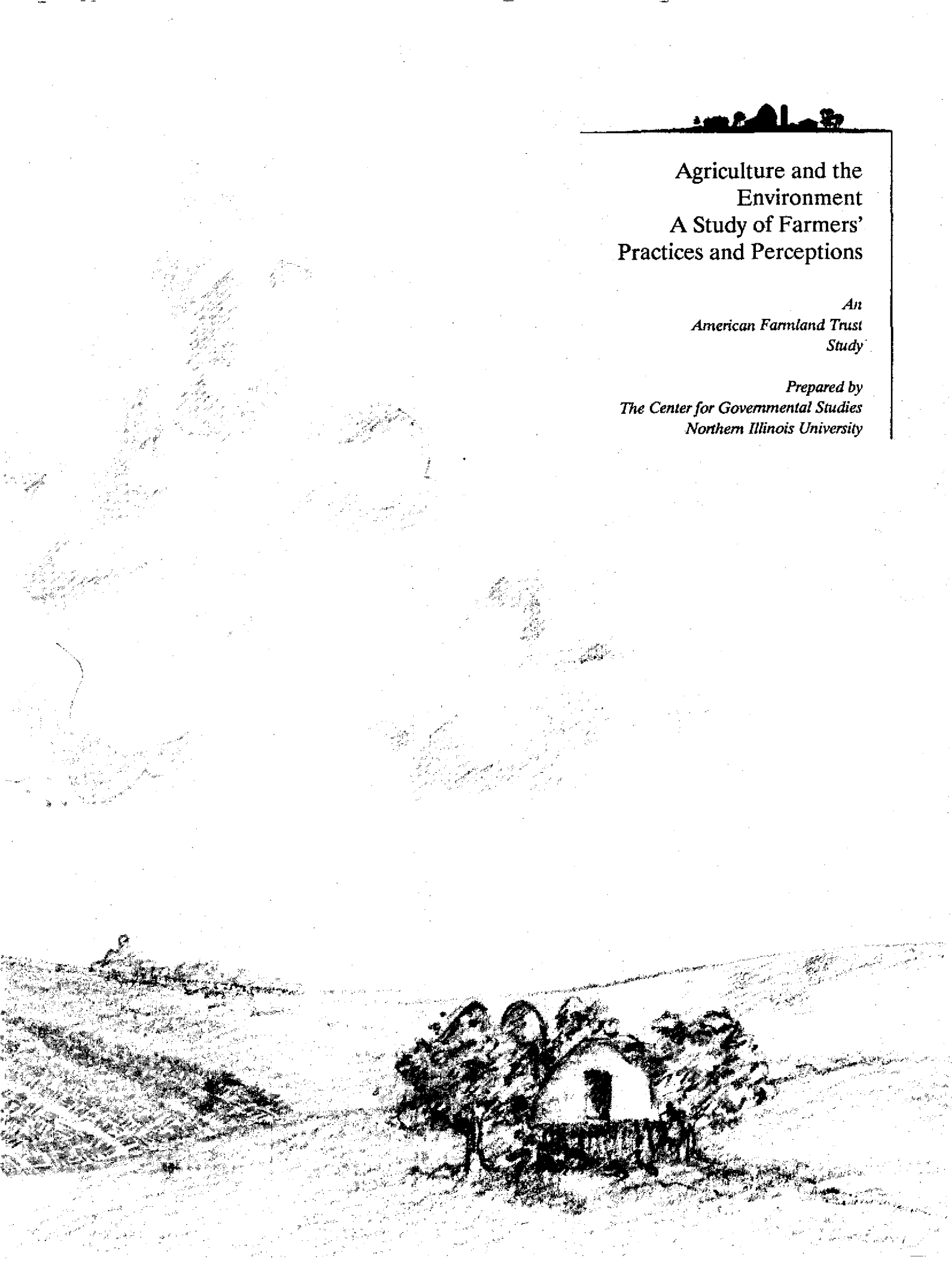
Agriculture and the Environment
A Study of Farmers' Practices and Perceptions

An
American Farmland Trust
Study

Prepared by
The Center for Governmental Studies
Northern Illinois University



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Report on a survey sponsored by
The American Farmland Trust
and conducted by
Resource Management Consultants, Inc.

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The American Farmland Trust

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Chapter 1

Introduction

Objective of the Study

American farmers face economic constraints in producing their crops, public pressure to produce safe foods, and environmental concerns over soil erosion and water quality and protection of wildlife habitats. The overall objective of this study was to provide information that would help strengthen public and private programs for achieving more economical use of chemical fertilizers and pesticides. For this purpose, almost 500 farmers in five diverse parts of the country were interviewed during 1989 about their current farming practices and their opinions regarding proposed policies for promoting practices that economize on chemical inputs.

Why the Study Was Conducted

The American Farmland Trust did not design the questionnaire or interpret its findings with any hostility toward the use of chemical fertilizers and pesticides. Over time, these production inputs have brought great benefits to American agriculture and consumers of farm products. In most farming situations today, use of such inputs is essential for financial viability. However, there is widespread evidence that an overdependence on their use has developed, and much effort today is devoted to seeking ways to enable farmers to economize on the use of chemicals and fertilizers.

In particular, some research indicates that many farmers apply excessive amounts of fertilizers or pesticides as a form of insurance or because they lack adequate information about what their fields really need. Moreover, in some situations the problem of groundwater or surface water pollution is serious enough that a reduction in the use of chemicals may be necessary for health reasons. Therefore, both to achieve savings in production costs and to protect drinking water supplies, we conducted this survey of farmers.

The Current Public Policy Context

Alar residue in American apples and cyanide residues in Chilean grapes catapulted food safety issues to the front pages of American newspapers in 1989. These are only the most recent and widely publicized events directing public attention to potentially serious problems with standard agricultural practices. Whether fair or not, the fears these events raised in the minds of American consumers may be the most powerful forces driving farmers, agribusinesses, and federal farm policymakers to rethink the way food is grown in this country.

Farmers must not only produce food that is cosmetically beautiful and free of chemical residues, but face the day-to-day concern of maintaining cost-effective operations within a tight margin of profitability. They may choose to do so either by striving to increase their yields or by attempting to reduce their costs of production. In general, farmers of commodity crops eligible for federal benefits have been rewarded for taking the first course; however, maximizing yields may be in conflict with sound management of land and water resources. Concern that current farming practices were leading to intol-

erable soil erosion and other environmental damage resulted in the inclusion of three conservation provisions in the 1985 Food Security Act designed to protect highly erodible farm-land. Since then, the U.S. Environmental Protection Agency has also amassed evidence that agricultural pesticides have contaminated groundwater supplies in 26 states.

These three factors, consumer concern about food safety, increasing costs of food production, and the incidence of agricultural contamination of the nation's drinking water, are generating momentum to alter standard farming practices. In separate federal bills, Senators Wyche Fowler and Patrick Leahy and Representative Jim Jontz proposed adjustments to federal farm programs that would encourage farmers to reduce their use of fertilizers and pesticides.

Research into the viability of practices designed to improve farm profitability while protecting soil and water quality is now being conducted at many levels. Under the Low-Input Sustainable Agriculture Program, the U.S. Department of Agriculture is supporting limited research efforts nationwide to test and evaluate specific low-input practices. In 1989, the National Research Council of the National Academy of Sciences released its own assessment of low-input technology in which it studied 11 farms that had successfully converted to low-input practices. In the report, entitled *Alternative Agriculture,* the council concluded that these changes in farm practices are economically feasible and environmentally sound. It strongly urged the expansion of research into low-input practices and the restructuring of federal commodity programs to help farmers convert to alternative agricultural practices.

The American Farmland Trust undertook this study in recognition that any successful effort to influence agricultural practices will depend upon the acceptance of farmers. Although the National Research Council and others have studied individual farmers who have converted to low-input practices, no policymaking or research group has systematically questioned a random selection of farmers in diverse parts of the country about their own use of production practices for achieving savings in chemical inputs or about their opinions of public programs for helping growers to realize such savings.

Design of the Study

The current study obtained the opinions of farmers by conducting individual, face-to-face interviews of 489 operators in five sites across the United States. The American Farmland Trust, Resource Management Consultants, Inc., and the Center for Governmental Studies at Northern Illinois University developed the questionnaire. Local interviewers were trained to conduct the one-hour interviews.

The type of questions we asked most frequently in the interviews concerned the farming practices respondents used in 1988, the most recently completed farming year. The American Farmland Trust had three specific purposes for surveying growers about their particular farming methods: (1) to determine the extent to which farmers were using practices that could potentially be substituted for chemical inputs or otherwise permit growers to reduce their use of chemicals, (2) to learn if farmers using these practices rated them highly, and (3) to understand the conditions that facilitated or hindered adoption of such practices.

These types of questions permitted us to categorize the various practices according to criteria of special interest to the study. One such category includes practices that respondents in diverse sites used frequently and rated highly. Such practices are prime

candidates for adoption by other farmers. Another significant category includes practices that apparently need more research, development, or marketing because, even though experts recommend them, very few farmers use them and the few users do not regard them highly. A third important group includes practices whose adoption is influenced by conditions that public agencies may be able to shape or should at least take into account when designing programs to promote the economic use of chemicals. Our survey found that the use of certain practices was related to the sources of advice that farmers followed, the kinds of crops they grew, and the climate in their region.

