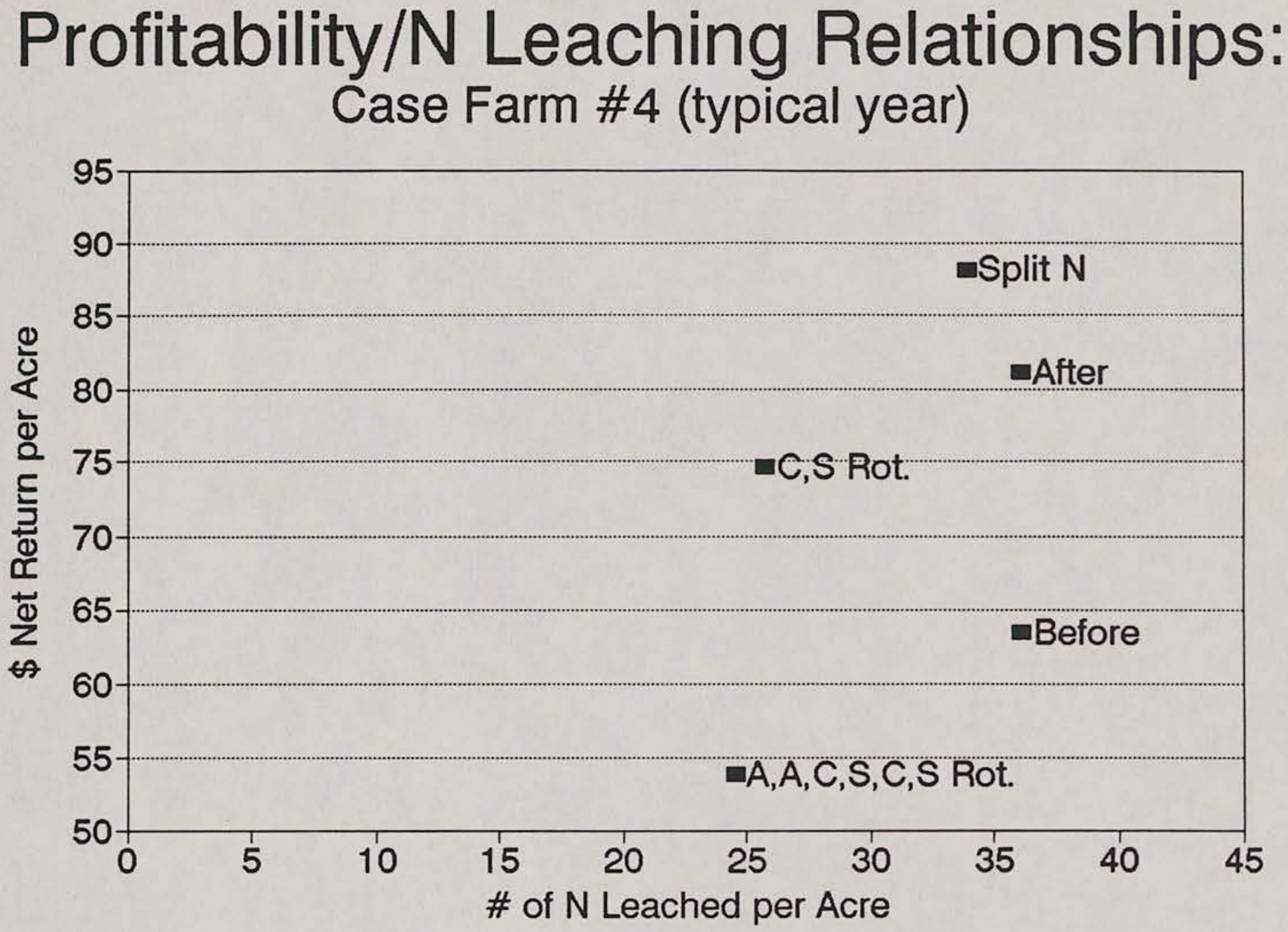

Profitability/N Leaching Relationships:
Case Farm #4 (typical year)
$ Net Return per Acre
# of N Leached per Acre
Split N
After
C,S Rot.
Before
A,A,C,S,C,S Rot.
95
90
85
80
75
70
65
60
55
50
0
5
10
15
20
25
30
35
40
45

Figure 9.

