Case Study of the Potential Economic and Environmental Effects of the Water Quality Incentive Program and the Integrated Crop Management Program: Preliminary Results[1]

by

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Introduction

Regulatory versus incentive approaches for addressing environmental problems related to agriculture are being hotly debated in various policy arenas. A recent task force of the Great Plains Agricultural Council emphasized the challenges in the Great Plains region of providing sufficient economic incentives to induce voluntary adoption of farming practices and systems that are friendly to water quality (Water Quality Task Force, 1992). Two Federal programs introduced in the early 1990s were specifically intended to bring about such voluntary changes.

The overall goal of a study we began in late 1993 has been to determine whether the economic incentives offered by these two programs are sufficient to induce Western Corn Belt/Northern Great Plains farmers in environmentally sensitive areas to adopt sustainable farming practices and systems. The programs are the Integrated Crop Management (ICM) cost-share program and the Water Quality Incentive Program (WQIP). These programs started as pilot efforts and, thus far, have had limited funding and participation. National policy makers need to know whether these programs are viable options to expand upon and/or substantially modify in the 1995 farm bill. Our study is intended to provide such policy insights for grain farming areas in which groundwater quality is a critical concern.

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 cost share. Practices may

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include soil and tissue testing, field scouting, cover crops, green manures, improved rotations, composting, and other techniques for reducing the use of agrichemicals (Hoefner, et al., 1992).

The WQIP is a voluntary program to encourage producers to adopt practices that improve water quality. It provides incentive payments for farms to develop and implement 3- to 5-year farm management plans that will protect water quality through reduction in the waste stream of agricultural pollutants, including fertilizer, manure, and pesticides. Participating farmers must agree to implement a water quality plan approved by the U.S.D.A., report their usage rates of nutrient, pesticide, and animal waste materials for the previous 3 years, and supply well test results, soil tests, tissue tests, and application levels to the Natural Resources Conservation Service and the local conservation district for each year in the program (Hoefner, et al., 1992).

Only a very limited number of studies have thus far focused on the ICM and WQIP programs as policy options. Dicks, et al. (1993) and Osborn, et al. (1994) analyzed some of the effects of the ICM program in its first year of operation, 1990. Their analyses relied heavily on records farmers must keep as part of the program, and no farm-level modeling was done. Higgins (1995) analyzed barriers to full implementation of the WQIP and proposed some changes to make the program more attractive and effective.

The study reported here is a case study of representative farms over the Big Sioux Aquifer (BSA), a shallow aquifer located under the fertile soils of eastern South Dakota. Most of this land is devoted to intensive agriculture. Preventing groundwater contamination from fertilizers, pesticides, and animal wastes is a major objective of the Big Sioux Aquifer Water Quality Demonstration Project. The BSA Project is one of sixteen demonstration projects in the United States developed as part of a 5-year comprehensive program funded by the U.S.D.A. The BSA Project is aimed at protecting groundwater quality in shallow aquifers by identifying farm management practices which are environmentally sound and economically feasible. The goal is to promote voluntary adoption of innovative production practices, management systems, and land treatment to reduce or eliminate contamination of the aquifer by agricultural operations. (Cooperative Extension Service, 1992) The main environmental concern in the BSA area is with NO3-N leaching through the soil profile into shallow groundwater used for drinking.

As of Fall 1993, 45 out of 400 farms in the BSA area had enrolled in the ICM program or the WQIP, or both. The most popular practices under these programs were nutrient management, pest management, conservation cropping sequence, and crop residue use. There was very little change in either crop type or crop rotation.

Methods of Analysis

Four case study farms are being used for analyses. They represent different farm sizes, soils, cropping systems, topography, and management in the Big Sioux Aquifer study area.