The survey's questions about farming practices were divided into three groups: (1) tillage and cultivation practices (that is, practices dealing with the preparation of a seedbed, planting methods, and seeding rates and spacing), (2) fertility practices (those concerned with satisfying the crops' need for nutrients), and (3) pest-control practices (those designed to control weeds, insects, and other pests). For each category, the interviewers gave farmers a printed list of practices and asked which, if any, they applied to their crops in 1988.

Most of the practices were either direct means for reducing chemical use, such as employing nonchemical methods to control pests or to fertilize crops, or they were analytical techniques (soil tests, plant tissue tests, integrated pest management programs) that should permit farmers to avoid applying unnecessary kinds or amounts of chemicals.

Selection of Sites

Since the policy section of the interview dealt mostly with proposed changes in the federal commodity programs, the American Farmland Trust targeted the survey to parts of the country where production of major program crops predominates: corn, soybeans, wheat, cotton, and rice. The targeted areas were Minnesota and Illinois for corn and soybean production, Washington for wheat, Georgia for cotton, and California for rice. Within each state, site selection focused on localities that are representative of their growing areas and are not affected by extreme or atypical environmental or economic conditions. If the responses of farmers from a majority of these geographically and agronomically diverse sites are similar, we can infer that their attitudes are shared by a broader population of farmers. In contrast, if responses are not similar across a majority of sites, analysis should elucidate the extent to which these differences may be attributed to the different cropping systems or some other factor. Such differences could determine the success or failure of proposed legislative changes which may be more suitable for one region and cropping system than for another. For example, it may be more realistic to promote crop rotations in the corn and soybean areas than in rice-producing regions.

In selecting the survey sites, Resource Management Consultants and the American Farmland Trust sought advice from national agricultural experts: staff of the U.S. Department of Agriculture, the Appropriate Technology Transfer for Rural Areas Information Center in Arkansas, the Institute for Alternative Agriculture, and the National Research Council. National commodity associations were asked to suggest states with the strongest production of their respective commodities. Once a list of candidate states was determined, Cooperative Extension specialists at the state land grant institutions were asked to identify the six counties they considered most representative of the production in that state of the commodity of interest (e.g., corn, cotton). At the county level, Resource Management Consultants staff conferred with personnel of the Cooperative Extension Service, the Agricultural Stabilization and Conservation Service, and the Soil Conservation Service to determine areas within the county that would be most suitable. Sites selected for this study needed to fit the following three criteria:

1. They had to produce one of the five major commodity crops of interest.

2. They had to represent typical farming conditions for that commodity in that region.

3. They had to include at least 300 farmers in order to ensure an adequate population for sampling.

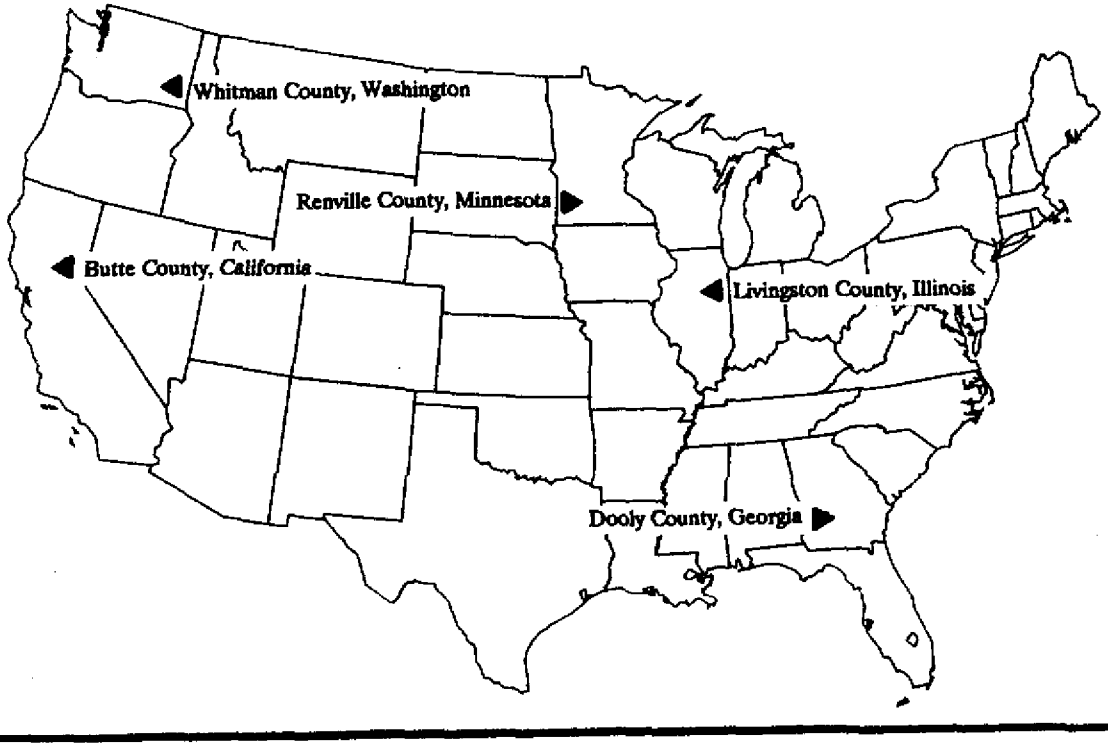
In most cases the study site encompassed two or three townships. See Figure 1 for a map that locates the five survey sites.

Interview Sites

Whitman County, Washington

In 1987 Washington ranked fifth among states in wheat production, much of which was raised in the Palouse region of the state. Whitman County, situated in the center of the Palouse, is often the nation's leader in wheat yields.

Figure 1
Location of the Survey Sites



In 1987 Whitman County farmers harvested wheat from 345,500 acres with an average yield of 70.9 bushels per acre, well above the state average of 56.7 bushels per acre.[1] This county, with 1,009 farmers raising wheat, accounted for more than 17% of the wheat production in Washington.

Additionally, in 1987 a total of 910 farms in Whitman County raised barley. This crop, which is often integrated into the rotation schedule with wheat and summer fallow, was harvested on 182,135 acres in 1987.

Farmers frequently use contouring and terracing to reduce the effects of erosion on the Palouse slopes. Between the constant winds and heavy spring runoff, soil erosion poses a serious threat to these productive soils. Most farms in Whitman County will be required to install conservation plans in order to retain their eligibility for federal farm program benefits according to the conservation provisions of the 1985 Farm Bill.

Butte County, California

California competes with Arkansas, Louisiana, Texas, and Mississippi in rice production. Favorable climate, correct soil types, and proximity to the export market have contributed to the growth of California rice production since 1912. Butte County is situated in the Sacramento Valley, where about 85% of California's rice is grown. In 1987 Butte County's 2,030 farms included 255,965 acres of cropland, of which 178,926 acres were irrigated. Three hundred four farms grew rice on 76,308 acres. In 1987, the rice producers of Butte County harvested 5,351,431 cwt. of rice.

In this area of the country, rice cultivars yield best under continuous flooding from the time of planting until several weeks prior to harvest. Seeds, herbicides, insecticides and fertilizer are applied from the air. Since these agricultural inputs are applied directly to the standing water, the practice raises questions about water quality. Although some water evaporates during the summer or percolates into the ground, much of the water is recirculated through rivers and canals.

Renville County, Minnesota

Minnesota often ranks in the top three states for production of corn and soybeans. Much of the southern part of Minnesota is included in the Corn Belt, benefiting from reliable precipitation, fertile soils, and relatively level fields.

Renville County is in the center of a region often referred to as the Black Desert because of its consistently black soil, built up when the land was open prairie. Fewer than 50 years ago, Renville County was noted for its high populations of quail, pheasants, and other game birds. Since that time Renville County has become one of the most extensively tiled and drained areas in North America, greatly reducing the wildlife habitat that was once its hallmark. With many of the surface moisture problems abated, the soil in Renville County now produces record harvests of corn, soybeans, and sugar beets. Of the 1,455 farms in the county in 1987, a total of 1,096 produced corn for grain and 1,201 produced soybeans.

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[1]Crop and farm data for these sites for 1987 came from the U.S. Department of Commerce, *1987 Census of Agriculture* (Washington, D.C.: Government Printing Office, 1989).

Renville County is prone to erosion problems, primarily due to wind. The lack of trees coupled with fall-tilled fields leaves most soil exposed to the wind during the winter.

Livingston County, Illinois

Located in the heart of the Corn Belt, Livingston County with its fertile soil and level topography offers the perfect environment for growing row crops. Corn and soybeans predominate, although some farmers also raise wheat, oats, alfalfa, and grass hay, as well as beef cattle and hogs.

Of the 1,760 farms in Livingston County in 1987, a total of 1,652 raised corn for grain and 1,577 produced soybeans. The county ranked fourth in total soybean production and ninth in total corn production for the state.

Rivers and streams are plentiful in Livingston County, providing much riparian habitat for wildlife and recreational opportunities. Many of these riparian areas abut the prime farmland of the county and are directly affected by agricultural production practices.

Dooly County, Georgia

Georgia ranks tenth in the United States for upland cotton production, supplying 2.3% of the nation's total in 1987. The loamy soils of the Southern Coastal Plains coupled with Georgia's long growing season also permit the state's farmers to raise corn, wheat, rye, sorghum, tobacco, sweet potatoes, peaches, and pecans.

Dooly County typifies the diversity of Georgia's agriculture. Ranking third in Georgia for cotton production, Dooly County produced 30,500 bales in 1987. The county is also strong in peanut production. The output of its 203 peanut farmers ranked seventh in the state in 1987.