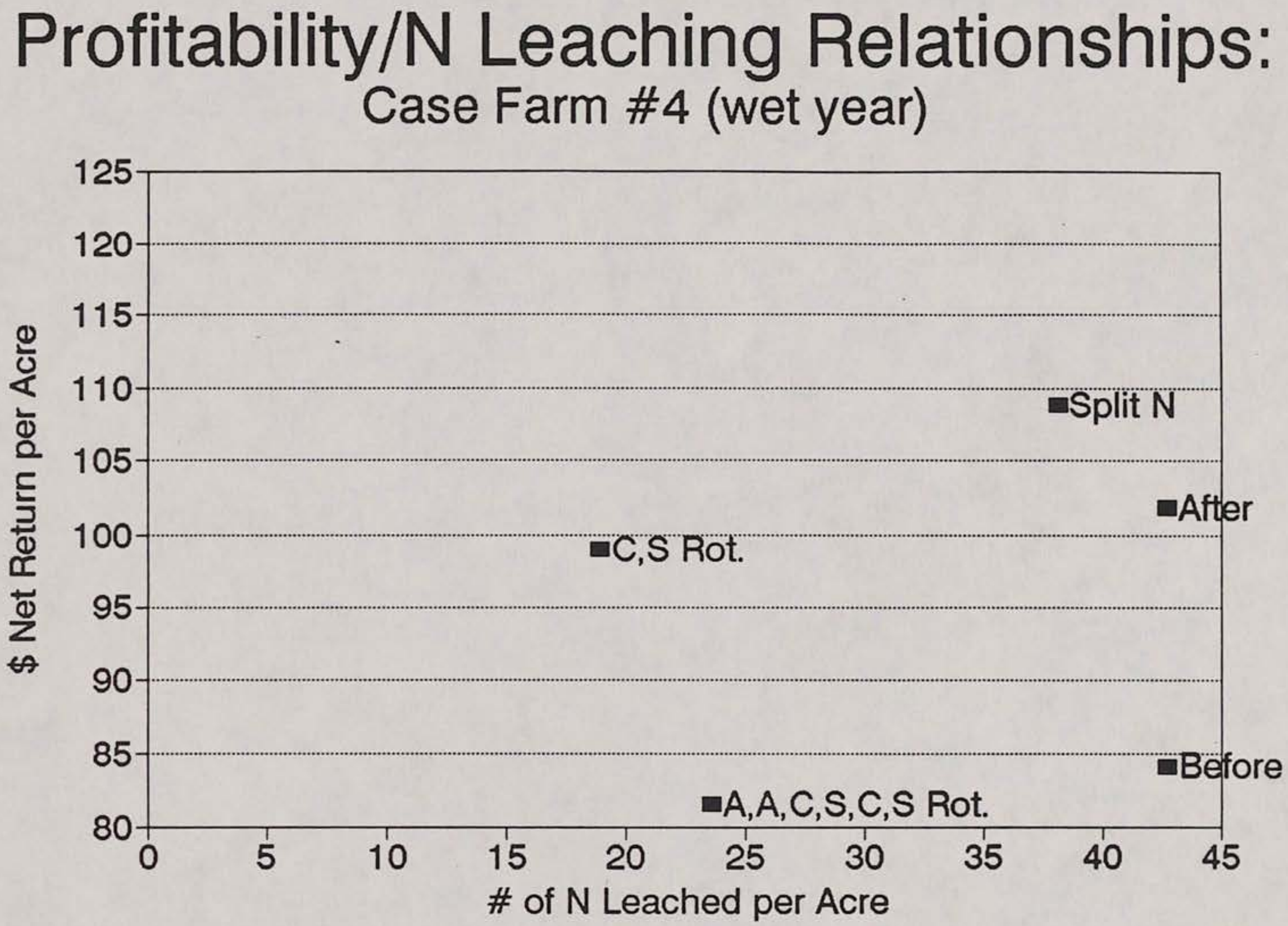

Profitability/N Leaching Relationships:
Case Farm #4 (wet year)
$ Net Return per Acre
125
120
115
110
105
100
95
90
85
80
Split N
After
C,S Rot.
Before
A,A,C,S,C,S Rot.
0
5
10
15
20
25
30
35
40
45
# of N Leached per Acre

Figure 10.