The case farms are a mix of three dryland operations and one irrigated operation. Farm #1 is a dryland operation that uses reduced tillage on a corn-soybean rotation, with some alfalfa. Farm #2 is a dryland operation that uses some aspects of reduced tillage on corn, soybeans, and oats. Farm #3 is a dryland operation that has corn, soybeans, oats, alfalfa, and clover. This is a part-time farm on which conservation practices have long been emphasized. Farm #4 is an irrigated operation that uses conventional tillage on continuous corn under a center-pivot sprinkler irrigation system. Two of the dryland farms are enrolled in the ICM program and one is enrolled in the WQIP, as is the irrigated farm.

Crop enterprise budgets have been developed for these farms using a budget generator package called CARE (Cost And Return Estimator). Profitability results (from CARE) for individual crops, fields, and soils have been aggregated to a rotation and farming system level with special spreadsheets that take Federal farm program acreage set-aside requirements into account. The computer model NLEAP (Nitrogen Leaching and Economic Analysis Package) is being used to evaluate nitrate leaching to groundwater; leaching results also are being aggregated to the rotation and farming system level.

Baseline economic analyses were completed using data collected from each case farmer. When the data were collected, the farmers were asked to distinguish what practices would <u>typically</u> be used before enrollment in the ICM program and/or the WQIP, and what practices would typically be used after enrollment in these special programs. Since these farms have only recently entered into the program, and one of the years (1993) since entering had far from typical weather conditions, a good deal of farmer and researcher judgement has been used in making yield and other estimates necessary for the "after" economic analysis.

In this study, we also did profitability analyses for possible additional **practice** changes. These are changes that some farmers are not actually using yet, but that could be added to the "after" scenario. One is banding fertilizer at planting and another is splitting nitrogen fertilizer applications. Other changes involve **system** changes. The system changes involve switching to more diverse crop rotations than existed in the "before" and "after" scenarios for each individual case farmer.

Economic Results

Baseline economic analyses were conducted with the Federal farm program as it existed in 1993. Market prices were "typical" prices for the early 1990's in eastern South Dakota. The per acre profitability results shown in Table 1 are composites for all farming systems on the affected fields of each case farm; they were determined by dividing the "whole-farm" results by the number of acres. Shown in the first row of data are "baseline" net returns to land and management per acre for each case farm; these represent net returns in a "typical" year "before" entering the ICM or WQIP. In the second row are estimates of what net returns are likely to be in a typical year "after" entering into the ICM or WQIP and making associated farm management adjustments.

ICM and WQIP payments were $7/ac for Farm #1, $3.50/ac for Farm #2, $3/ac for Farm #3, and $17/ac for Farm #4. These payments were not added into the budgets since the payments were used to directly pay for costs incurred to make management adjustments; these costs, such as for crop consulting and soil testing services, were not included in the budgets, either. Thus, those payments were treated as direct "pass-throughs".

Estimated "before" and "after" net returns on Case Farm #1 were the same, because the crop consulting services received under the ICM program for that farm apparently did not lead directly to any farming practice or system changes. Estimated net returns increased substantially on Case Farm #2 (by $30/acre), where the ICM program contributed to a decision to switch to no-till practices for corn and soybeans and to begin drilling soybeans. Net returns were estimated to increase by $6/acre on Case Farm #3, where the WQIP involved reduced usage of inorganic fertilizer and changes in pesticides on corn. Estimated net returns increased substantially (by $18/ac) on Case Farm #4, where the WQIP involved eliminating dry preplant inorganic fertilizer.

The third and fourth rows of data in Table 1 constitute profitability estimates for possible additional **practice** changes. Each--analyzed individually, rather than in combination--appears to add modestly to net profitability in each case. The final rows show estimates for four additional hypothetical scenarios; these involving **system** changes. All involve changes to more diverse crop rotations than existed in the "before" and "after" scenarios. The first two include oats (as a nurse crop for alfalfa), alfalfa (harvested for 2 years after seeding), soybeans, and corn in 6-year rotations. In one alternative, soybeans are grown 2 years out of 6 and corn is only grown 1 year; in the other, soybeans are grown 1 year and corn is grown 2 years. Both of these scenarios appear to add to net farm profitability--compared to the "after" scenario on Case Farms #1, #2, and #3.