Approximately 90% of the soils in Dooly County are well-suited for crop production, with nearly level to gently sloping terrain and well-drained sandy or loamy surfaces. However, the high percentage of land under the chemical-intensive cropping systems of cotton and peanuts in Dooly County has raised concerns about possible nonpoint source pollution of its groundwater supplies.

Drawing of the Samples and the Response Rates

Members of the samples in each site were randomly selected from lists of farmers kept by the county offices of the Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture. Specifically, these lists contained the names of the operators of farm units that had certified land for one or more of the federal government's commodity programs.

The interviews in these survey sites extended from spring to fall of 1989. Across the five sites from 72% to 95% of the farmers selected for the sample were interviewed (Table 1.1).

The following three chapters of this study analyze the responses of farmers to questions regarding three different aspects of crop management: tillage and cultivation, fertility, and pest management. Within each chapter, we correlate farmers' responses to

Table 1.1
Sizes of Samples and Response Rates

	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Refusals	16	20	5	17	19
Not contacted	27	18	1	10	10
Completed interviews	110	100	114	92	73
Sample size	153	138	120	119	102
Response rate*	72%	72%	95%	77%	72%

*Response rate is the number of completed interviews divided by the sample size.

questions about specific practices to responses about various characteristics of their farm and themselves. We pay special attention to whether obtaining information from fertilizer and pesticide dealers and from the Cooperative Extension Service made a difference in the practices the farmers used. The last chapter of this study discusses farmers' responses to 13 federal government policies proposed to promote savings in the use of chemical inputs.

Chapter 2

Farmers' Use of Tillage and Cultivation Practices with the Potential for Reducing Chemical Inputs

Chapter Overview

Majorities or near-majorities of respondents (45% to 50%) used four of the seven tillage and cultivation practices in at least three of the five sites. Although this finding is encouraging, clearly a great deal more could be accomplished to ensure that economical practices are used when farmers till and cultivate their fields.

To control weeds, the most frequently used tillage and cultivation practices were:

1. Adjusting seeding rates.
2. Using crop rotations to break the weed cycles.
3. Spacing rows.
4. Reducing tillage to leave crop residues.

Farmers who applied these practices to their primary crop rated three of them rather highly:

1. **Rotations,** rated first or second by 76% to 88% of users in the sites where rotations were widely applied.
2. **Reduced tillage,** 55% to 59%.
3. **Row Spacing,** 34% to 61%.

Not surprisingly, use of tillage and cultivation practices varied significantly by crop and climate.

None of the hypothesized explanatory variables--such as a farmer's age, years of formal education, or size of farm--explained use or non-use of more than one tillage or cultivation practice by respondents in more than one study site. More research will be needed to determine what motivates farmers to experiment with and adopt different cultivation techniques. Respondents' classification of themselves as "low-input," sustainable," "organic," or "conventional" farmers proved to be a rather poor tool for predicting whether they used a particular practice.

Introduction

Our survey asked farmers to report on the production practices they used in 1988, the last complete year of operation.[1] This chapter focuses on tillage and cultivation

[1]Since operators tend to choose practices because of their combined effects, our analysis of farmers' responses would ideally focus on groups of practices. Moreover, the

practices, defined in the interview as those dealing with the preparation of a seedbed, planting methods, seeding rate, and row spacing. We asked farmers whether they had used any of seven tillage and cultivation practices on their primary, secondary, or any other crop in 1988.[2] If they had used any other practice, we asked them to describe it.

The interview presented five of the practices as weed- or pest-control practices:

1. Used rotation to reduce a weed problem.

2. Timed planting to avoid pest problems.

3. Used row spacing to compete better against weeds or allow cultivation.

4. Used seeding rate to improve competitiveness with weeds.

5. Used increased frequency of tillage to clear fields of refuges for pests and weeds.

All these practices have the potential for reducing the application of chemicals because, if they are effective in controlling weeds, there should be less need for herbicides. For example, rotations may suppress weeds by interrupting the life cycles of those that thrive on continuous cropping. Seeds may be planted in sufficient densities to produce thick plant canopies, which suppress weeds because not enough sunlight reaches their seedlings.

Ideally, we would have data on how practices were actually used, in order to determine whether they in fact achieved savings in the use of chemical inputs. However, reliable data on the implementation of practices and their net effects on chemical use would have been difficult to obtain. Therefore, we are limited to reporting the frequency with which respondents used practices with the *potential* for achieving savings in chemical inputs.

The other two tillage practices were presented in the interview without an explicit weed- or pest-control objective:

1. Used reduced tillage systems (fewer passes per field or less disturbance of the soil per pass).

2. Used controlled burning after harvest to reduce crop residues.

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cost savings and environmental benefits of low-input, sustainable, or alternative agricultural practices are very likely to be greater when such practices are appropriately combined. However, since we did not find sufficient agreement in the literature as to what constitutes genuine groups or systems of practices, we limit our analysis to individual practices.

[2]Throughout this report, we define the primary crop as that which was planted on the largest number of acres in 1988 and the secondary crop as that which ranked second in acreage.

Controlled burning may help farmers to economize on chemical inputs if the residues harbor crop pests and the burning replaces or reduces the need for pesticides.

Reducing the frequency of tillage may reduce the need for chemicals, but it may also increase the need. Stinner and House (1989) report that crop residues left on the surface hinder the growth of weeds, "by reducing the amount of light reaching seedlings, by lowering soil temperatures, [and] by raising soil humidity and thus increasing opportunities for seed pathogens" (p. 113). Testifying before a Senate agriculture subcommittee, a no-till farmer from Illinois reported that he needed "less chemicals with no till" because he limited them to post-emergence applications and was able to use "lower rates with lower active ingredients per acre" (U.S. Senate, 1989, p. 27). On the other hand, the National Research Council's recent study *Alternative Agriculture* (1989) reported that residues may provide favorable habitats to some pests, especially if the same crop is planted year after year, and that, compared to mouldboard plowing, no-till may decrease the nitrogen available to crops. Conventional tillage typically incorporates crop residues into the soil. Moreover, if there is no cultivation or only one or two passes per growing season, farmers may be forced to increase their applications of herbicides to fight weed problems.

For each of the seven practices, we report four findings: (1) the relative popularity of the practice across the five survey sites, (2) the comparative importance of the practice as measured by how its users rank it relative to the other practices of the same general type they applied to their primary crop, (3) the degree to which the use of a practice varies by type of crop, and (4) the traits of farmers and farm operations associated with such use.

The first two findings tell us whether a practice was frequently used and highly valued, frequently used but not highly valued, infrequently used but highly valued, or infrequently used and not highly valued.[3] Practices that were frequently used and highly valued should attract attention because many farmers in diverse parts of the country have applied them successfully. Practices that were infrequently used but highly valued may attract interest, but the relatively few farmers in our survey who found them well-suited to their needs might have had idiosyncratic needs.

With the second two of our four findings, we analyzed the relationship between various traits of farmers and their use of practices with the potential for reducing chemical inputs. Reporting *how* the use of a practice varied with each such trait helps explain *why* farmers did or did not use a particular practice. Provided with such explanations, public and private agencies concerned with promoting the use of low-input practices should be more effective in encouraging farmers to adopt them.

We used regression analysis to test the relationship between the presence of 13 traits and the use of a practice. The traits are listed below, and the appendix to this report defines each trait and explains why we selected it for regression analysis. Tables 2.3 to 2.9 give the distribution of the values for each trait (e.g., the percentage of respondents with wheat as the primary or secondary crop, respondents' median age, etc.). The traits we tested are as follows:

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[3]We defined a practice as frequently used if it was applied by at least one-third of the sample in at least three of the five survey sites.

1. Kind of primary and secondary crop (Table 2.3).
2. Age (Table 2.4).
3. Years of formal schooling (Table 2.4).
4. Size of operation as measured by gross farm revenues, sales plus government payments, if any (Table 2.4).
5. Percentage of family income derived from agriculture (Table 2.4).
6. Number of family members working on the farm (Table 2.4).
7. Debt as a percentage of total farm assets (Table 2.4).
8. Presence or absence of a commercial livestock component to the farm operation (Table 2.4).
9. Attitude towards conservation (Table 2.4).
10. Concern about agricultural contamination of local groundwater (Table 2.4).
11. Respondents' classification of themselves as conventional or nonconventional farmers (Table 2.5).
12. Information sources on farming practices that respondents rated highly (Tables 2.7, 3.5, 4.10).
13. The importance of federal farm program benefits to the farmer (Table 2.9).

Using these 13 variables, we conducted separate logistic regression analyses for each practice in each sample. In the first regression equations for a practice we included all the variables that could plausibly be related to using that practice. The final equation for a sample contained only those variables that proved to be statistically significant when the initial equation was run. Although we report all variables that qualified for the final equation, we are most interested in the cases where the same variable helps to explain either the use of a practice in two or more samples or the use of at least two separate practices in the same site.[4]

Results

Using Crop Rotations to Suppress Weeds

Crop rotations involve planting different crops in succession in the same field in either the same or different years. One cash crop (soybeans) may follow another (corn), or the rotation may include a soil-conserving crop (such as clover) that is used for for-

[4]A variable (age, education) helped to explain a practice if it was significantly associated with the usage variable in the predicted direction (for example, the younger the farmer, the more likely the usage). An association is significant if the coefficient measuring it is larger than could be expected through the influence of chance alone.

age or is incorporated into the soil. Either way, rotations may help to suppress pests because they can interrupt the life cycles of weeds or insects that thrive on a single crop or its residue.

