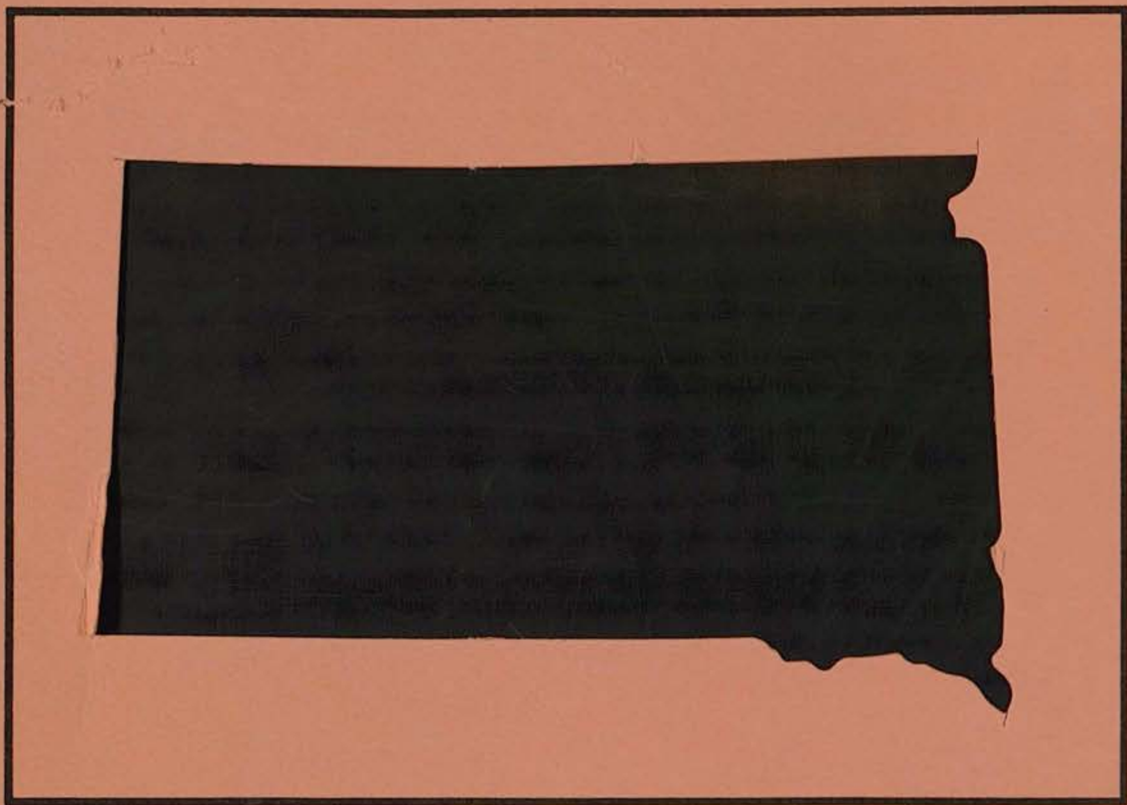

ECONOMICS DEPARTMENT

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. 2 Summary

by

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CASE FARM NO. 2 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. 2 is located in Moody County and followed a corn-soybean-oats rotation on the acres focused on in the analysis prior to enrollment in the Integrated Crop Management (ICM) program. It is a dryland operation that used conventional tillage prior to enrollment in the ICM program. The total operation consists of 1,858 acres, with 710 acres under the ICM program. We focused on 299 of those ICM acres in our analyses. Lamo and Clamo soils make up the majority of the ICM crop acres. These are medium to fine-textured soils overlying 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 ICM 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 ICM program incorporates pest and nutrient management, crop selection and rotation, and conservation measures into a more comprehensive management program than is usually associated with Agricultural Conservation Program[1] cost share. Practices may include soil and tissue testing, field scouting, cover crops, green manures, improved rotations, composting, and other techniques for reducing the use of agrichemicals.

Enrollment in the ICM program began in 1993 for Case Farm No. 2. After enrollment, Case Farm No. 2 switched to no-till corn and no-till drilled soybeans. Case Farm No. 2 received cost-share to help pay for crop

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[1] The ICM is one of many different practices that are administered through the USDA's Agricultural Conservation Program (ACP).

consulting. The total "projected" to be received each year in the program was $4,963/year, or $14,889 for the 3-year contract. At the projected cost share of $4,963/year, Case Farm No. 2 would receive $7/acre on 710 acres enrolled in the ICM program. However, with the amount that can be received limited to $3,500/year, Case Farm No. 2 is actually receiving $4.93/acre.

The farmer is receiving cost-share on nutrient management and pesticide management practices. The cost-share from both of these practices can go towards payment of the crop consultant. The cost-share payments from the two practices cover the crop consulting cost, so neither were included in the economics summary spreadsheet (Table 2). Practices that are being followed but not cost-shared are nutrient management, pesticide management, conservation cropping sequence, and crop residue.

Major Simulated Changes

Description of Practice Changes

In this study, we also performed profitability analyses for possible additional **practice** changes. These are changes that are not actually being used at this time, but that could be added to the "after" scenario. The key in Table 3 shows all of the different alternatives analyzed for this case farm. The practice changes for Case Farm No. 2 involved banding the fertilizer on corn (Alternative #3) and splitting the nitrogen application into two operations on corn (Alternative #4), one application at planting and the second application sometime in the middle of June. Alternative #18 incorporated the use of a 4-acre filter strip along the river. This alternative practice is discussed more in a later section of this report.

Description of System Changes

Also, 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 oats (as a nurse crop for alfalfa), alfalfa (harvested for 2 years after seeding), soybeans, and corn. In one rotation, soybeans are grown 2 years out of 6 and corn is only grown 1 year (Alternative #9); in the other, soybeans are grown 1 year and corn is grown 2 years (Alternative #10). Alternative #19 switched all of the acres to a reed canary grass/alfalfa mix. This alternative is discussed more in a later section of this report. Table 4 shows the yield estimates for the baseline "before", baseline "after", and the alternative practices and systems under different climate scenarios.

Input Expenditure Summary Comparison

Input expenditure comparisons were made between the baseline systems and the alternatives with practice or system changes. These comparisons were categorized into fertilizer, pesticide, fuel, labor, machinery, and other (seed cost, trucking, etc.) expenses and were put into separate bar charts (Figures 1-6). Practice changes involved little change in the input expenditures, while changing to more diverse rotations caused a more dramatic change in input expenditures. The inclusion of alfalfa, which tends to be machinery and labor intensive, in the diverse rotations led to higher machinery, fuel, and labor costs, but it also dropped pesticide and fertilizer costs.

Nitrate Leaching Comparisons

The nitrate leaching estimates below the root zone 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 groundwater quality (nitrates) under various rotational cropping systems over several years of simulation.

Case Farm No. 2 had two soils analyzed with different management alternatives (Table 3). The "whole-farm" nitrate leaching is dependent upon how many acres of each soil were used in the analysis. As an example, if there were 10#/Ac of 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 nitrate leaching amounts given in pounds/Ac (Figures 7-9) are whole-farm leaching annual averages**. The nitrate 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 magnitudes and variability of nitrate leaching might be on typical farms in the Big Sioux Aquifer area.

The annual average whole-farm leaching of nitrates for an average year is less than 5# for any of the alternatives. For a wet year, the leaching jumped to around 15# of nitrates per year. In both of these cases, practice and system changes tended to decrease the leaching amount. In a dry year, the practice and system changes were less than 3# of nitrates per year. At this low rate, the model is not sensitive enough to identify the subtle differences between practices.

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. These different conditions had varying effects on the economic and environmental results for the various 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 their economic and environmental results (stated in annual averages), illustrating tradeoffs and complements for each precipitation situation (Figures 7-9).