The last two alternatives are system changes for Case Farm #4. These hypothetical scenarios also involve changes to more diverse rotations, but the scenarios are different from those of the other farms because the irrigated farm's baseline involves a continuous corn rotation. In one alternative, a 6-year rotation, alfalfa (clear-seeded) is harvested 2 years, and soybeans and corn are each grown for 2 years. The other alternative for Case Farm #4 is a corn/soybean rotation. (Corn/soybean rotations were part of the baseline for some of the other case farms.) Neither one of these system alternatives appear to be as profitable as the continuous corn rotation in the "after" scenario.

<u>Preliminary Environmental Results</u>

Preliminary results of the NLEAP analysis of nitrate leaching associated with different scenarios are shown for the four case farms in the attached figures. Pounds of nitrate leached (per acre) are plotted against per acre profits (from Table 1) in those figures. Both profits and nitrates leached are weighted averages based on all crop acres included in the rotation systems studied on each farm. The exception to this statement is the figure for Case Farm #3, where the pounds of nitrates leached per acre are only for the <u>lower</u> field of Case Farm #3, which is subject to leaching into the aquifer. The <u>upper</u> fields of that farm--although analyzed as part of the overall farm system as part of the profitability analysis--sit too far above the aquifer to be subject to direct nitrate leaching. Potential leaching from runoff from upper fields onto the lower field is presently being analyzed, but is not accounted for in the figure at this time.

The data for Case Farm #1 show that splitting N applications could decrease leaching slightly, while also increasing profits by a small amount. The changes shown in crop rotation system on Farm #1--for "typical year" weather conditions--appear to increase profits and perhaps actually increase leaching by a very small amount.

On Case Farm #2, profits appear higher after beginning participation in the ICM program. Other possible practice and rotation system changes on Case Farm #2 appear to have the possibility of further increasing profits while slightly decreasing leaching or leaving it unchanged, relative to the "After" scenario. Overall, the practice and system changes considered for Farm #2 appear to have little potential effect on N leaching in typical years, probably because the initial level of leaching is relatively low.

Practice changes brought about by the WQIP (the "After" scenario) and possibly also banding fertilizer or splitting nitrogen applications appear to add to profits without measurably changing N leaching on Case Farm #3. This probably is because Farm #3 was already using very good management practices before enrolling in the WQIP and apparently had very little N leaching in typical years. This farm already had some forage and green manure legumes in its rotation systems, but adding more, as represented by the two rotation system changes shown, appears to both add to profits and reduce N leaching.

Case Farm #4 is the irrigated farm with continuous corn. Practice changes represented by the "After" scenario and by splitting nitrogen applications appear to increase profits and, in the case of the latter practice, reduce N leaching slightly. Tradeoffs between N leaching and profits are quite noticeable when one introduces the possibility of more diverse rotations on this farm, however. A corn-soybean rotation would reduce N leaching considerably, but that is less profitable than the continuous corn "After" scenario. A diverse rotation involving alfalfa in addition to corn and soybeans also involves much less N leaching than the "After" scenario, but reduces profits even more than does the corn-soybean rotation.

Profitability and N leaching estimates also have been made for both "high" and "low" rainfall years, and we are in the process of plotting and interpreting those results. The discussion in this paper is limited to results for "typical" rainfall years.