In four of our five survey sites, majorities of respondents (54% to 82%) reported using rotations in 1988 for the purpose of reducing a weed problem (Table 2.1). By contrast only 20% applied rotations with this objective in the remaining site, Butte County. There, two-thirds of the sample planted only one crop, rice. Because of the area's heavy winter rains and poorly drained soils, which leave the root zone waterlogged, winter cover crops are not feasible. Moreover, many farmers find rice to be too remunerative to plant anything else for the spring-to-fall period.

Besides using rotations frequently, respondents in the other four sites rated them highly. From 76% to 88% ranked them first or second in importance among the tillage and cultivation practices used for their primary crop (Table 2.2).

With regard to the relationship between tillage and cultivation practices and the crops to which they are applied, we can look for similarities and differences across sites and within sites. Our analyses focused on (1) primary and secondary crops, the only ones for which we had information on the farming practices used, and (2) crops that had at least ten growers per site.[5] For example, among the 104 farmers surveyed in Whitman County who planted crops in 1988, 101 (97%) had wheat as their first- or second-largest crop, and 66 (64%) had barley, but fewer than ten grew any of the other major crops listed in the questionnaire (corn, soybeans, oats, and hay; see Tables 2.3 and 2.10). In the Butte County sample, only one listed crop, rice, was grown by as many as ten respondents. In the two Midwestern sites, just two crops, corn and soybeans, met this criterion. By contrast, in the Dooly County sample, 24% of the respondents had soybeans as their most or second-most important crop, 69% had cotton, 73% had peanuts, and 21% had wheat (Table 2.3).

A majority (70%) of the farmers surveyed in Whitman County with wheat as their first or second crop rotated their wheat land with another crop (Table 2.10). Relatively few rice farmers (19%) in the Butte County sample used rotations, but majorities of the corn and soybean farmers in the Midwestern sites used them, as did 60% to 76% of the relevant growers of soybeans, cotton, peanuts, and wheat in the Dooly County sample.

A potentially useful type of comparison is between farmers in different sites who raise the same crop. We can make three comparisons of this kind: (1) between wheat farmers in Whitman and Dooly counties, (2) between corn growers in Renville and Livingston counties, and (3) among growers of soybeans in the two Midwestern sites and in Dooly County (Table 2.10). Holding type of crop constant, we may find differences in usage, suggesting that some contextual factor like climate affects the use of a practice. However, regarding use of crop rotations, we found no substantial differences across farmers of the same crop except between corn growers in Renville and Livingston counties. Some advantage in soil conditions or climate may have made continuous cropping of corn and soybeans more attractive in the Illinois site.

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[5]Throughout this report, we refer to such groups of ten or more farmers as relevant groups. For each survey site, the relevant groups and the number of farmers in each group are as follows: **Whitman County,** wheat (101 farmers) and barley (66 farmers); **Butte County,** rice (89); **Renville County,** corn (99) and soybeans (102); **Livingston County,** corn (91) and soybeans (89); **Dooly County,** soybeans (17), cotton (48), peanuts (51), and wheat (15).

The logistic regression analyses identified only one variable that was significantly associated in more than one sample with using crop rotations against weeds, CLASSIF, i.e., whether respondents classified themselves as conventional or nonconventional farmers (Table 2.11). In the Whitman, Butte, and Livingston county samples, respondents who labeled themselves as low-input or sustainable farmers were more likely to use this practice. Understandably, readers want to know how much *more likely* nonconventional farmers were to use the practice compared to conventional farmers. Our best estimate is that in these three samples the likelihood of farmers using crop rotations against weeds increased 10 to 35 percentage points if they were sustainable rather than conventional farmers (Table 2.11). For example, in the Livingston County case, the likelihood would be 59% if they classified themselves as conventional but 80% if they called themselves sustainable or low-input farmers (the other variable in the equation, COMMERCL, was held constant).

Timing the Planting Dates of Crops to Avoid Pest Problems

Timing the planting dates of crops to avoid pest problems was not very popular compared to rotations. Only in the Whitman County sample did a majority of the respondents report using it (51%). Forty percent used the practice in the Dooly County site, but elsewhere the percentages ranged from just 17% to 26% (Table 2.1). In the two sites where this practice was popular, its users tended to rate it highly. Sixty-one percent of the respondents in Whitman County ranked it first or second in importance; the corresponding percentage for Dooly County was 51% (Table 2.2).

We found no significant intra-site differences by crop in the use of this practice (Table 2.12). In the Whitman County sample exactly the same percentage of wheat growers as barley farmers used it. In Dooly County frequency of application ranged rather narrowly (from 27% to 40%) among soybean, cotton, peanut, and wheat growers. In the two Midwestern sites the differences in usage between corn and soybean farmers were even smaller. Climate did not seem to affect use, at least not systematically. Soybean farmers in the warmer, wetter Dooly County site used the practice about as frequently as farmers in the two Midwestern sites.

Findings from the regression analyses of the timing of planting dates are too scattered to warrant discussion. No variables proved to be statistically significant for more than one sample.

Adjusting Row Spacing to Compete Better against Weeds or to Allow Cultivations

In the Whitman and Butte county samples, few respondents (17% and 14%) spaced rows to compete better against weeds or to allow cultivations, but usage in the other three sites was very high--70% to 91% (Table 2.1). The difference probably results from the different kinds of crops that predominate in the sites. The major crops in Whitman and Butte counties (wheat, barley, and rice) are closely sown. In the other three sites the major crops are row crops so row spacing is much more appropriate. For example, only 18% of the relevant Whitman County wheat farmers reported using the practice, compared to 71% to 87% of the soybean farmers in Renville, Livingston, and Dooly counties (Table 2.13).

Users of row spacing in Renville, Livingston, and Dooly counties rated the practice rather highly. From 34% to 61% ranked it first or second in importance for their primary crop (Table 2.2).

We have already noted differences in usage by general type of crop (closely sown and row crops). Among row crops, the usage rates did not vary greatly either across or within sites. From 74% to 87% of the corn and soybean farmers in the Renville and Livingston county samples applied this practice, as did 67% to 71% of the relevant row-crop farmers in Dooly County (Table 2.13).

The logistic regression analyses for this practice were not very helpful. For three samples, not a single hypothesized explanatory variable was statistically significant (Table 2.11). In the remaining two survey sites, no variable was significant for more than a single sample.

Adjusting Rates of Seeding to Improve Crop Competitiveness with Weeds

The practice of adjusting seeding rates was rather widely used but not highly rated. Across the five survey sites from 47% to 59% of the respondents used it on their primary crop, and from 49% to 62% applied it to at least one crop (Table 2.1). This was the only practice used by majorities or near majorities in all five areas. However, only 17% to 38% of the users ranked the practice first or second in importance for their primary crop (Table 2.2).

The frequency of usage did not vary much by crop. Among the various groups of ten or more farmers in the five sites with the same primary or secondary crop, the percentages who adjusted seeding rates ranged rather narrowly from 41% to 65% (Table 2.14). The practice seems to have broad applicability, popular with farmers of different crops and in different climatic areas of the country.

The results of the regression analyses for the practice of adjusting seeding rates were very meager. No more than a single variable was statistically significant per site. In two samples the same variable qualified, but the signs were different--positive in one case and negative in the other. That is, in one site use of the practice was more likely if the farm had a livestock component, but in the other site it was less likely.

Reducing or Increasing the Frequency of Tillage

Reduced tillage practices (such as conservation tillage or no-till) were popular in three of our five sites.[6] Majorities of 60% to 80% of the respondents in Whitman, Renville, and Livingston counties used these practices (Table 2.1). By contrast only 15% of the Butte County sample and 24% in Dooly County used reduced tillage. In those two sites respondents preferred to increase the frequency of tillage to clear fields of refuges for pests and weeds. Majorities of 64% and 69% followed that approach in the Butte and Dooly county sites, respectively, on at least one of their crops (Table 2.1). Moreover, the users in both these counties tended to value the practice more highly than did the users of reduced tillage. Among the Dooly County respondents, no other practice had as high a percentage of first- or second-place rankings--79%. In the Butte County case 69% of the users rated it first or second (Table 2.2). By comparison, the combined rankings given to reduced tillage practices ranged from 31% to 59%.

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[6]In the questionnaire we defined reduced tillage practices as fewer passes per field or less disturbance of the soil per pass.

Use of these two approaches varied both by crop and by climatic conditions. Farmers of the same crops in different sites used these approaches with much different frequencies (Table 2.15). In Dooly County only 24% of the relevant soybean farmers used reduced tillage, but 57% and 74% of the soybean growers in the two Midwestern sites used it. Similarly, just 20% of the wheat farmers surveyed in Dooly County applied reduced tillage, but 82% of the corresponding group in Whitman County did so. In other words, type of crop cannot explain these differences. Interviews with knowledgeable local people provided the following explanations. Reduced tillage has not been popular in Dooly County because farmers tend to believe that the weed problems resulting from a long growing season and ample rainfall compel frequent cultivations. Dooly County is in a Major Land Resource Area whose annual average precipitation is about 1,525 mm. and whose growing season averages approximately 280 days (U.S. Department of Agriculture, 1981). By contrast, the Illinois site's frost-free period extends only about 160 to 180 days on average, and it is in an area whose mean precipitation level ranges from 750 to 900 mm. The corresponding figures for the Renville County site are lower in both respects, and the Whitman County figures are lower still.