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

In the "typical" year (Figure 7), profitability increased dramatically from the baseline "before" scenario ($39.28/acre) to the baseline "after" scenario ($68.99/acre). Profitability was slightly greater for the additional practices--$71.12 and $73.29/per acre for banding fertilizer and splitting nitrogen application, respectively--compared to the baseline "after" scenario. The alternative systems had significantly greater economic returns ($96.28/acre for the O/A,A,A,S,C,S rotation and $82.63/acre for the O/A,A,A,C,S,C rotation) than the baseline systems and the alternative practices. Environmental results for the baseline "after" scenario showed a slight decrease in the amount of nitrate leached (2.9 lbs/acre), compared to the baseline "before" (3.3 lbs/acre), as expected. Even further decreases in the amount of nitrate leached were observed for banding fertilizer (2.3 lbs/acre) and splitting nitrogen application (2.4 lbs/acre). The amount of nitrate leaching for the O/A,A,A,S,C,S rotation (2.4 lbs/acre) was similar to that for the alternative practices, and was slightly lower for the O/A,A,A,C,S,C rotation (2 lbs/acre). It should be emphasized that the nitrate leaching calculated by the model was only to the nearest pound, but the 6-year annual average is given in tenths of pounds to help the reader see trends.

In the "wet" year (Figure 8), the profitability rankings remained the same as for the "typical" year, except that the oats/alf-alf-alf-corn-soybeans-corn rotation dropped below all of the other scenarios except the baseline "before" scenario. This could be attributed to the low corn yield estimates for this scenario, due to late planting and a high water table in wet years. Environmental results showed that the alternative practices had a lower level of nitrate leaching (13 lbs/acre for banding nitrogen and 10 lbs/acre for splitting nitrogen applications) than the baseline "after" (14 lbs/acre), and the alternative systems had lower levels of nitrate leaching than the alternative practices (9 lbs/acre for the O/A,A,A,S,C,S rotation and 7 lbs/acre for the O/A,A,A,C,S,C rotation).

In the "dry" year (Figure 9), the profitability rankings were the same as the "wet" year. The levels of nitrate leaching were extremely low for the baseline systems and for all of the alternatives. However, the alternative systems were slightly higher in nitrate leaching than the baseline systems and the alternative practices. This is due to the relatively high amount of nitrate leaching that is calculated for the oats/alfalfa and the first full year of alfalfa in the alternative systems. However, the difference between the alternative systems and the other systems is very small and is likely to be insignificant.

It appears that the alternative practices' and systems' abilities to reduce the amount of nitrate leaching is most noticeable in a "wet" year, when there are higher overall amounts of nitrate being leached for all systems.

Sensitivity Analyses

In addition to the simulated practice and system changes, some sensitivity analyses were done with alfalfa prices (Figure 10) and yields (Figure 11). For these analyses, whole farm net returns were recorded for the baseline "after" system and the alternative systems which included alfalfa as alfalfa prices or alfalfa yields were decreased. The purpose of these analyses was to determine how sensitive the rankings of the different alternatives are to assumed alfalfa prices and yields. Case Farm No. 2 did not have any alfalfa in the baseline rotation. Prior to the sensitivity analyses, the oats/alfalfa-alfalfa-alfalfa-soybeans-corn-soybeans rotation had the highest profitability, in a "typical" weather year, followed by the oats/alfalfa-alfalfa-alfalfa-corn-soybeans-corn rotation, and the baseline "after". In order to change the profitability rankings for Case Farm No. 2, an 18% decrease in price (Figure 10) or a 25% decrease in yield (Figure 11) would be required to make the baseline "after" system more profitable than either of the alternative systems.

Selected analyses were conducted to explore policy alternatives to green payments (such as ICM 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 would be dropped and price supports (i.e., deficiency payments) would be dropped and crop mixes would be influenced more strongly by market prices. In the "normal crop acreage" scenario, the deficiency payments would be decoupled from the crops grown (i.e., a flat payment equivalent to that in the "after" baseline was assumed for each case farm) and overall set-aside acreage was left the same as in the "after" baseline (for all practices and systems). These analyses were done only for the baseline "after" and alternatives with a rotational change from the baseline "after" (Alternatives #9 and #10) in order to determine the relative profitability of different systems under these policy options, compared to provisions of the farm program in 1993. The results of this analysis show that these policy options have little influence on the profitability ranking of the systems under "typical" weather conditions. Under all three policy scenarios, the O/A,A,A,S,C,S rotation is the most profitable, and it is followed by the O/A,A,A,C,S,C rotation and the baseline "after" system (Figure 12). As indicated in Figure 12, even without fundamental policy changes, there would appear to be adequate economic incentive for farmers to adopt the more diverse rotations.

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

Other analyses were performed for comparisons to the baseline "after". They consisted of including a 4-acre reed canary grass filter strip on land along the river on one parcel (Alternative #18) and switching all (299) of the acres to a reed canary grass/alfalfa mix (Alternative #19). For the filter strip, many of the whole-farm per acre input expenditures were similar to those of the baseline system, since only 4 acres were assumed to be used for the reed canary grass. Profitability increased slightly, from $68.99/acre for the baseline "after" system to $69.04. This is due to the 4 acres in the filter strip taking the place of 4 set-aside acres, which had a more negative return (-$36.30/acre) than the filter strip acres (-$32.95/acre). Switching to a reed canary grass/alfalfa mix for all of the acres lowered input expenditures drastically. For the "typical" year, the reed canary grass/alfalfa mix had an estimated yield of 3 tons/acre, harvested in two cuttings and put into round bales. The value for the reed canary grass/alfalfa mix was based on the calculated number of AUM's per acre and the price/AUM in the CARE database, which was $14.50/AUM. The reed canary grass/alfalfa system had a net return per acre of $18.98, which was about $50/acre less than the baseline "after" system. Consequently, this alternative system appears to have little chance of viability for voluntary, cost-shared adoption.

Methodological Notes

In some situations, we were unable to model both economic and environmental implications of an alternative. For Case Farm No. 2, there was not enough information to enable us to model the impact on nitrate leaching of using reed canary grass in a filter strip or in a whole-field scenario with alfalfa. The analysis of those alternatives was based solely on economic returns.

Table 1. CARE Budget Spreadsheet: Case Farm #2 - Before Program

	Corn	Soybeans	Oats 1	set aside	WHOLE FARM
Units	Bushels	Bushels	Bushels	Bushels	
Acres	117	117	52	13	299.00
Yield/ac	85	25	65	0	
Defc. Pmts./ac	$31.00	$0.00	$0.00	$0.00	
Total Receipts ($/acre)	$201.00	$137.50	$114.25	$0.00	
Operating Costs ($/acre)	$156.83	$91.66	$82.33	$36.30	
Net Returns ($/acre)	$44.17	$45.84	$31.92	($36.30)	
********* *********	*********	*********	*********	*********	*********
Total Crop Returns ($/crop)	$5,167.89	$5,363.28	$1,659.84	($471.90)	$11,719.11
				$/ac =	$39.19

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

	Corn	Soybeans	Oats	set aside	WHOLE FARM
Units	Bushels	Bushels	Bushels	Bushels	
Acres	117	117	52	13	299.00
Yield/ac	85	35	65	0	
Defc. Pmts./ac	$31.00	$0.00	$0.00	$0.00	
Total Receipts ($/acre)	$201.00	$192.50	$114.25	$0.00	
Operating Costs	$151.77	$76.47	$80.30	$36.30	
Net Returns ($/acre)	$49.23	$116.03	$33.95	($36.30)	
********* *********	*********	*********	*********	*********	*********
Total Crop Returns ($/crop)	$5,759.91	$13,575.51	$1,765.40	($471.90)	$20,628.92
				$/ac =	$68.99

Table 3. Baseline Systems and Other Possible Practice and System Changes, Case Farm No. 2