Tentative Conclusions

Economic results for the four case farms showed no change in "typical year" net profits "after" participation in ICM or WQIP--compared to "before" participation--on one farm, modest increase on another, and substantial increases on the other two. These results imply that the ICM program and the WQIP can enhance the profitability of some farms, while encouraging practices to improve water quality. Simulation of additional **practice** changes thought to improve groundwater quality showed possible modest increases in profits. Simulated **system** changes, involving adoption of more diverse crop rotations, also added to profitability under some circumstances. Nitrate leaching results for the **dryland** case farms showed some potential to both increase profits and decrease N leaching by changing certain practices and rotation systems. Results for the **irrigated** case farm also showed potential for increasing profits and decreasing leaching through certain practice changes, but changes in rotation system appear to involve sacrifices in profits for the gains in reduced N leaching.

Are WQIP and ICM payments adequate to induce targeted practice and system changes? Recall that we stated earlier that the ICM and WQIP payments were handled as "pass-throughs" in our budgets, representing costs passed on as payments to crop consultants and so forth. We did not change the payment level for different practices and systems. In reality, some of the rotation changes would qualify for higher payment levels if the farmer was not already at his or her $3,500/year payment limitation. The rotation changes appear to be profitable on the three dryland farms even without additional cost-share. The irrigated farm presumably would qualify for an average of an additional $5/acre if it went to the alfalfa-corn-soybean rotation that averages one-third of the acreage in alfalfa, since a $15/acre payment is allowed for legumes in rotation. However, that additional $5/acre would not be nearly enough to make that rotation as profitable as either the continuous corn or a corn-soybean rotation. The irrigated farm is already close to the $3,500/year payment limit, so it would not be eligible for an additional average payment of $5/acre on all of its acres under WQIP contract, anyway.

Fundamental policy reforms are more likely to induce change to diverse rotations in situations like that of Case Farm #4 than are programs like the WQIP. We have simulated some such policy reforms. Eliminating the farm program entirely **or** moving to a "Normal Crop Acreage" policy would cause the corn-soybean rotation to be more profitable than continuous corn on this irrigated farm; such changes would make the alfalfa-corn-soybeans rotation nearly as profitable as continuous corn, though that rotation would remain somewhat less profitable than the corn-soybean rotation.

How operators of farms of different sizes are likely to be impacted by and respond to various types of environmental initiatives can be judged by considering the *profitability, capital intensity, complexity, and risk* associated with the initiatives and with the practices and systems they are being encouraged to adopt. In this analysis, we have focused primarily on the profitability factor. However, subjective assessment of the other factors indicates that: (1) neither the practice changes nor the system changes are very capital intensive; (2) the practice changes involve minimal risk to participating farmers, but the system changes may involve more price and production risk; and (3) the WQIP and ICM <u>programs</u> are not complex, nor are the proposed <u>practices</u>, but alternative farming <u>systems</u> **are** more complex than current systems. Considering all four of these factors, we tentatively conclude that: (1) operators of "large", "medium", and "small" sized farms may adopt several of the *practice* changes being promoted through WQIP and ICM; and (2) *system* changes under consideration are more likely to be adopted by operators of "medium" sized farms than by operators of either "small" or "large" farms.