Type of crop was a factor in the Butte County sample. In northern California rice tends to be grown on flooded fields.[7] If significant crop residues are left on the fields when they are flooded, decomposition of the rice straw forms gasses that may kill the rice seedlings.

Since frequent tillage tends to be a conventional approach to farming, we applied regression analysis only to the responses for reduced tillage practices. Use of reduced tillage was associated with farmers' years of formal schooling in the two Midwestern sites. The more education, the more likely the farmer was to practice reduced tillage (Table 2.11). In one site (Butte County), respondents who classified themselves as low-input or sustainable farmers were more likely to use this practice.

Controlled Burning after Harvest to Reduce Crop Residue

Controlled burning had no users in the two Midwestern sites and proportionally many users only in the Butte County survey area, where 86% of the respondents reported using it, compared to 31% of the respondents in Whitman County and 41% in Dooly County (Table 2.1). Only in the California site did a majority of users (84%) rank it as first or second in importance for growing their primary crop (Table 2.2). By comparison, only 25% of the users in Whitman County and 9% in Dooly County rated it highly.

There are some significant variations in usage by crop type. Almost all the rice growers in Butte County (94%) and more than half the soybean and wheat farmers in Dooly County used controlled burning (Table 2.17). By contrast, none of the Midwestern soybean farmers and less than a quarter of the Whitman County wheat growers used it. Burning of rice residue is the recommended means for controlling stem rot, the main disease attacking rice in northern California (National Research Council, 1989). Presumably, the higher frequency of burning crop residues in Dooly County, compared to Whitman County and the two Midwestern sites, relates to differences in disease or pest problems. The warmer, wetter Georgia site has more such problems or more serious ones.

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[7]See the case study discussing rice farming in northern California, "Rice Production in California: The Lundberg Family Farms," in National Research Council, 1989, pp. 398-417.

Summary and Policy Inferences

Majorities or near-majorities of respondents (45% to 50%) in at least three of the five sites used four of the seven tillage and cultivation practices. To fight weeds 49% to 62% in all five sites adjusted the rates of seeding so that stands of young plants would become too thick for weeds to compete well. In four sites, from 54% to 82% of the growers used crop rotations to break the weed cycles of continuous cropping. Majorities of 70% to 91% in three sites combatted weeds through the technique of spacing rows. Also in three sites, 60% to 80% reported that they suppressed weeds with reduced tillage, such as through the effect of crop residues reducing the amount of light reaching weed seedlings.

Among these frequently used practices, three were highly rated. Farmers applying them to their primary crop ranked them first or second in importance among the tillage and cultivation practices they used for those crops. The three were rotations, rated first or second by 76% to 88% of its users in the sites where they were widely applied; reduced tillage (55% to 59%), and row spacing (34% to 61%). These three methods for saving chemical inputs recommend themselves because they are frequently used in diverse agricultural areas and users regard them highly.

Use of some practices varied significantly by crop or climate. Rotations were not popular in the California site in part because heavy rain prevented planting a winter crop, but also because farmers found rice was too remunerative not to plant it continuously in the spring. Not surprisingly, spacing rows to control weeds was more frequently applied to row crops than to closely sown crops. Reduced tillage was not feasible for rice farming in the California site since the fields were flooded and the decomposition of residues left on the surface would be toxic to rice seedlings. In the warm temperatures and high levels of precipitation prevailing in the Georgia site, weeds do so well that farmers tend to believe that frequent tillage is necessary. The obvious policy inference to be drawn from these findings is that some practices with the potential for economizing on chemical inputs will be largely unacceptable to the growers of certain crops or to farmers in certain climatic regions unless the practices can be modified to accommodate the special needs of these farmers.

Logistic regression analyses tested various hypotheses about why farmers used tillage and cultivation practices. The results were disappointing because none of the hypotheses helped to explain usage of more than one practice by the respondents in more than one survey site. Among the largely unsupported hypotheses was that growers who considered themselves to be low-input, sustainable, or organic farmers were more likely than conventional farmers to use practices with the potential for saving chemical inputs. Only for crop rotations did this variable relate to the use of the practice in the predicted way in more than one site (Table 2.11).

Tables for Chapter 2

Table 2.1

Farmers' Reports of their 1988 Tillage and Cultivation Practices

Practices[1]	Percentage of Farmers Applying Each Practice				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Percentage who used a rotation to reduce a weed problem for:					
At least one crop	73	20	82	54	73
Their primary crop[2]	68	19	79	54	70
Their secondary crop[3]	70	13	77	50	67
Some other crop[4]	50	0	71	14	42
Percentage who timed planting date to avoid pest problem for:					
At least one crop	51	17	19	26	40
Their primary crop	51	17	18	23	36
Their secondary crop	43	7	19	22	31
Some other crop	24	0	12	3	15
Percentage who used row spacing to compete better against weeds or allow cultivation for:					
At least one crop	17	14	91	81	70
Their primary crop	17	12	89	73	69
Their secondary crop	18	10	82	75	64
Some other crop	14	0	67	0	40
Percentage who used seeding rate to improve crop competitiveness with weeds for:					
At least one crop	58	61	62	55	49
Their primary crop	54	59	56	47	47
Their secondary crop	55	26	53	45	46
Some other crop	40	0	51	14	31

Table 2.1 continues

Table 2.1 continued

Practices[1]	Percentage of Farmers Applying Each Practice				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Percentage who used reduced tillage (fewer passes or less disturbance of soil per pass) for:					
At least one crop	80	15	60	79	24
Their primary crop	79	14	59	76	17
Their secondary crop	70	10	58	75	16
Some other crop	45	8	53	10	8
Percentage who increased tillage frequency to clear field of refuge for pests and weeds for:					
At least one crop	31	64	17	14	69
Their primary crop	25	61	14	13	67
Their secondary crop	25	23	13	13	66
Some other crop	14	25	11	3	46
Percentage who used controlled burning after harvest to reduce crop residue for:					
At least one crop	31	86	0	0	41
Their primary crop	26	83	0	0	31
Their secondary crop	14	16	0	0	37
Some other crop	14	8	0	0	33
Percentage who used another tillage practice for:					
At least one crop	7	13	2	0	0
Their primary crop	7	13	2	0	0
Their secondary crop	7	3	2	0	0
Some other crop	10	1	1	0	0
All farmers with crops	(104)	(100)	(114)	(92)	(70)
Those with two or more crops	(100)	(31)	(113)	(90)	(67)
Those with three or more crops	(58)	(12)	(98)	(29)	(52)

Table 2.1 continues

Table 2.1 continued

[1]A list of practices was provided, and farmers were asked to indicate which ones they used.

[2]The primary crop is that crop which in 1988 was planted on the largest number of acres.

[3]The secondary crop is that crop which in 1988 was planted on the second largest number of acres. Entries are only for the farmers with at least two crops.

[4]Entries are only for the farmers with at least three crops.

Table 2.2

Farmers' Rankings of the Importance of Practices for the Cultivation of Their Primary Crop

Practice[2]	Percentage of Farmers Ranking Each Practice[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Used a rotation to reduce a weed problem	47	29	16	21	67	21	48	28	26	52
Timed planting date to avoid pest problem	44	17	53	18	24	24	38	19	39	12
Used row spacing to compete better against weeds or allow cultivation	6	11	0	42	18	43	32	29	22	12
Used seeding rate to improve crop competitiveness with weeds	5	29	14	24	6	11	2	25	6	15
Used reduced tillage systems (fewer passes or less disturbance of soil per pass)	28	30	7[3]	36[3]	31	24	39	20	23	8
Increased tillage frequency to clear field of refuge for pests and weeds	8	12	28	41	6[3]	38[3]	33[3]	17[3]	53	26
Used controlled burning after harvest to reduce crop residue	4	21	57	27	0	0	0	0	0	9
Used another practice	0	0	31[3]	15[3]	50[3]	0	0	0	0	0

[3]The number of respondents varied with the practice

[1]For each survey site, the column labeled "1st" indicates the percentage of users of a practice who ranked it the most important in the cultivation of a primary crop. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

Table 2.3

Percentages of Respondents Reporting Selected Crops As Their Primary or Secondary Crop[1]

	Percentages Reporting Crop as Primary or Secondary[2]														
	Whitman County (WA)			Butte County (CA)			Renville County (MN)			Livingston County (IL)			Dooly County (GA)		
Crops	I	II	E	I	II	E	I	II	E	I	II	E	I	II	E
Corn	0	1	1	2	0	3	27	61	87	41	59	99	1	0	1
Soybeans	0	0	0	0	0	0	64	25	89	59	39	97	20	5	24
Cotton	0	0	0	0	0	0	0	0	0	0	0	0	49	21	69
Peanuts	0	0	0	0	0	0	0	0	0	0	0	0	19	57	73
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Other row crops	0	0	0	0	3	1	9	10	18	0	0	0	6	0	6
Wheat	83	14	97	2	7	4	0	4	4	0	0	0	4	18	21
Oats	0	2	2	1	7	3	0	3	3	0	0	0	0	2	2
Barley	12	54	64	0	3	1	0	0	0	0	0	0	0	0	0
Rice	0	0	0	87	7	89	0	0	0	0	0	0	0	0	0
Other small grains	4	24	27	0	7	2	0	0	0	0	0	0	0	0	0
Hay forage	1	3	4	3	6	5	0	1	1	0	3	3	1	0	1
Fruit	0	0	0	2	16	7	0	0	0	0	0	0	0	0	0
Vegetables	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0
Xmas trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other crops	0	4	4	3	41[3]	16	0	0	0	0	0	0	1	3	4
Respondents	104	100	104	100	31	100	114	113	114	92	90	92	70	67	70

Table 2.3 continues

Table 2.3 continued

[1]The *primary crop* is the crop with the largest number of acres planted to it in 1988. The secondary crop is the one with the second largest number of acres.