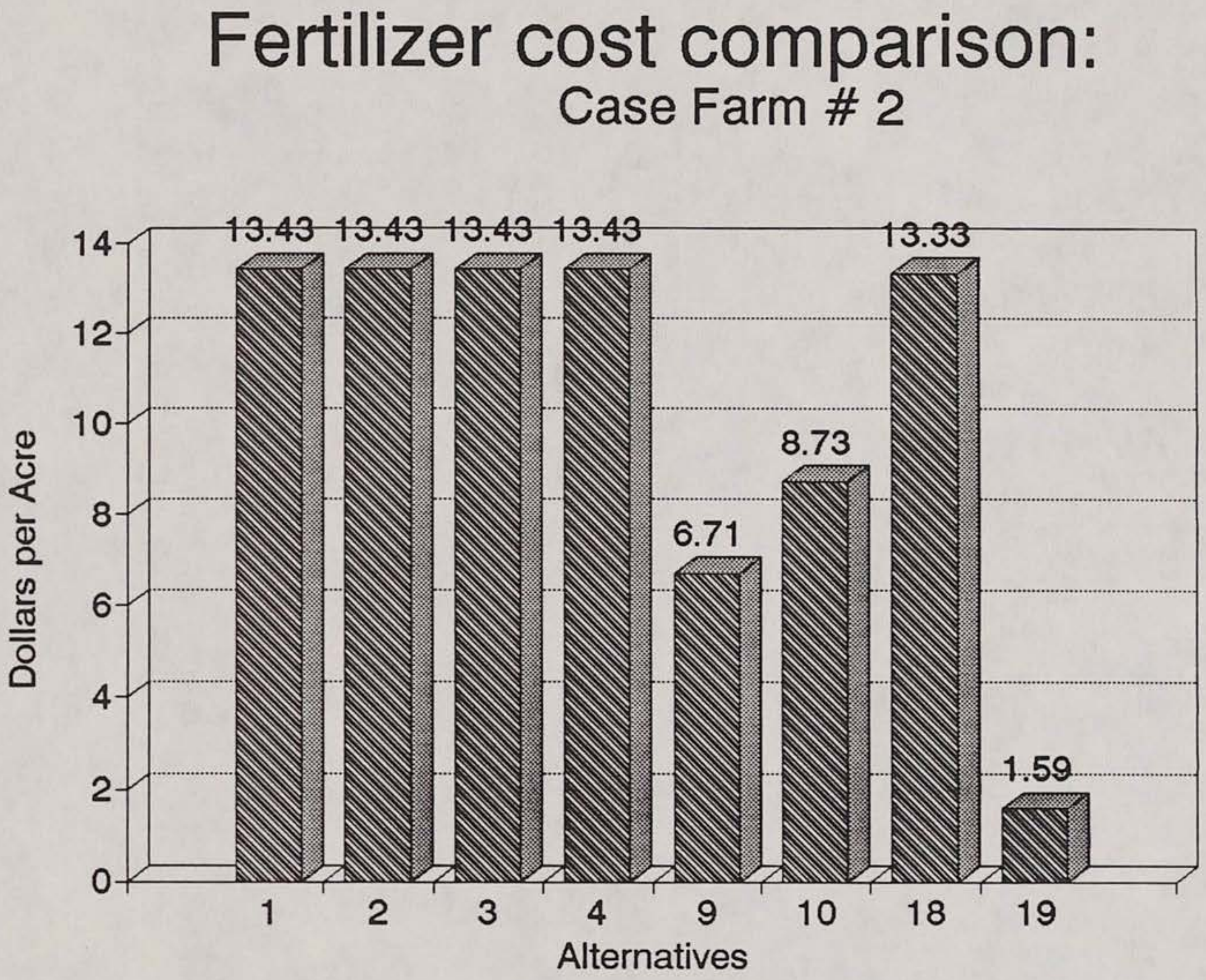
Key #	Alternative Description
1	Baseline (Before)
2	Baseline (After)
3	Banding fertilizer
4	Splitting N application
9	O/A,A,A,S,C,S rotation*
10	O/A,A,A,C,S,C rotation**
18	Reed Canary filter strip
19	Reed Canary/Alfalfa Mix

*-Oats/Alfalfa,Alfalfa,Alfalfa,Soybeans,Corn,Soybeans rotation
**-Oats/Alfalfa,Alfalfa,Alfalfa,Corn,Soybeans,Corn rotation

Table 4. Yield Estimates for Various Management Practices with Different Climates for Case Farm #2.

System, field rotation and soils	Corn Yields in Bu/ac. Average	Dry	Wet	Soybean Yields in Bu/ac. Average	Dry	Wet	Oat Yields Bu/ac. Average	Dry	Wet	Alfalfa Yields in Tons/ac. Average	Dry	Wet
"Before"												
Parcel A (Clamo) C,S rotation	85	75	55	25	22	22						
Parcel B (Lamo) C,S rotation	85	75	50	25	22	22						
Parcel C (Lamo) C,S,O rotation	85	75	50	25	22	22	65	50	30			
"After" No-Till for both Corn & Soybeans												
Parcel A (Clamo) C,S rotation	85	75	55	35	30	30						
Parcel B (Lamo) C,S rotation	85	75	50	35	30	30						
Parcel C (Lamo) C,S,O rotation	85	75	50	35	30	30	65	50	30			
Banding Fertilizer												
Parcel A (Clamo) C,S rotation	87	77	57	35	30	30						
Parcel B (Lamo) C,S rotation	87	77	52	35	30	30						
Parcel C (Lamo) C,S,O rotation	87	77	52	35	30	30	65	50	30			
Splitting N Applications												
Parcel A (Clamo) C,S rotation	90	80	60	35	30	30						
Parcel B (Lamo) C,S rotation	90	80	55	35	30	30						
Parcel C (Lamo) C,S,O rotation	90	80	55	35	30	30	65	50	30			
O/A,A,A,S,C,S rotation												
Parcel A (Clamo) O/A,A,A,S,C,S rotation	85	75	55	35	30	30	70	55	35	5	3.5	3
Parcel B (Lamo) O/A,A,A,S,C,S rotation	85	75	50	35	30	30	70	55	35	5	3.5	3
Parcel C (Lamo) O/A,A,A,S,C,S rotation	85	75	50	35	30	30	70	55	35	5	3.5	3
O/A,A,A,C,S,C rotation												
Parcel A (Clamo) O/A,A,A,C,S,C rotation	80	70	50	35	30	30	65	50	30	5	3.5	3
Parcel B (Lamo) O/A,A,A,C,S,C rotation	80	70	45	35	30	30	65	50	30	5	3.5	3
Parcel C (Lamo) O/A,A,A,C,S,C rotation	80	70	45	35	30	30	65	50	30	5	3.5	3

Figure 1.



Fertilizer cost comparison:
Case Farm # 2
Dollars per Acre
14
12
10
8
6
4
2
0
13.43
13.43
13.43
13.43
6.71
8.73
13.33
1.59
1
2
3
4
9
10
18
19
Alternatives

Figure 2.