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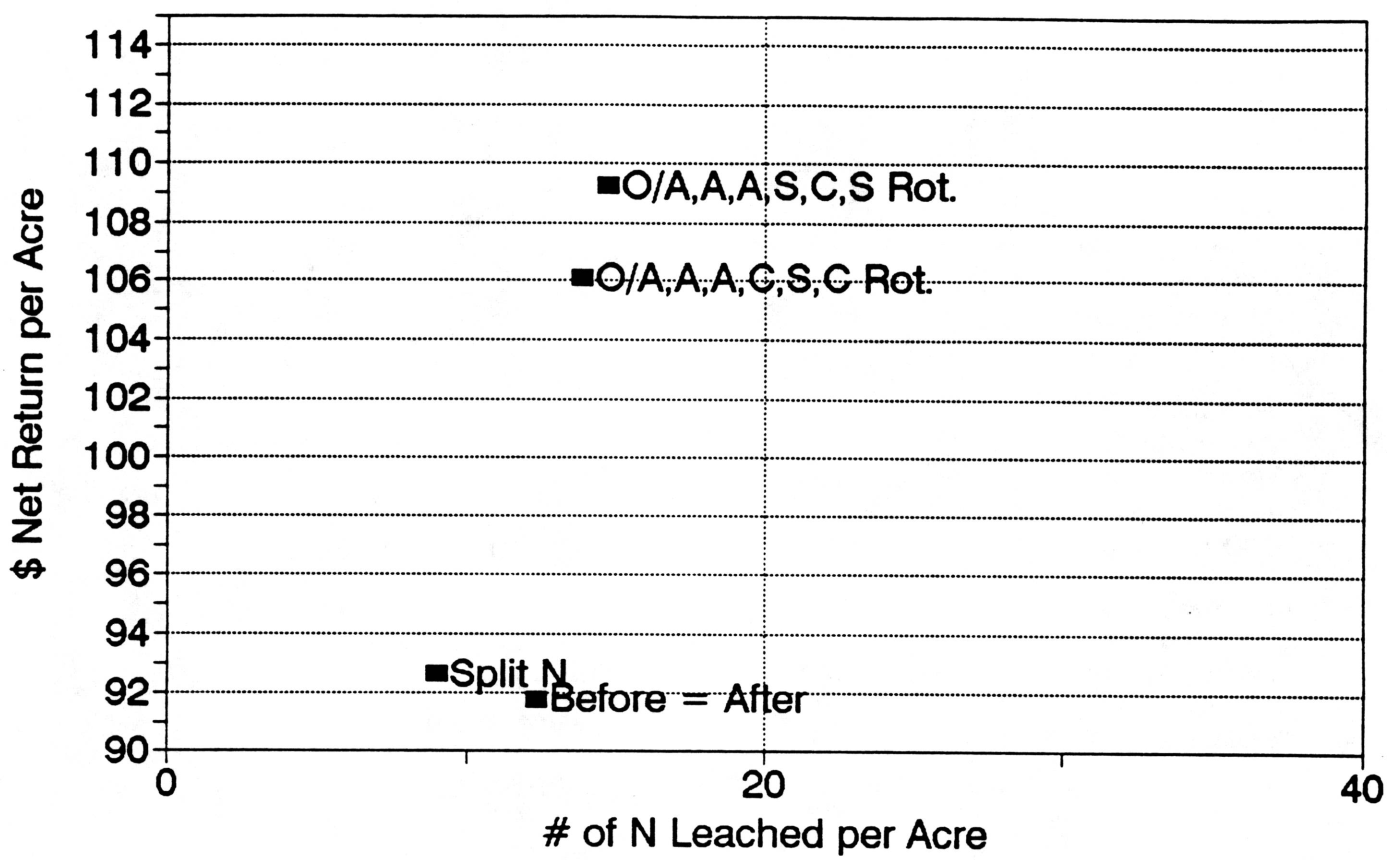
Table 1. Profitability Estimates for Selected Management Scenarios on Four Case Farms

Management scenario	Net returns to land and management ($/ac.)			
	Case Farm #1	Case Farm #2	Case Farm #3	Case Farm #4
Baseline ("before" ICM or WQIP)	$92	$39	$95	$63
"After" ICM or WQIP	$92	$69	$101	$81
Banding fertilizer at planting	Not Applicable	$71	$102	Not Applicable
Splitting nitrogen applications	$93	$73	$102	$88
Diverse rotation with 1 yr oats, 2 yrs alfalfa, 2 yrs soybeans, & 1 yr corn (between soybean years)	$109	$96	$109	Not Applicable
Diverse rotation with 1 yr oats, 2 yrs alfalfa, 2 yrs corn, & 1 yr soybeans (between corn yrs)	$106	$83	$111	Not Applicable
Diverse rotation with 2 yrs Alfalfa, 2 yrs soybeans, & 2 yrs corn	Not Applicable	Not Applicable	Not Applicable	$54
Corn/soybean rotation	Not Applicable	Not Applicable	Not Applicable	$75