[2]The columns labeled "I" list the percentage of farmers with one or more crops who reported the indicated crop as their primary crop. The columns labeled "II" list the percentage of farmers with two or more crops who reported the indicated crop as their secondary crop. The columns labeled "E" list the percentage of farmers who reported the indicated crop as either their primary or secondary crop.

[5]In Butte County other crops are mostly almonds and walnuts.

Table 2.4

Traits of Farmers or Their Operations Hypothesized to Be Associated with Whether They Used Tillage, Fertility, and Pest-Control Practices with the Potential for Saving on Chemical Inputs

Traits	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Age					
75th percentile	60	64	56	61	61
median	50	48	45	51	46
25th percentile	37	40	35	38	40
Years of formal schooling					
75th percentile	17	17	15	15	15
median	15	15	13	13	13
25th percentile	13	13	13	13	13
Gross farm revenue (in $1,000s)					
75th percentile	250	250	250	150	450
median	150	150	150	70	150
25th percentile	70	70	70	70	150
Percentage of family income from farming					
75th percentile	90	90	90	90	90
median	90	90	90	90	90
25th percentile	60	70	70	53	68
Family members working on farm					
75th percentile	4	3	3	3	3
median	2	2	2	2	2
25th percentile	2	1	2	1	1
Debt as a percentage of total farm assets					
75th percentile	33	33	33	33	55
median	18	18	18	18	55
25th percentile	5	5	5	5[1]	33
Percentage who raised, fed, pastured, or purchased at least ten animals for commercial purposes	22	9	33	25	18
Percentage who participated in either the Conservation Reserve Program or the Agricultural Conservation Program (1986-88)	49	9	10	3	29

Table 2.4 continues

Table 2.4 continued

Traits	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Percentage who believed that agr. chemicals were contaminating local drinking water	46	38	57	62	17
Percentage who ranked local USDA personnel as the first or second most helpful information source on tillage/cultivation practices for their primary crop	25	8	19	5	43
Percentage who ranked dealers or applicators of fertilizers or pesticides as the first or second most helpful information source on tillage/cultivation practices for their primary crop	48	31	53	65	39
Percentage who ranked the availability of federal farm program benefits as the first or second most important factor in their decisions as to which crops to plant	23	42	40	47	53
(Number of respondents)	(106)	(100)	(114)	(92)	(72)

[1]Almost 40 percent of the members of the Livingston County Sample did not answer this question.

Table 2.5

Farmers' Classification of the Type of Farmer They Considered Themselves to Be

Classification[1]	Percentage of Farmers Selecting Each Classification				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Low-input farmer[2]	12	10	10	11	7
Sustainable farmer[3]	26	2	9	6	7
Organic farmer[4]	0	0	1	0	0
Conventional farmer[5]	55	86	77	80	83
Other type of farmer	3	0	1	1	0
Respondent checked more than one type	3	0	1	2	2
No response	1	2	1	0	1
Total respondents	(106)	(100)	(114)	(92)	(72)
Total percentage of farmers who considered themselves low-input, sustainable, or organic farmers	38	12	19	18	14
Percentage who typed themselves as conventional or other farmers	58	86	78	81	83

[1]A list of classifications was provided, and respondents were asked to indicate which one best described them.

[2]Low-input farmers were those who attempted to reduce their use of inputs such as chemicals and fertilizers purchased off the farm.

[3]Sustainable farmers were those who attempted to develop a balanced agricultural system by adjusting their use of inputs, their crops, and their livestock in recognition of the ecology of their farmland.

[4]Organic farmers were those who avoided the use of any synthetic or manufactured substances in growing their crops and managing their land.

[5]Conventional farmers were those who followed standard recommended practices in tillage systems, fertility management, and the control of pests.

Table 2.6

Farmers' Reports of Sources That Provided Information or Advice in 1988 for the Tillage and Cultivation Practices They Used

Information Sources[1]	Percentage of Farmers Selecting Each Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Staff member of Cooperative Extension Service (CES)					
Yes	26	29	38	19	63
No	72	69	62	80	36
No response	2	2	0	1	1
Publications, meetings, or field days of CES					
Yes	42	53	61	47	58
No	56	45	39	52	41
No response	2	2	0	1	1
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)					
Yes	42	2	23	9	29
No	57	96	77	90	70
No response	1	2	0	1	1
Publications, meetings, or field day of SCS or CD					
Yes	42	4	35	38	22
No	57	94	65	61	77
No response	1	2	0	1	1
Staff member of Agricultural Stabilization and Conservation Service (ASCS)					
Yes	32	7	22	18	21
No	67	91	78	81	78
No response	1	2	0	1	1
Publications, meetings, or field days of ASCS					
Yes	36	14	39	37	15
No	63	84	61	62	83
No response	1	2	0	1	2

Table 2.6 continues

Table 2.6 continued

Information Sources[1]	Percentage of Farmers Selecting Each Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Staff and publications of other public agencies					
Yes	22	10	30	23	17
No	77	78	70	76	82
No response	1	2	0	1	1
Farm organization personnel[2]					
Yes	20	27	41	40	13
No	79	70	59	59	86
No response	1	3	0	1	1
Fertilizer dealer					
Yes	76	54	83	79	56
No	23	44	17	19	43
No response	1	2	0	2	1
Herbicide or insecticide dealer					
Yes	73	51	82	77	58
No	26	47	18	22	40
No response	1	2	0	1	2
Fertilizer or pesticide applicator					
Yes	46	21	51	44	22
No	53	76	49	55	75
No response	1	3	0	1	3
Other farmers					
Yes	78	75	87	72	79
No	21	23	13	28	20
No response	1	2	0	1	1
Family members					
Yes	71	63	72	57	40
No	28	35	28	42	58
No response	1	2	0	1	1
Nonprofit, educational, or environmental organizations					
Yes	12	12	21	25	3
No	87	85	79	74	96
No response	1	3	0	1	1

Table 2.6 continues

Table 2.6 continued

Information Sources[1]	Percentage of Farmers Selecting Each Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Farm magazines, journals, radio and television programs					
Yes	53	40	90	79	71
No	46	56	10	20	28
No response	1	4	0	1	1
Other					
Yes	8	19	8	5	6
No	79	72	92	88	90
No response	13	9	0	7	4

[1]The survey instrument provided a list of information sources, and farmers were asked to indicate which ones they used.

[2]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 2.7

Farmers' Rankings of the Importance of Sources That Provided Information or Advice in 1988 for the Tillage and Cultivation Practices They Used

Information Sources[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Staff member of Cooperative Extension Service (CES)	1	6	2	4	7	3	1	0	29	11
Publications, meetings, or field days of CES	5	4	10	6	3	0	3	1	4	10
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)	9	6	0	1	0	0	1	0	1	6
Publications, meetings, or field days of SCS or CD	1	3	1	0	0	1	0	3	1	1
Staff member of Agricultural Stabilization and Conservation Service (ASCS)	4	6	0	1	0	0	3	0	0	1
Publications, meetings, or field days of ASCS	2	1	0	1	0	1	1	2	0	0
Staff and publications of other public agencies	0	0	1	2	1	1	0	1	1	0
Farm organization personnel[3]	1	0	7	2	0	3	3	1	0	3
Fertilizer dealer	32	11	14	8	33	11	44	13	17	4
Herbicide or insecticide dealer	3	9	4	10	6	14	2	24	8	14
Fertilizer or pesticide applicator	1	3	0	3	2	1	0	1	0	1
Other farmers	19	21	12	25	25	20	10	14	19	21
Family members	10	15	19	16	8	15	8	7	4	10

Table 2.7 continues

Table 2.7 continued

Information Sources[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Nonprofit, educational, or environmental organizations	0	1	1	1	2	1	1	2	0	0
Farm magazines, journals, radio and television programs	4	6	2	4	10	27	14	20	8	10
Other	5	1	14	0	4	2	1	0	3	1
No response	5	10	5	16	0	1	7	11	3	7

[1]For each survey site, the column labeled "1st" indicates the percentages of respondents who ranked each information source first in importance. The column labeled "2nd" indicates the percentage who ranked it second.

[2]The survey instrument provided a list of sources, and farmers were asked to indicate which ones they used.

[2]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 2.8
Farmers' Reports of Factors That Influenced Their Decisions about Which Crops to Plant in 1988

Factors[1]	Percentage of Farmers Selecting Each Factor				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Crop prices					
Yes	81	52	78	47	90
No	18	46	21	53	10
No response	1	2	0	0	0
Availability of markets					
Yes	72	70	70	48	56
No	28	28	30	52	43
No response	0	2	0	0	0
Availability of federal farm program benefits					
Yes	75	78	78	73	82
No	24	20	30	27	43
No response	1	2	0	0	0
Availability of equipment					
Yes	50	81	66	39	57
No	50	17	34	61	42
No response	0	2	0	0	1
Availability of labor					
Yes	25	54	41	25	39
No	75	44	58	74	58
No response	0	2	0	1	3
Familiarity with crop and cropping system					
Yes	73	90	85	71	82
No	27	8	15	28	18
No response	0	2	0	1	0
Need to produce feed for animals					
Yes	14	10	32	20	8
No	85	88	68	79	92
No response	1	2	0	1	0

Table 2.8 continues

Table 2.8 continued

Factors[1]	Percentage of Farmers Selecting Each Factor				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Need to rotate crops					
Yes	84	10	92	84	58
No	16	88	8	15	42
No response	0	2	0	1	0
Other					
Yes	13	24	4	1	6
No	80	70	96	97	93
No response	7	6	0	2	1
Total Respondents	(106)	(100)	(114)	(92)	(72)

[1]The survey instrument provided farmers with a list of factors from which they could choose.