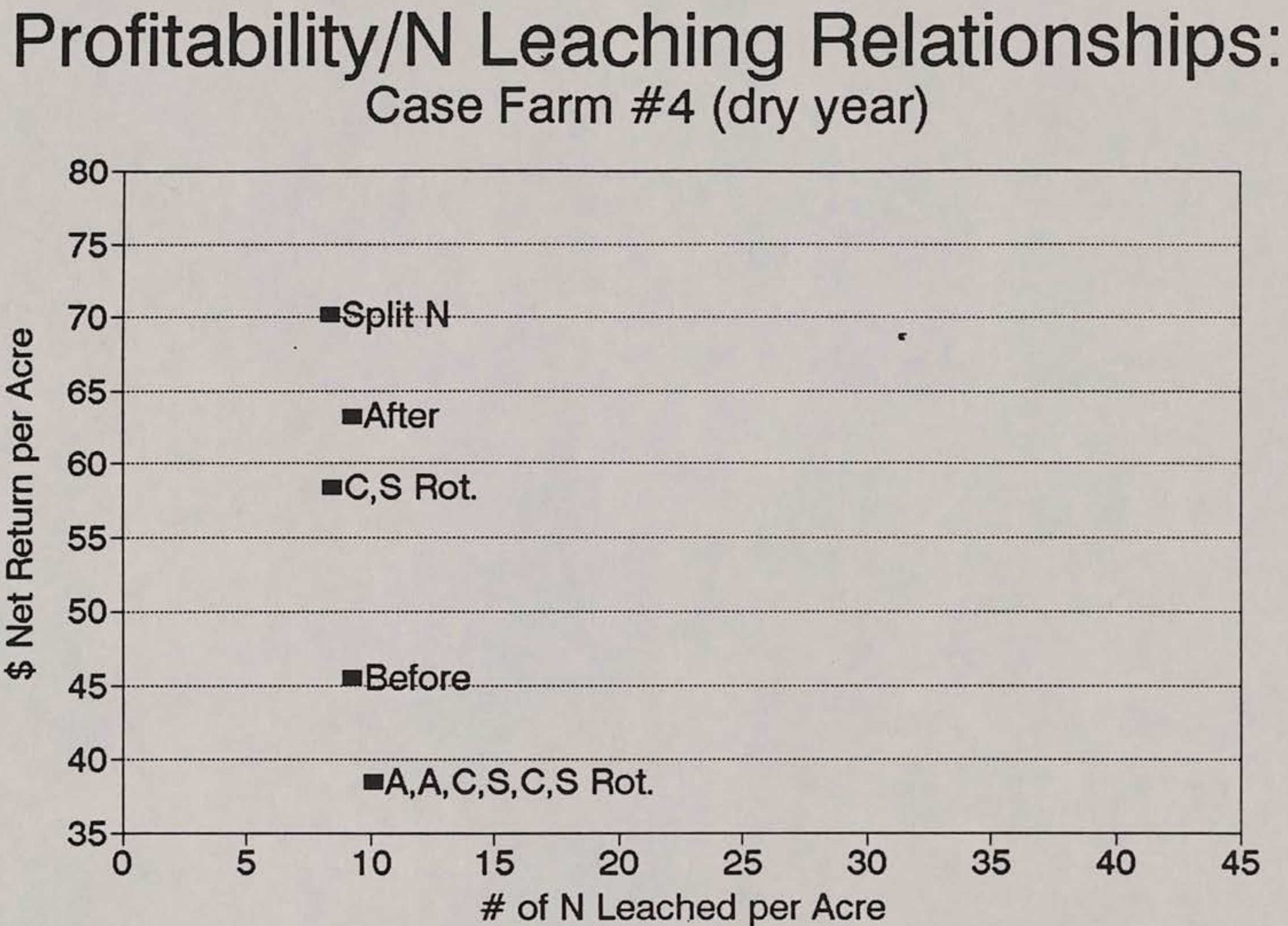
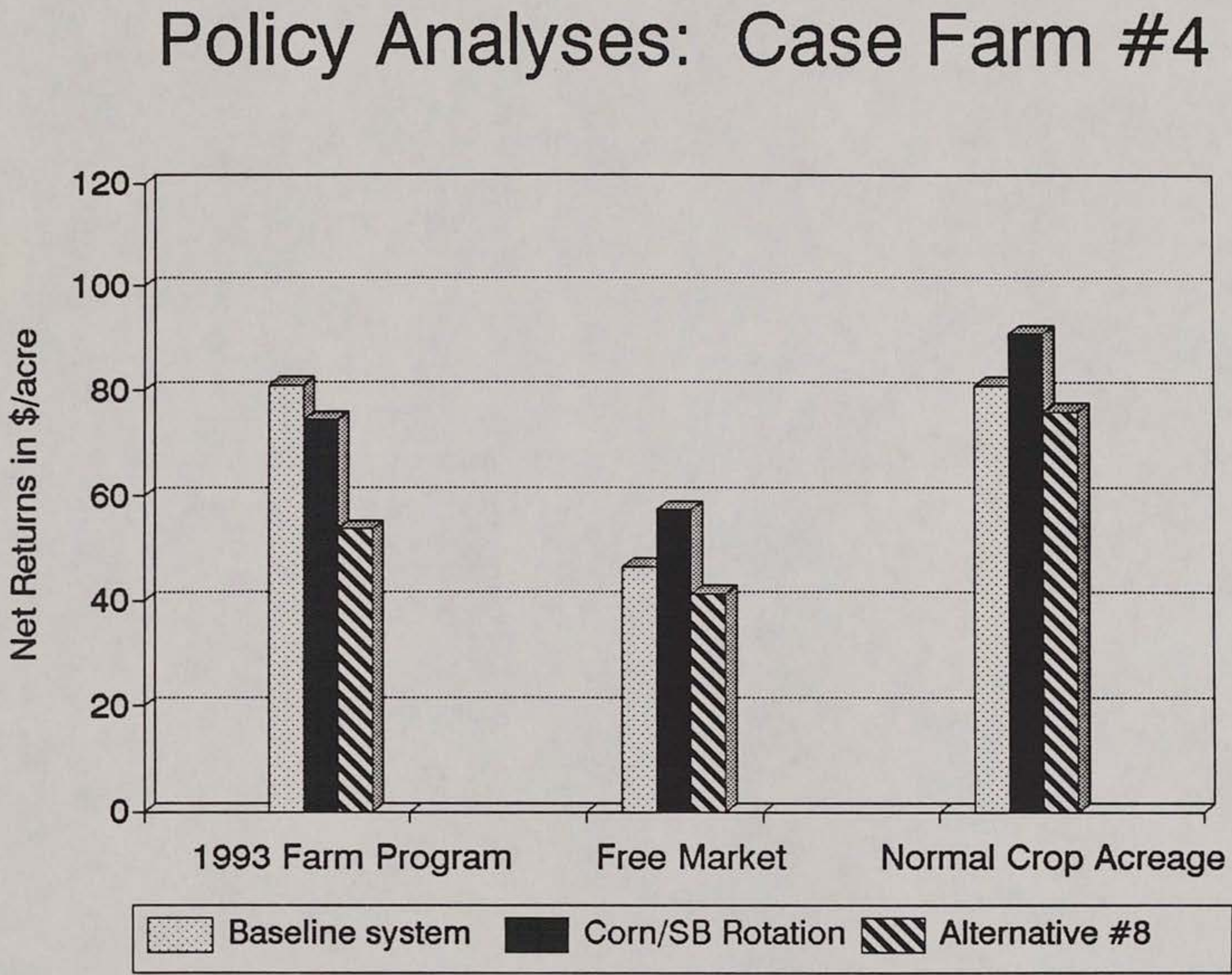

Profitability/N Leaching Relationships:
Case Farm #4 (dry year)
$ Net Return per Acre
80
75
70
65
60
55
50
45
40
35
0
5
10
15
20
25
30
35
40
45
# of N Leached per Acre
Split N
After
C,S Rot.
Before
A,A,C,S,C,S Rot.

Figure 11.


Policy Analyses: Case Farm #4
Net Returns in $/acre
120
100
80
60
40
20
0
1993 Farm Program
Free Market
Normal Crop Acreage
Baseline system
Corn/SB Rotation
Alternative #8