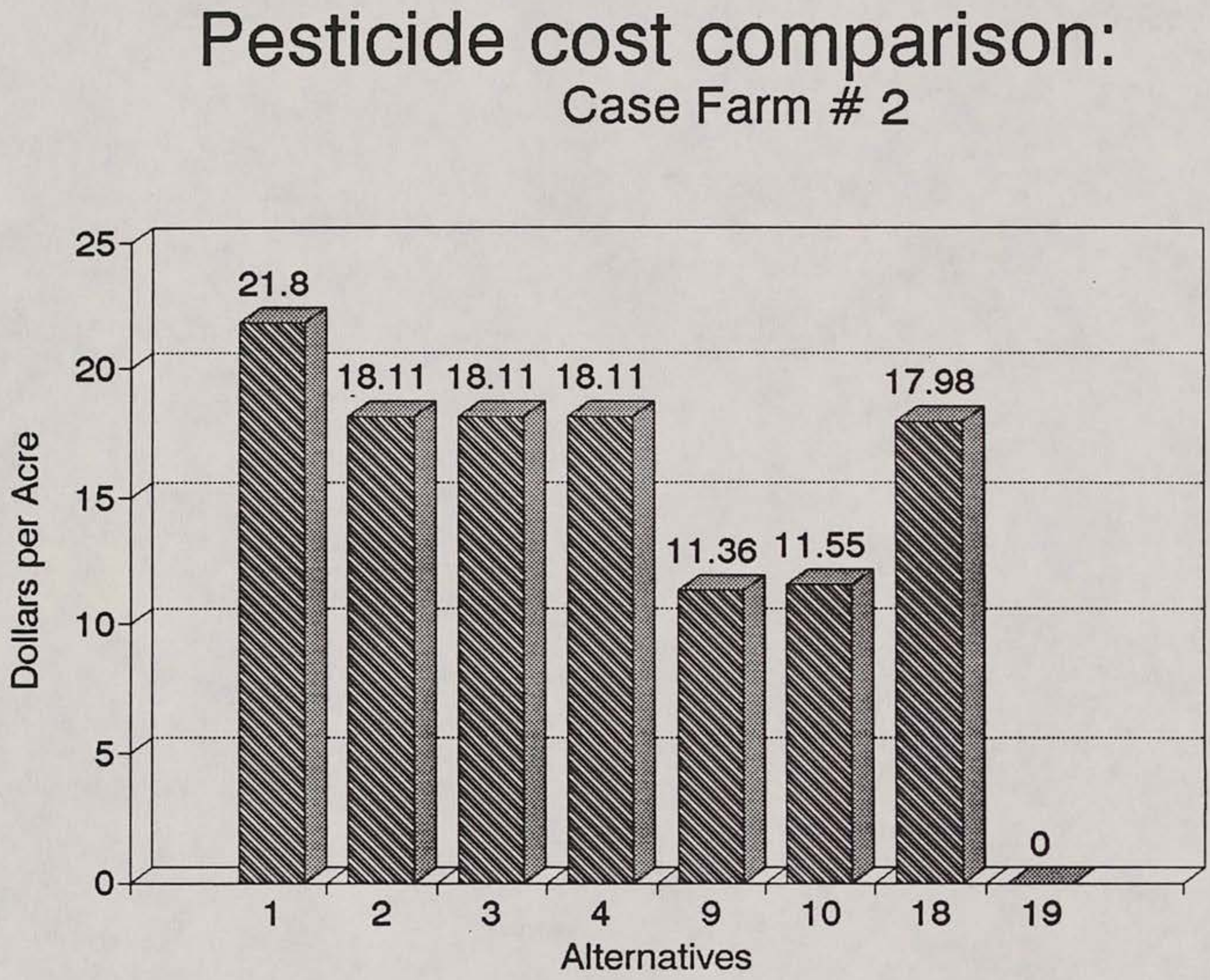
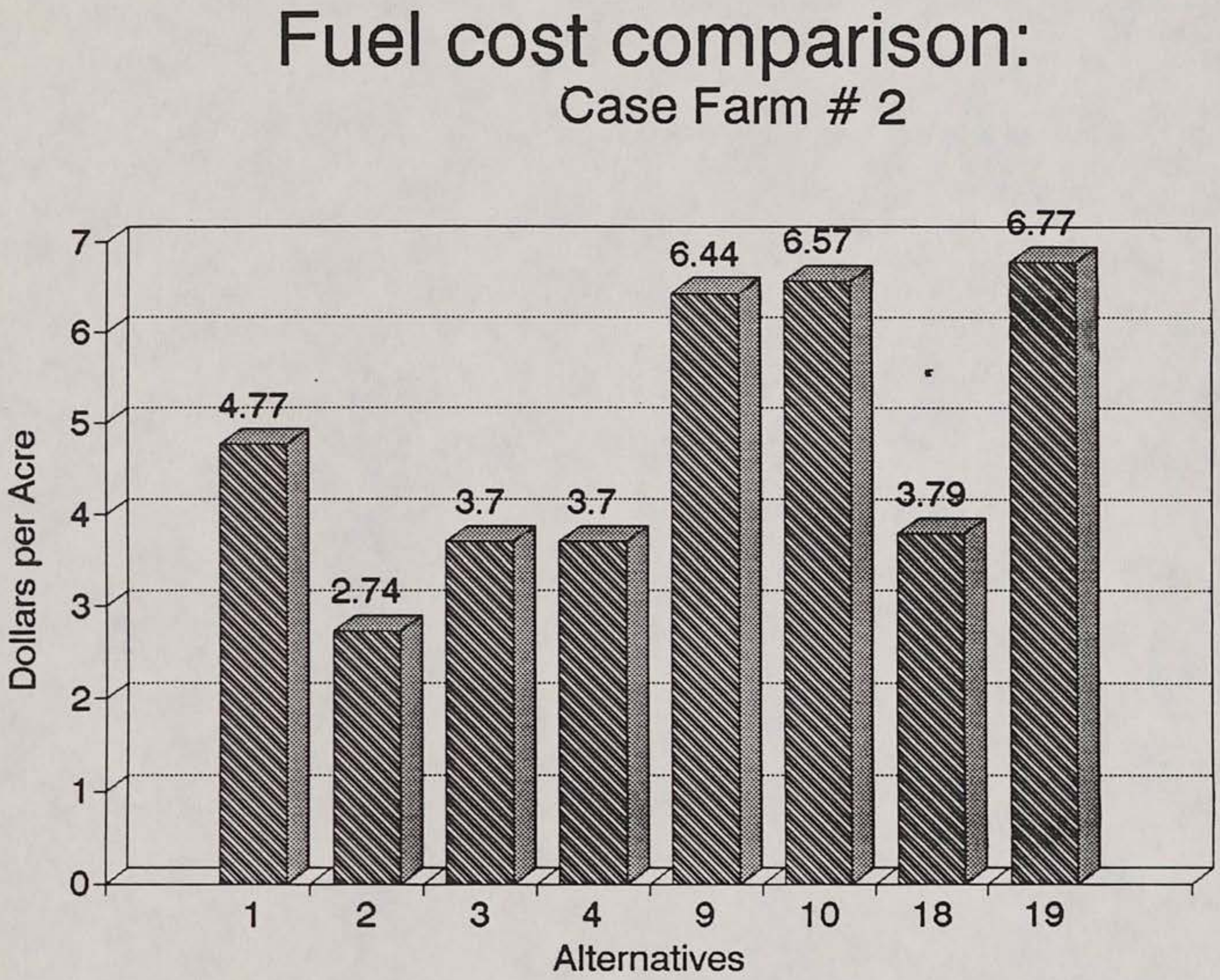

Pesticide cost comparison:
Case Farm # 2
25
20
15
10
5
0
Dollars per Acre
21.8
18.11
18.11
18.11
11.36
11.55
17.98
0
1
2
3
4
9
10
18
19
Alternatives

Figure 3.