Table 2.9

Farmers' Rankings of Factors That Influenced Their Decisions about Which Crops to Plant in 1988

	Percentage of Farmers Ranking Each Factor[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
Factors[2]	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Crop prices	52	15	22	13	44	18	30	10	57	22
Availability of markets	10	23	7	14	4	6	9	9	4	17
Availability of federal farm program benefits	9	13	13	29	19	21	27	20	29	24
Availability of equipment	1	6	1	19	1	9	0	7	0	8
Availability of labor	0	1	0	0	0	1	0	2	1	0
Familiarity with crop and cropping system	7	12	35	19	7	11	9	18	1	18
Need to produce feed for animals	0	0	1	0	9	3	3	4	1	0
Need to rotate crops	12	25	1	0	15	29	23	15	0	6
Other	5	0	14	2	1	0	0	0	3	0
Total Respondents	(104)		(100)		(114)		(92)		(70)	

[1]For each survey site, the column labeled "1st" indicates the percentage of respondents who ranked each factor first in importance. The column labeled "2nd" indicates the percentage who ranked it second.

[2]The survey instrument provided farmers with a list of factors from which they could choose.

Table 2.10

Use of Rotations to Reduce Weed Problems

Crop	Percentage of Farmers Using Rotations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	76	53	--
Soybeans	--	--	81	53	76
Cotton	--	--	--	--	73
Peanuts	--	--	--	--	75
Wheat	70	--	--	--	60
Barley	76	--	--	--	--
Rice	--	19	--	--	--

[1]Table 2.10 reports percentages only for relevant groups, that is, those where at least ten farmers reported an indicated crop as their primary or secondary crop. By crop, the relevant groups of farmers and the number in each group in each site are as follows:

corn: Renville County (99 farmers)
Livingston County (91 farmers)
soybeans: Renville County (102)
Livingston County (89)
Dooly County (17)
cotton: Dooly County (48)
peanuts: Dooly County (51)
wheat: Whitman County (101)
Dooly County (15)
barley: Whitman County (66)
rice: Butte County (89)

Table 2.11

Traits of Farmers or Their Operations Found to Be Associated with the Use of Tillage and Cultivation Practices[1]

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Rotations to reduce a weed problem	-AGE (7)[3] BARLEY (13) CLASSIF (10)	CLASSIF (35)	BEANS (6) -LABOR (17)	CLASSIF (22) COMERCL (22)	—— ——
Timed planting to avoid pest problem	——	CLASSIF (54) COMERCL (61)	CONSERVE (30)	——	——
Spaced rows to compete better against weeds or allow cultivation	——	——	-COMMERCL (34) -LVSTOCK (29)	——	CHMPRB (22) PCTINC (3)
Used seeding rate to compete better against weeds	-LVSTOCK (27)	COMERCL (30)	——	LVSTOCK (22)	——
Reduced tillage	——	CLASSIF (53) LVSTOCK (42)	EDUC (9)	EDUC (8)	——

Table 2.11 continues

Table 2.11 continued

[1]Associated means that logistic regression coefficients measuring the presence of a relationship between a trait and a practice were statistically significant in a t-test at the 0.1 level for one-tailed tests and at the 0.05 level for two-tailed tests.

[2]Traits are defined as follows:

AGE:	farmers' age in years.
BARLEY:	farmers did or did not have barley as their primary or secondary crop in 1988.
BEANS:	farmers did or did not have soybeans as their primary or secondary crop in 1988.
CHEMPRB:	farmers did or did not believe that agricultural chemicals had contaminated drinking water in their county.
CLASSIF:	farmers did or did not classify themselves as low-input, organic, or sustainable farmers.
COMERCL:	farmers did or did not rank fertilizer and pesticide dealers or applicators as the most or second most important source of information for cultivation of their primary crop.
CONSERVE:	farmers did or did not participate recently (1986-88) in either the Conservation Reserve Program or the Agricultural Conservation Program.
EDUC:	farmers' years of formal education.
INCOME:	farmers' 1988 gross revenues from agriculture, including government payments.
LABOR:	number of family members who worked on the farm in 1988.
LVSTOCK:	farmers did or did not raise, feed, pasture, or purchase at least ten animals for commercial purposes.
PCTINC:	percentage of farmers' 1988 family income derived from agriculture.

[3]The numbers in parentheses indicate the percentage-point change in the estimated probability of using the indicated practice, when a dichotomous explanatory variable is changed from its positive to its negative value or when an interval-level variable is changed from its 25th- to its 75th-percentile value, with the other variables held constant.

Table 2.12

Use of the Timing of Planting Dates to Avoid Pest Problems

Crop	Percentage of Farmers Using Timed Planting Dates[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	20	25	--
Soybeans	--	--	19	20	29
Cotton	--	--	--	--	40
Peanuts	--	--	--	--	31
Wheat	50	--	--	--	27
Barley	50	--	--	--	--
Rice	--	17	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 2.13

Use of the Practice of Spacing Rows to Enable Crops to Compete Better against Weeds or to Allow Cultivation

Crop	Percentage of Farmers Spacing Rows[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	84	74	--
Soybeans	--	--	87	76	71
Cotton	--	--	--	--	69
Peanuts	--	--	--	--	67
Wheat	18	--	--	--	73
Barley	17	--	--	--	--
Rice	--	9	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 2.14

Use of Adjusting the Seeding Rate to Enable Crops to Compete Better against Weeds

Crop	Percentage of Farmers Adjusting Seeding Rate[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	52	44	--
Soybeans	--	--	55	48	65
Cotton	--	--	--	--	44
Peanuts	--	--	--	--	41
Wheat	52	--	--	--	60
Barley	55	--	--	--	--
Rice	--	64	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers reporting each crop as their primary or secondary crop.

Table 2.15

Use of Reduced Tillage

Crop	Percentage of Farmers Using Reduced Tillage[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	58	77	--
Soybeans	--	--	57	74	24
Cotton	--	--	--	--	17
Peanuts	--	--	--	--	14
Wheat	82	--	--	--	20
Barley	73	--	--	--	--
Rice	--	14	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers reporting each crop as their primary or secondary crop.

Table 2.16

Use of Increased Tillage to Fight Pests and Weeds

Crop	Percentage of Farmers Increasing Tillage[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	12	12	--
Soybeans	--	--	16	15	59
Cotton	--	--	--	--	71
Peanuts	--	--	--	--	69
Wheat	24	--	--	--	73
Barley	24	--	--	--	--
Rice	--	65	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers reporting each crop as their primary or secondary crop.

Table 2.17

Use of Controlled Burning after Harvest to Reduce Residues

Crop	Percentage of Farmers Using Controlled Burning[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	0	0	--
Soybeans	--	--	0	0	53
Cotton	--	--	--	--	29
Peanuts	--	--	--	--	27
Wheat	23	--	--	--	67
Barley	14	--	--	--	--
Rice	--	94	--	--	--

[1]See the footnote to Table 2.10 for the number of farmers reporting each crop as their primary or secondary crop.

Chapter 3

Farmers' Use of Fertility Practices with the Potential for Saving on Chemical Inputs

Chapter Overview

Majorities of respondents in at least four survey areas reported using one to three fertility practices with the potential for economizing on synthetic fertilizers. The three most frequently used practices were:

1. Conducting soil tests to determine nutrient levels.

2. Adjusting crop yield goals and the related fertilizer application rates on the basis of past yields.

3. Estimating the efficiency of nitrogen use based on variations in yields relative to the timing, source, and amount of nitrogen used.

Farmers ranked soil testing and adjustment of crop yield highly compared to other fertility measures applied.

Use of some fertility practices varied significantly with type of crop and, in some cases, differed among growers of the same crops in separate sites.

In one to four sites per practice, following the advice of the Cooperative Extension Service was associated with using five fertility practices with the potential for economizing on chemicals. By contrast, following the advice of fertilizer dealers was associated with the use of only two practices in just one site per practice.

Size of the farm operation was also found to be a significant predictor of use for the fertility practices discussed in this chapter. The smaller the operation, the less likely the farmer was to apply the practice, other variables held constant. For example, smaller farm operations were less likely to conduct soil or plant tissue tests than were larger operations.

Introduction

The second group of farming practices we will discuss is fertility practices, i.e., those concerned with satisfying the fertility needs of crops. We gave respondents a list of 11 fertility practices (Table 3.1) and asked if they had applied any in 1988 to their primary, secondary, or other crop.

Nitrate pollution of ground- and surface water has been found in many areas of the country, and agriculture has been its most important cause (Hallberg, 1986). Animal manure, such as that from confined livestock and poultry operations, is one source, and the application to fields of inorganic fertilizer is another. Hallberg's review of field research on groundwater pollution found that "many studies show a direct relationship between nitrate leaching to groundwater and nitrogen fertilization rates and/or fertilization history" (1986, p. 358).