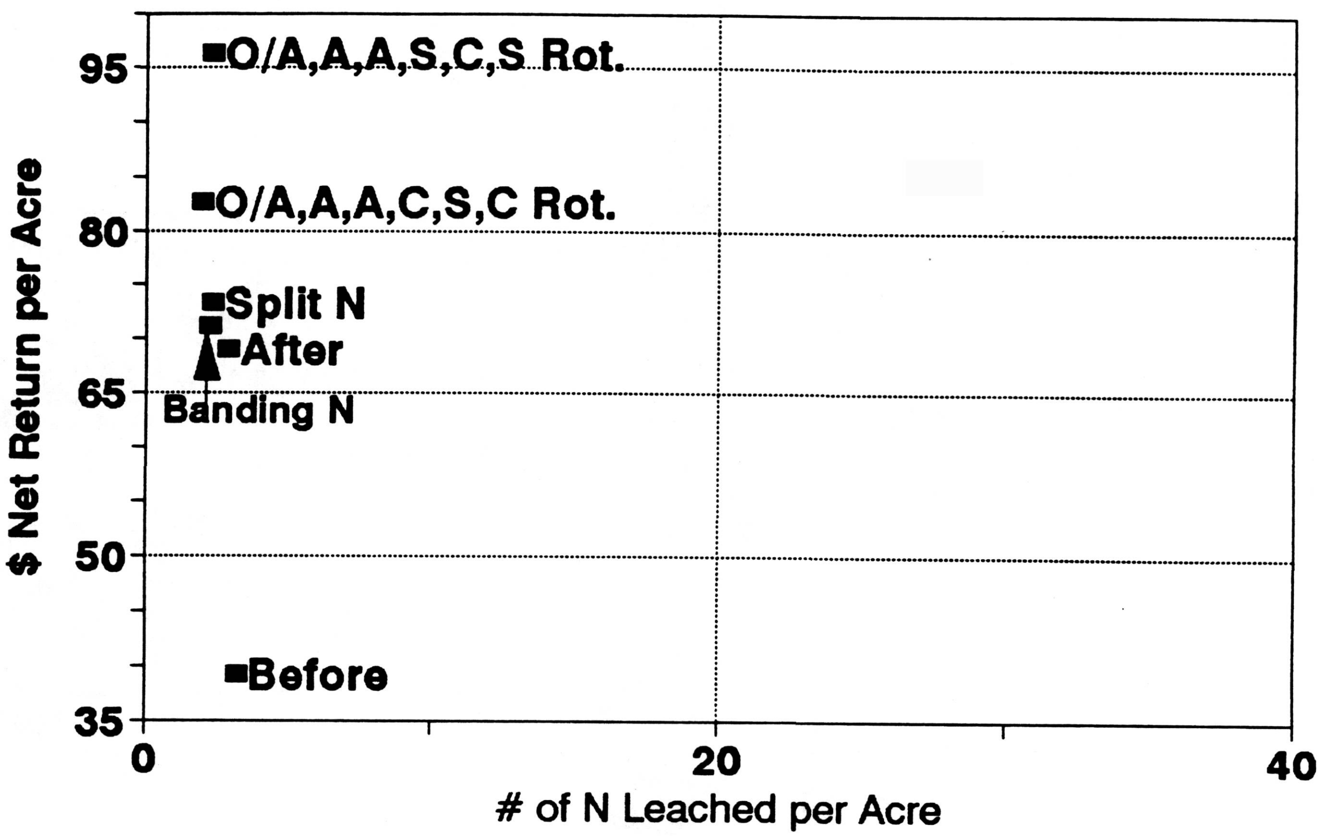
Profitability/N Leaching Relationships

Case Farm # 1



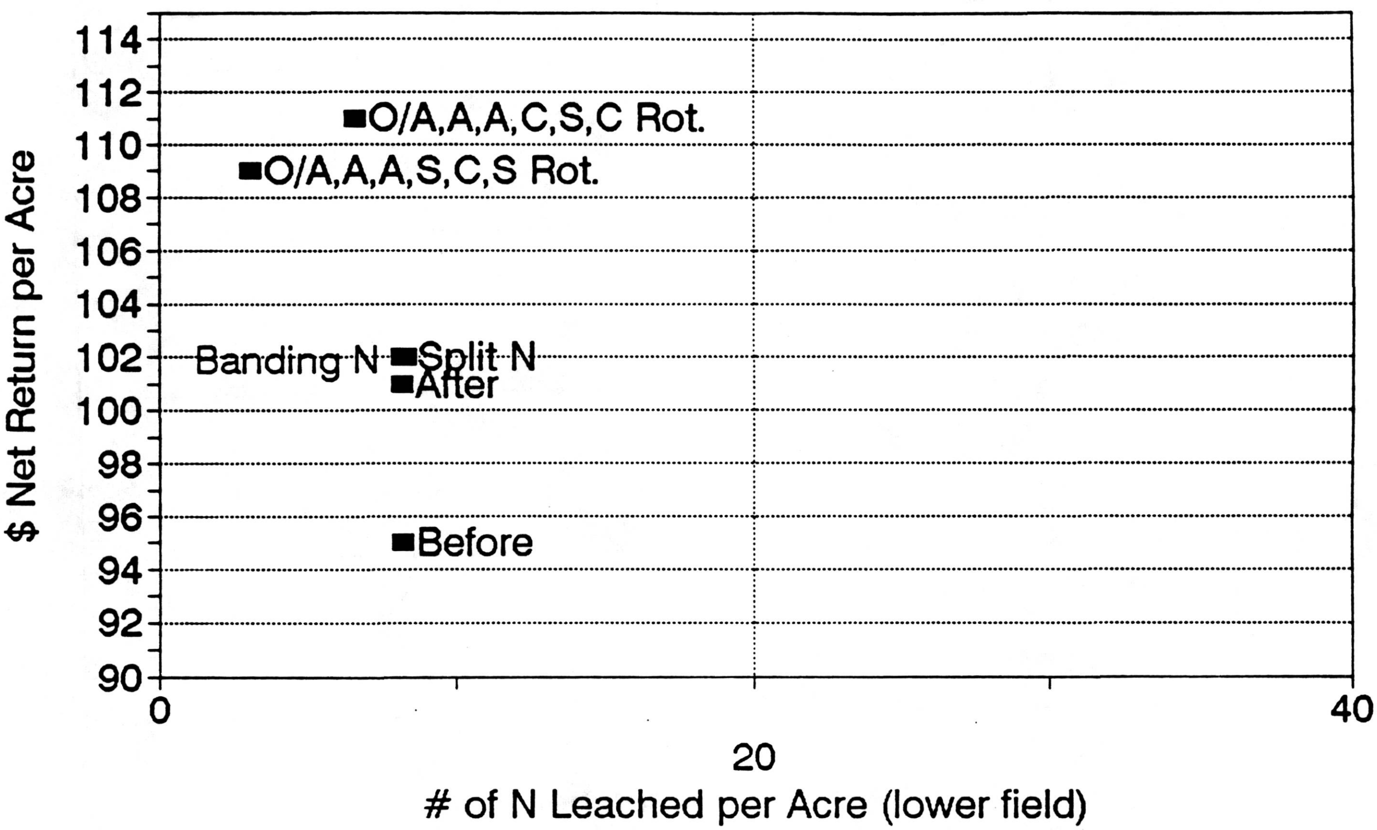
Profitability/N Leaching Relationships

Case Farm # 2



Profitability/N Leaching Relationships

Case Farm # 3



Profitability/N Leaching Relationships

Case Farm # 4