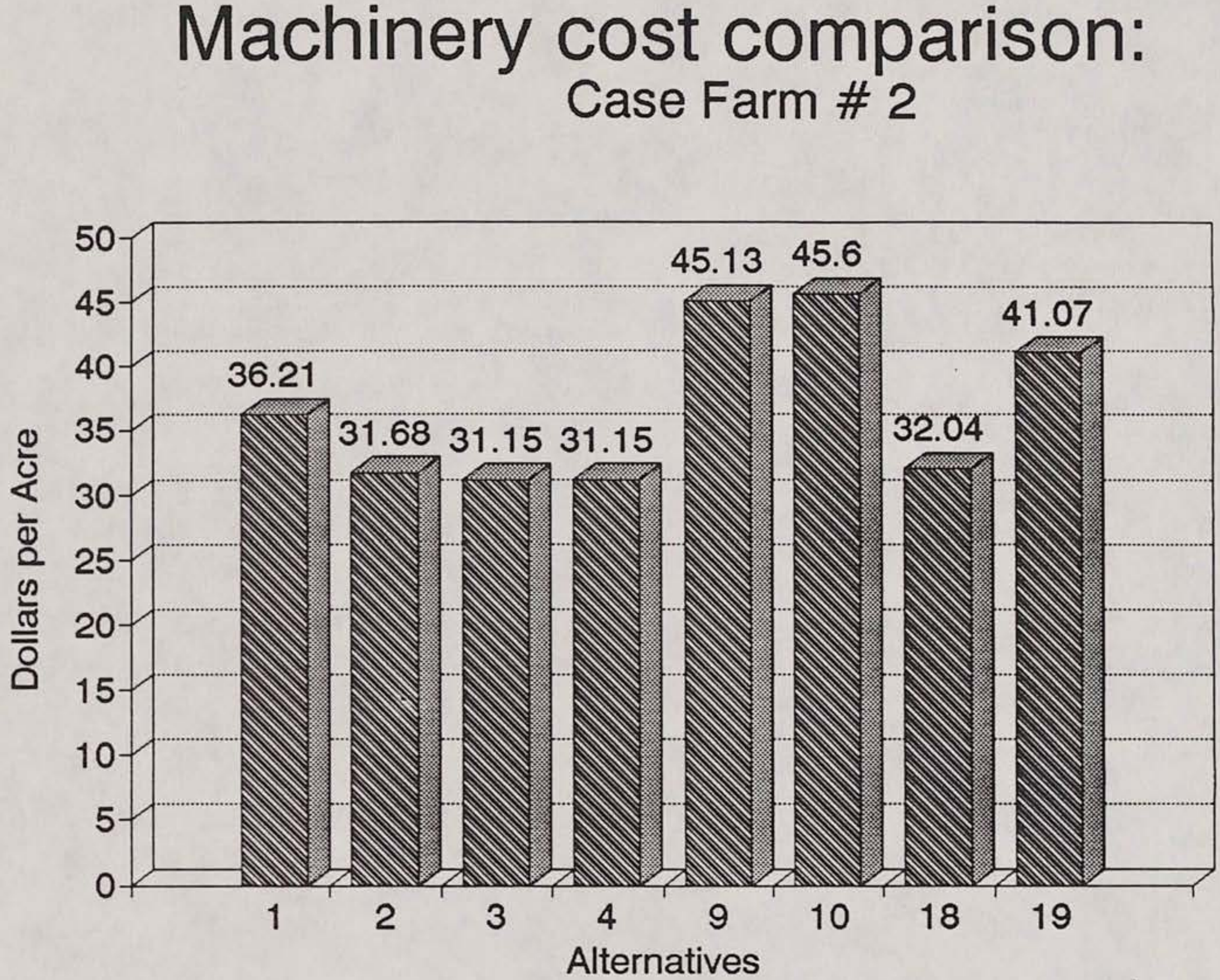


Fuel cost comparison:
Case Farm # 2
Dollars per Acre
0
1
2
3
4
5
6
7
4.77
2.74
3.7
3.7
6.44
6.57
3.79
6.77
1
2
3
4
9
10
18
19
Alternatives

Figure 4.

Labor cost comparison:
Case Farm # 2
Dollars per Acre
0
2
4
6
8
10
12
7.42
5.96
5.89
5.89
10.73
10.89
6.06
11.54
1
2
3
4
9
10
18
19
Alternatives

Figure 5.



Machinery cost comparison:
Case Farm # 2
50
45
40
35
30
25
20
15
10
5
0
Dollars per Acre
36.21
31.68
31.15
31.15
45.13
45.6
32.04
41.07
1
2
3
4
9
10
18
19
Alternatives

Figure 6.

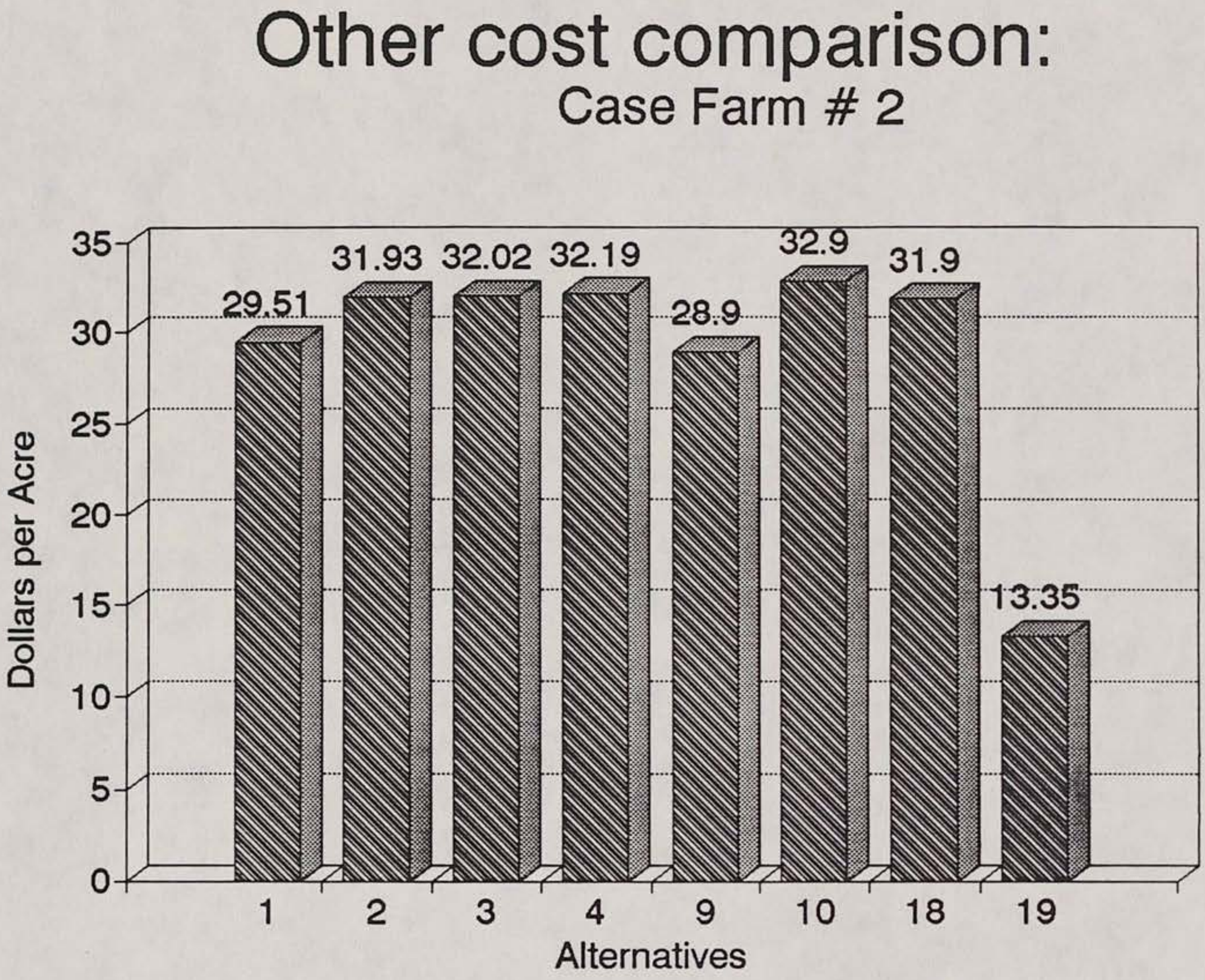

Other cost comparison:
Case Farm # 2
35
30
25
20
15
10
5
0
Dollars per Acre
29.51
31.93
32.02
32.19
28.9
32.9
31.9
13.35
1
2
3
4
9
10
18
19
Alternatives

Figure 7.

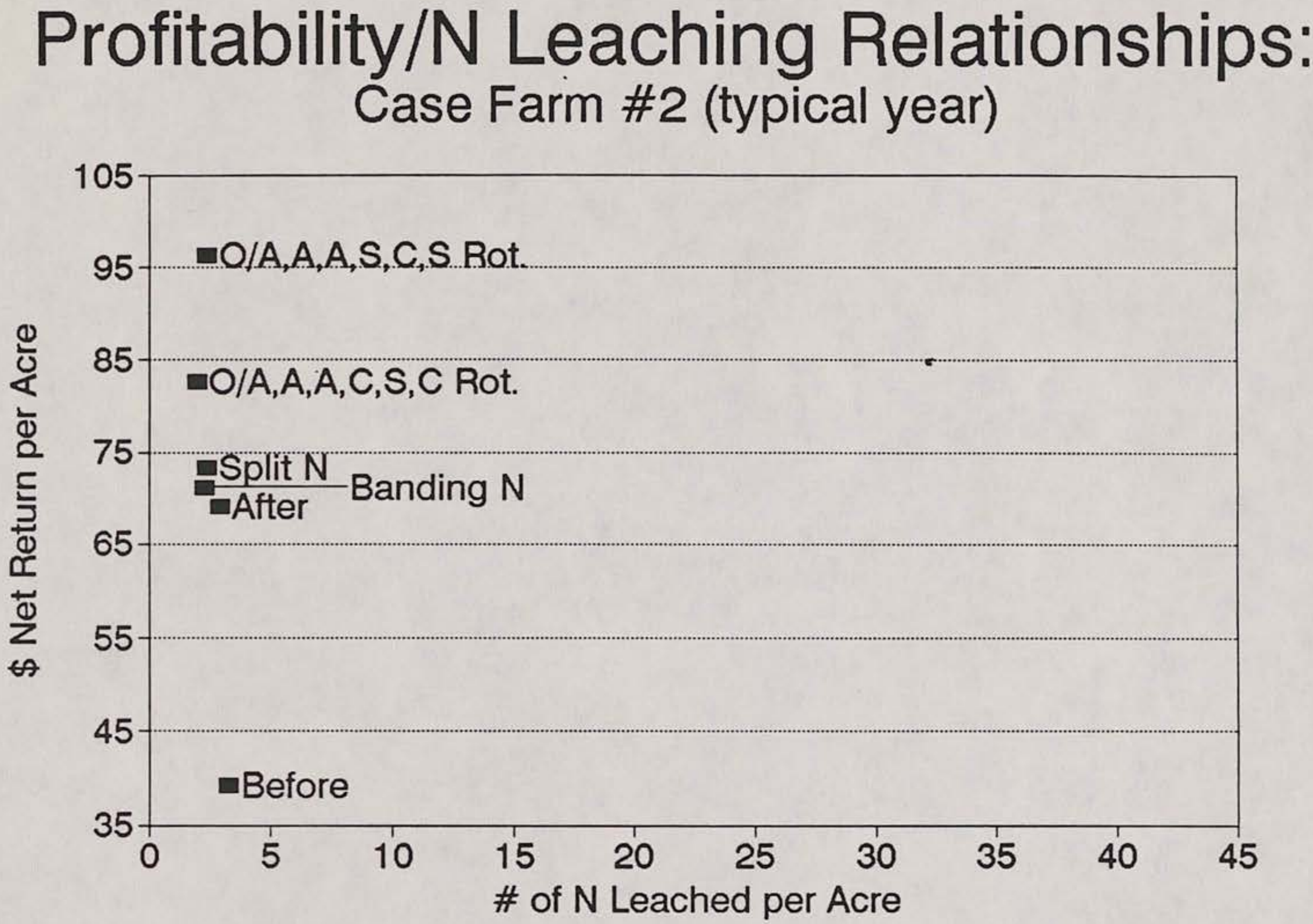

Profitability/N Leaching Relationships:
Case Farm #2 (typical year)
105
95
85
75
65
55
45
35
$ Net Return per Acre
O/A,A,A,S,C,S Rot.
O/A,A,A,C,S,C Rot.
Split N
Banding N
After
Before
0
5
10
15
20
25
30
35
40
45
# of N Leached per Acre

Figure 8.

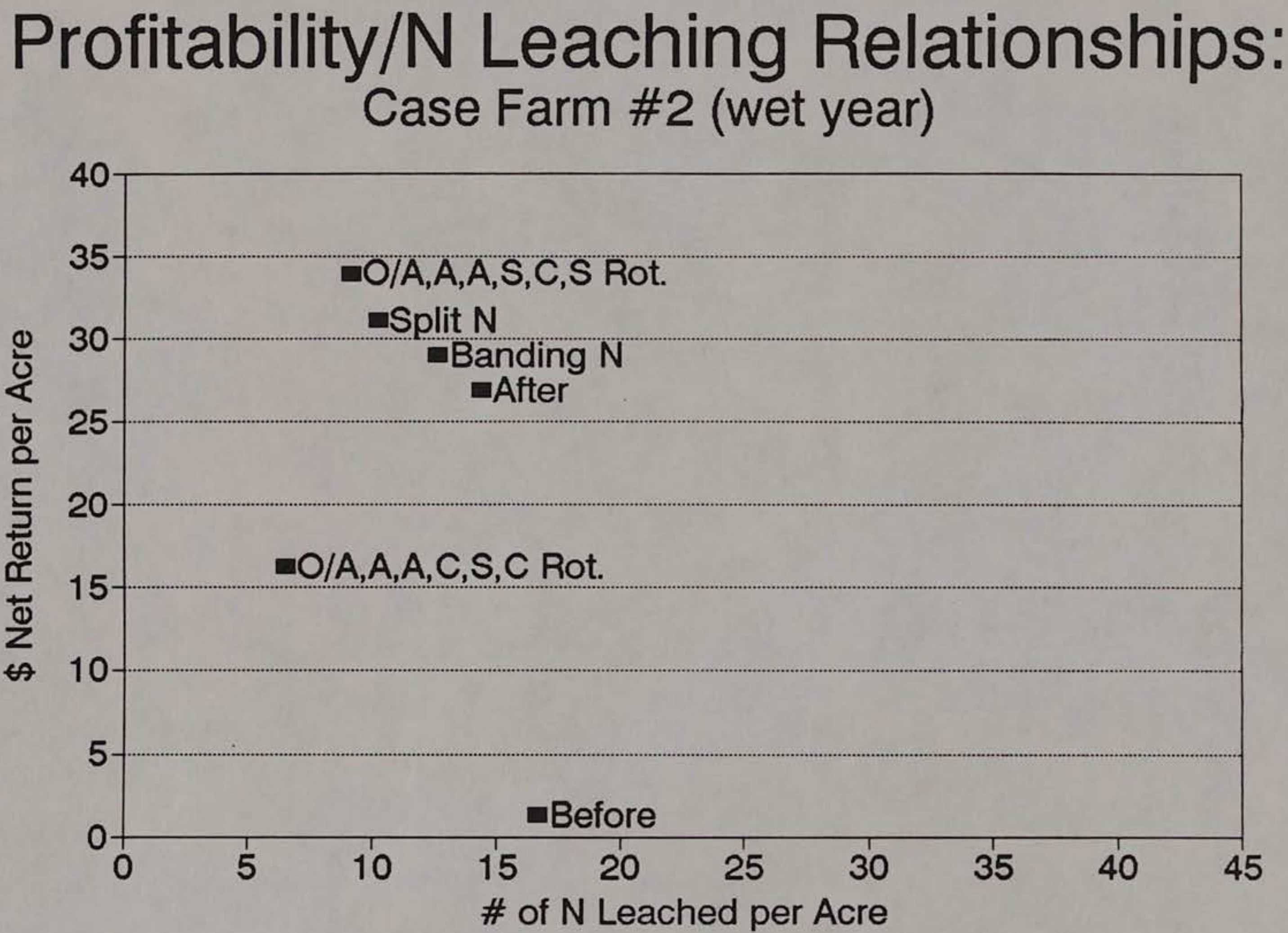

Profitability/N Leaching Relationships:
Case Farm #2 (wet year)
$ Net Return per Acre
# of N Leached per Acre
O/A,A,A,S,C,S Rot.
Split N
Banding N
After
O/A,A,A,C,S,C Rot.
Before
0
5
10
15
20
25
30
35
40
45

Figure 9.

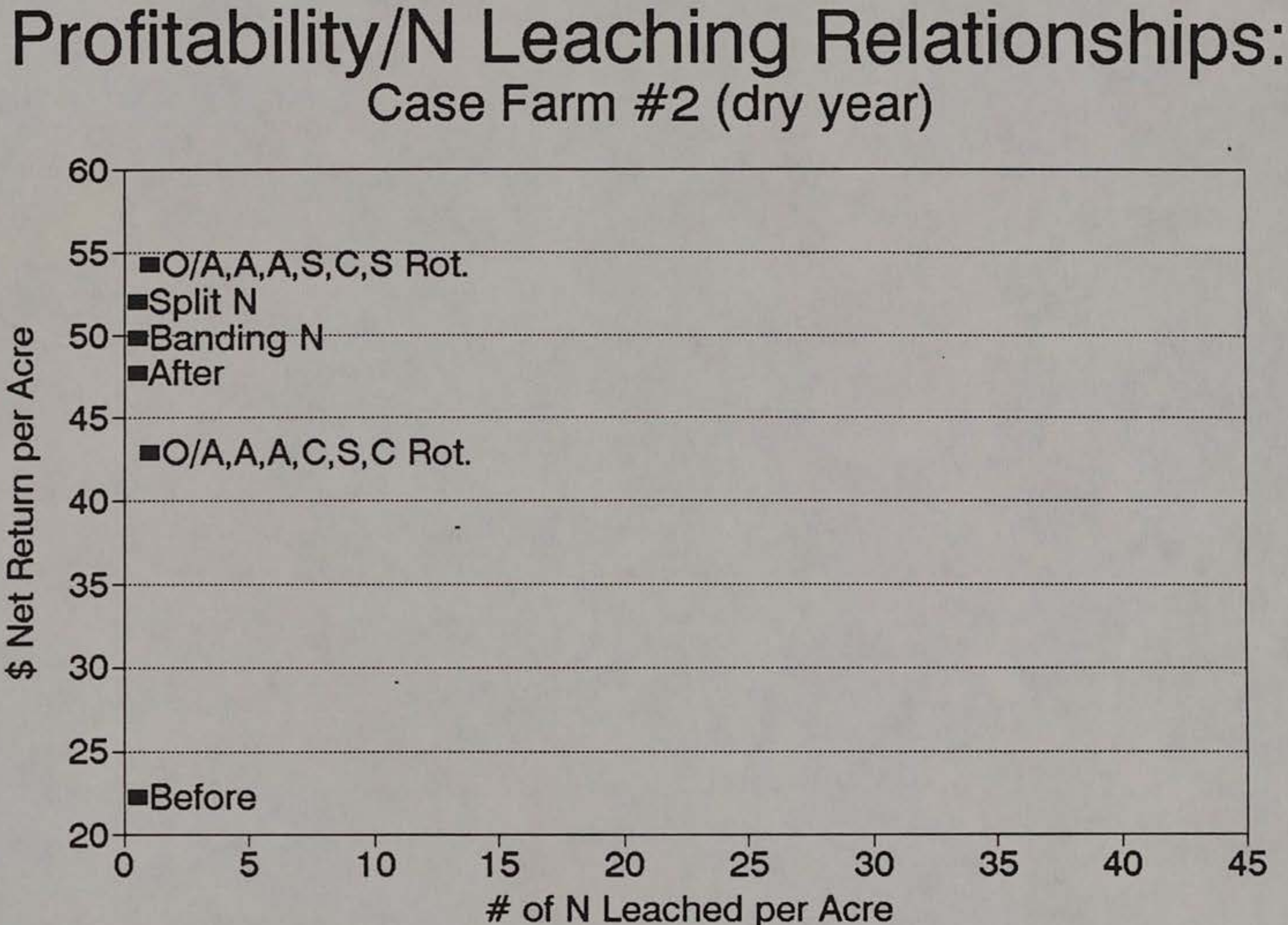

Profitability/N Leaching Relationships:
Case Farm #2 (dry year)
$ Net Return per Acre
60
55
50
45
40
35
30
25
20
O/A,A,A,S,C,S Rot.
Split N
Banding N
After
O/A,A,A,C,S,C Rot.
Before
0
5
10
15
20
25
30
35
40
45
# of N Leached per Acre

Figure 10.

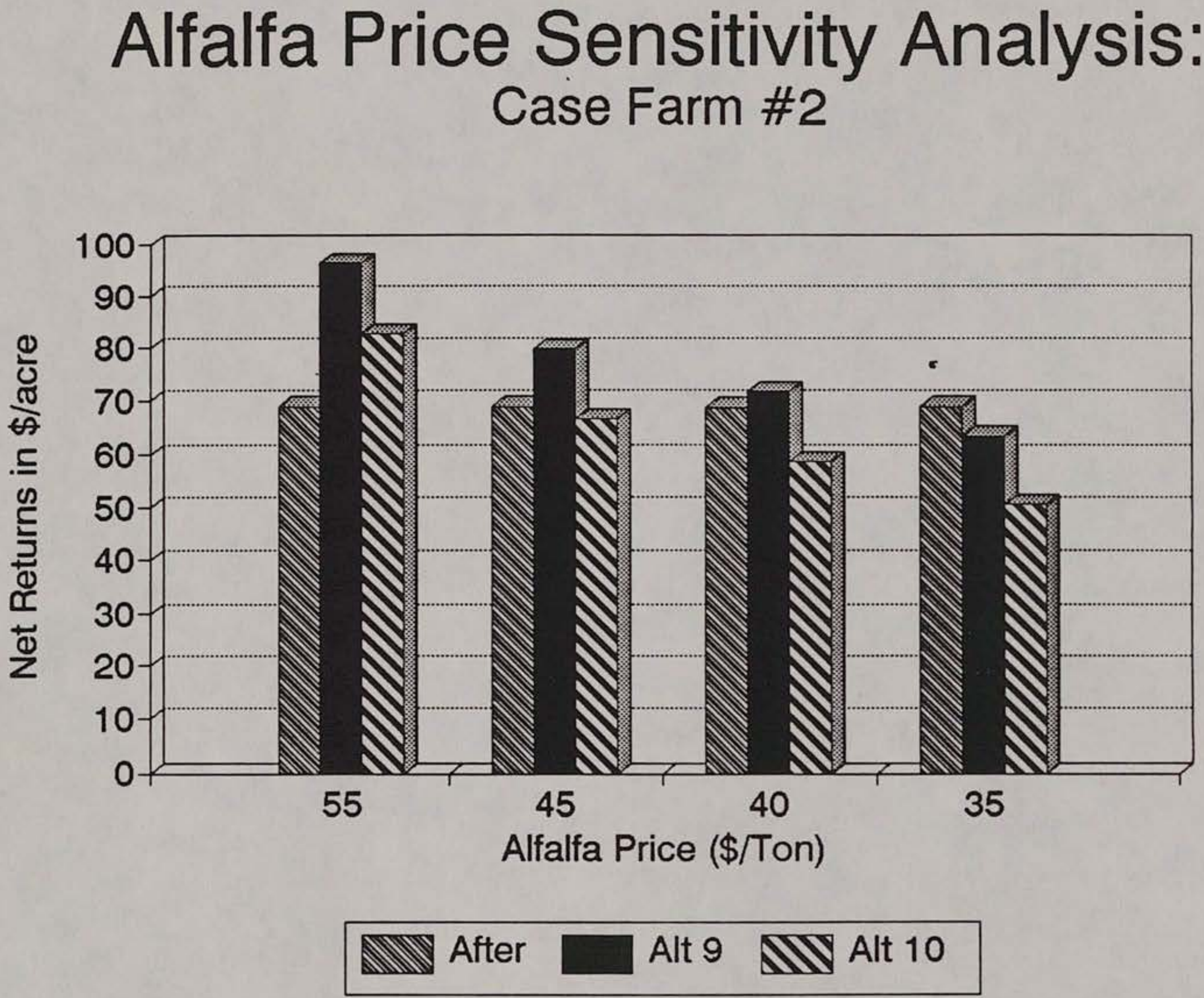

Alfalfa Price Sensitivity Analysis:
Case Farm #2
Net Returns in $/acre
100
90
80
70
60
50
40
30
20
10
0
55
45
40
35
Alfalfa Price ($/Ton)
After
Alt 9
Alt 10

Figure 11.

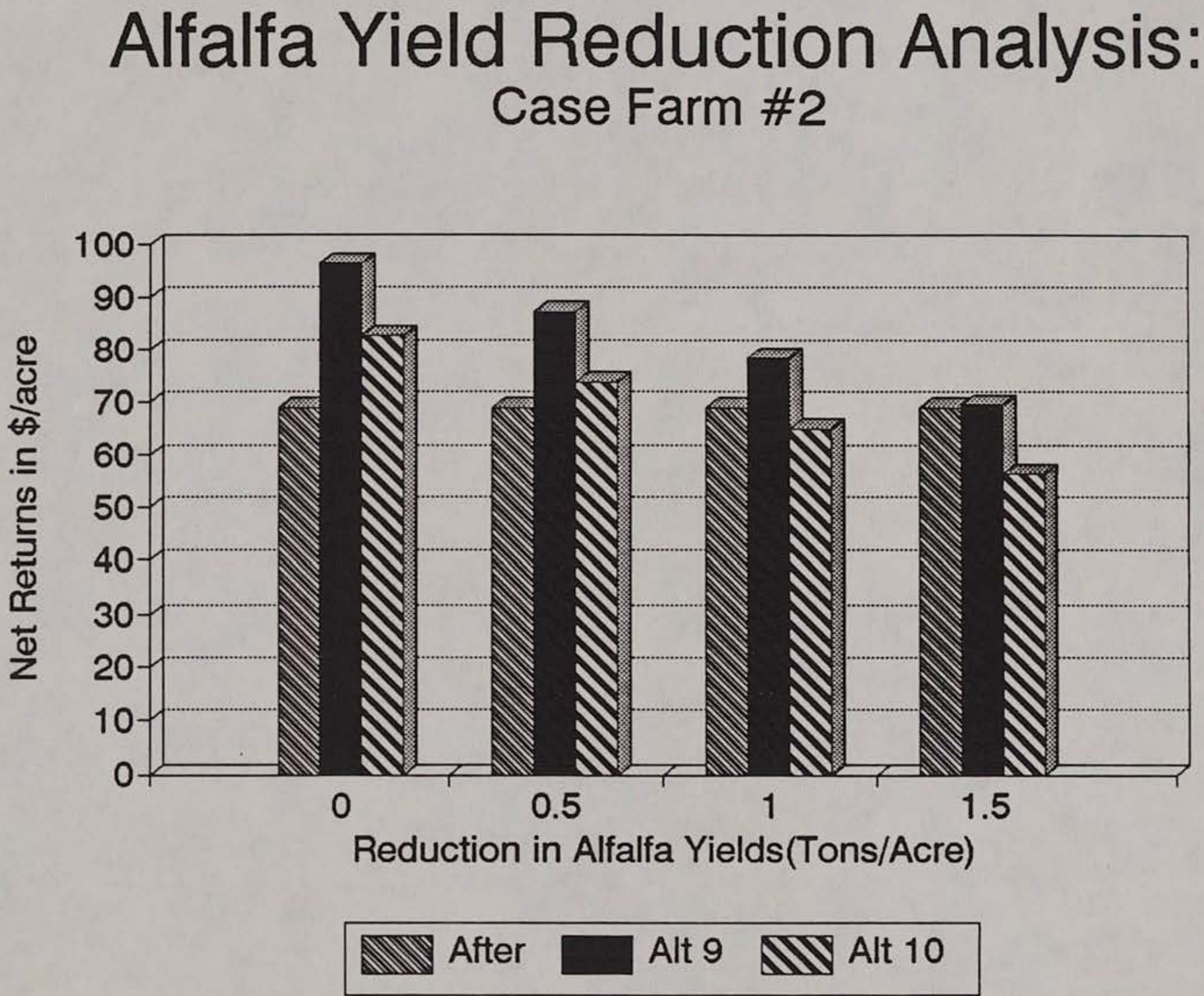
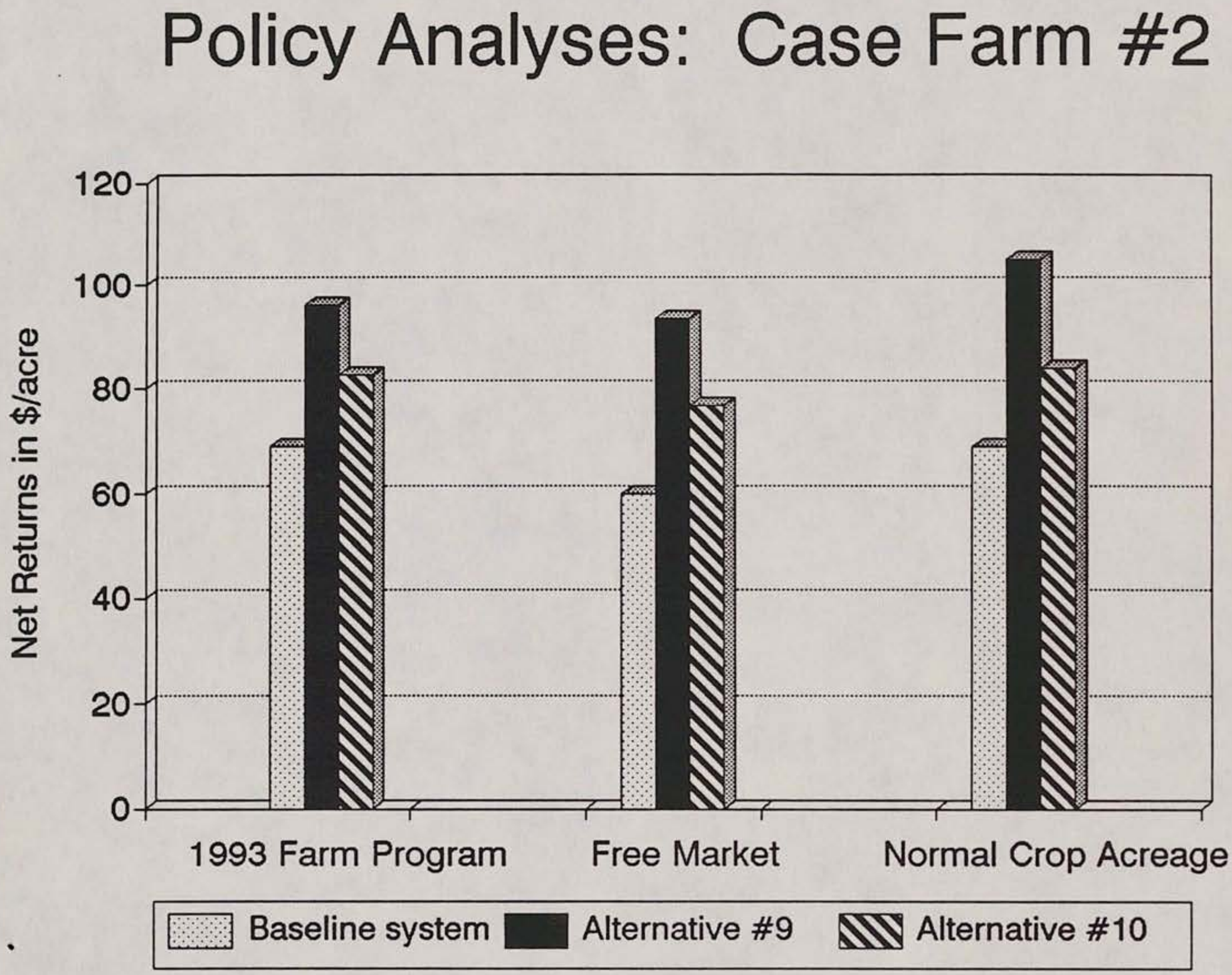

Alfalfa Yield Reduction Analysis:
Case Farm #2
Net Returns in $/acre
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
Reduction in Alfalfa Yields(Tons/Acre)
After
Alt 9
Alt 10

Figure 12.


Policy Analyses: Case Farm #2
Net Returns in $/acre
120
100
80
60
40
20
0
1993 Farm Program
Free Market
Normal Crop Acreage
Baseline system
Alternative #9
Alternative #10