For most farmers expenditures on fertilizers tend to comprise a substantial share of their total variable costs. Therefore, reducing the use of fertilizers has the potential for significant financial benefits to the farm operation as well as to the environment.

For many farm operations there may be a high potential for such savings. Hallberg (1987) cited several studies which show that crops did not use large percentages (65% or more) of the applied fertilizer. Instead, it remained stored in the soil or was lost to runoff water, groundwater, or denitrification (conversion to gas). High levels of stored nitrogen could permit reductions in the amount of fertilizer applied the following year. However, many farmers either do not monitor the levels of nutrients already available or they over-fertilize as a form of insurance (Papendick, Elliott, and Power, 1987). Farmers may reject monitoring because they feel comfortable with rules of thumb or the recommendations of dealers or other sources; however, for their particular fields and crops, standardized applications may lead to waste.

Results

Soil Tests to Determine Nutrient Levels

The first fertility practice covered in the interviews was the practice of conducting soil tests to determine nutrient levels. We will discuss four aspects of the responses per practice: (1) the practice's relative popularity across sites; (2) the comparative importance of the practice to its users; (3) the degree to which usage varied by type of crop, and (4) the traits of farmers and their operations that were associated with applying the practice.

Properly conducted and interpreted, soil tests can help farmers avoid applying larger amounts of fertilizers than their yield goals require. If those goals are set high, applications may be high, but at least they need not be wasteful relative to the goals. Except in the Butte County site, large majorities of the respondents (72% to 94%) reported using soil tests (Table 3.1). It was the most frequently applied fertility practice in the Renville and Dooly county sites, and it ranked second in Whitman County and third for the Livingston County sample.

Frequency of use is not the only criterion to determine the value of a practice. Ideally, it is both widely used and highly rated. In our survey soil tests to determine nutrient levels met both criteria. Across the five survey sites, 46% to 82% of the respondents who applied soil tests to their primary crop rated it the most important fertility practice, and 51% to 88% rated it either first or second (Table 3.2). Per site, no other practice had combined totals as high of first- and second-place rankings except in the Butte County case, where soil tests placed second by this standard.

It may be difficult to tie the use of soil tests to a particular crop since the tests typically are not made every year. For example, for northern Illinois the Cooperative Extension Service recommends testing soils every four years. Therefore, the results of a test done in 1986 when fields were planted to one crop can be applied to another crop on the same fields in 1988. We assume that farmers still answered "yes" if the tests were conducted in previous years but they applied their results to management decisions in 1988. However, since there might have been confusion regarding individual crops, we skip the discussion of use by crop (but present the results of the analysis in Table 3.3).

Regression results are based on whether respondents used soil test results for any of their 1988 crops. We used the same set of hypothesized explanatory variables that we presented in Chapter 2, except that for fertility practices we have more direct indicators of the influence of both the USDA and fertilizer dealers. The 11 fertility practices discussed in the interviews included two directly concerned with this kind of influence. We asked respondents whether they followed the recommendations of fertilizer dealers or the Cooperative Extension Service in deciding how to meet their crop fertility needs. We hypothesized that farmers who followed the recommendations of the Extension Service were more likely to use practices with the potential for saving on chemical fertilizers. Conversely, we assumed that respondents taking advice from fertilizer dealers were less likely to use such practices. Across the five sites, from 12% to 66% of the respondents said that they followed recommendations from the Extension Service for at least one of their 1988 crops. In all sites higher percentages--53% to 87%--took advice from fertilizer dealers (Table 3.1). Tables 3.4 and 3.5 report the survey's findings about other sources of information for fertility practices.

The regression findings for fertility practices are summarized in Table 3.6, which lists by practice and site the traits of farmers and their operations that were significantly associated with the use of a practice for primary or secondary crops. In the case of soil tests, the most interesting relationship that emerged was between the use of the practice and the size of the farm operation, as measured by gross revenues from agriculture. In the Butte, Renville, and Livingston county samples, the larger the operation, the more likely the farmer was to have conducted soil tests, other variables held constant. Larger operations (grossing at least $150,000 in the Illinois site and $250,000 in the other two survey areas) were estimated to be 5 to 24 percentage points more likely to use such tests than were smaller farms (those earning $70,000, Tables 3.6 and 2.4). There may be something about the management requirements of larger operations that incline their farmers to seek information of the type that these tests provide. Perhaps instead the commercial companies marketing such tests are more likely to seek out the larger farmers. The underlying cause should not be the operators' level of education, because we controlled for that variable.

Plant Tissue Tests to Determine Nitrogen Adequacy

Although sizable majorities of respondents in four sites conducted soil tests, relatively few reported using plant tissue tests to determine nitrogen adequacy. According to the results of such tests on young plants, farmers may dispense with supplementary applications of nitrogen or at least apply less than they would have used without the tests. In three survey sites, the percentages of users were only 9% to 14%. Twenty-six percent of the Dooly County respondents said they used them on at least one crop. The highest proportion was 41% in the Butte County site (Table 3.1).

Few of the users ranked plant tissue tests first or second among their fertility practices for their primary crop. From zero to only 14% of the relevant farmers rated it first; and just 9% to 38% ranked it either first or second (Table 3.2). Although the high ratings accorded to soil tests could be used to persuade nonusers to become users, these low assessments of plant tissue tests would discourage adoption. Either plant tissue tests really cannot provide highly important guidance for decisions on fertilization, or their promoters have failed to instruct farmers in how best to use information derived from the test.

Use of plant tissue tests varied considerably by crop, ranging from 6% of the farmers in Whitman County with barley as the primary or secondary crop to 37% of the rice

farmers in Butte County (Table 3.7). Differences were also significant among farmers of the same crop across sites. Where wheat was reported as the primary or secondary crop, only 11% of the relevant farmers in Whitman County used plant tissue tests, compared to 33% of those in Dooly County. In the case of soybeans, the proportions of farmers using plant tissue tests were limited to 6% and 8% in Livingston and Renville counties, but 24% of the soybean farmers in Dooly County used them. We will find the same kind of difference when discussing other practices with the potential for economizing on chemical fertilizers. Compared to growers of the same crops in other sites, the Georgia soybean and wheat farmers were more likely to use the practices.

The regression analyses found that in the Renville and Dooly county sites gross farm revenue was positively related to using plant tissue tests (Table 3.6). Size of operation was also associated with the use of soil tests. The decisive factor may be differences in management style attributable to size. Also, perhaps the costs of tissue tests discourage some smaller farmers.

In one site, Butte County, the farmers who followed the fertilization recommendations of the Extension Service were more likely than other respondents to use tissue tests (Table 3.6). This finding suggests that the Extension Office in Butte County promoted the practice and its clients tended to be persuaded. Alternatively clients chose to have tissue tests for other reasons. In any event, with its contacts with clients, the Extension Service at least had the opportunity to reinforce those choices. We will find that the Extension-recommendations variable is significantly associated with the use of other fertility practices potentially able to reduce the use of chemical fertilizers.

Estimated Contributions to Soil Fertility from Nitrogen Sources Other Than Commercial Fertilizers

Another recommended practice for saving on commercial fertilizers is to estimate the contributions to overall soil fertility made by other nitrogen sources such as animal manure and legume rotations. Among our respondents this practice was moderately popular. In two sites (Renville and Livingston counties) majorities of 63% and 54% reported developing such estimates, and in two others (Whitman and Dooly counties) more than a third of the respondents (37% and 41%) made them (Table 3.1). However, users of this practice tended to not rate it highly. Across the five survey sites, only 11% to 24% of respondents who used it for their primary crop ranked it first or second in importance (Table 3.2). Intuition suggests that it could be a very helpful practice. Perhaps the problem is that farmers have difficulty making useful estimates; they may need technical assistance from the Cooperative Extension Service or other agencies.

Use of this practice varied by crop (Table 3.8). However, as suggested by intuition and the regression analyses for the practice, more important than type of crop was whether farmers had legume-based rotations or livestock, i.e., whether they had other significant sources of nitrogen whose contributions to soil fertility were worth estimating. In four of the five sites, respondents were more likely to have estimated the contributions of alternative sources of nitrogen for their primary or secondary crops if they had followed legume-based rotations for those crops. In three sites there was a higher probability of such estimates if the farm operation included a commercial livestock component (Table 3.6).

In two samples there was a significant association between following the recommendations of the Cooperative Extension Service and estimating the contribution of other sources of nitrogen. Even if farmers had livestock or rotations with legumes, they were still more likely to apply this practice when they also followed the recommendations of the Extension Service. In other words, the agency may make a difference even when other variables disposed farmers to employ a practice. Again, we cannot be certain that Extension's advice influenced operators to use this practice, but at least Extension was in a position to reinforce farmers who for other reasons were inclined to do so.

Adjusted Crop Yield Goals and Fertilizer Rates Based on Past Performance

Hallberg (1986) cited field studies from Nebraska and Iowa indicating that many farmers set yield goals 20% to 25% higher than they could realistically achieve. Growers may base such goals on their best years' yields rather than on an average of good, moderate, and poor harvests (Hoover and Hale, 1982). Unrealistically high goals may lead to wastefully high application rates of fertilizers. Therefore, for financial reasons if not also for environmental purposes, farmers should periodically review the record of yield performance and adjust their goals and related fertilization rates accordingly.

In all five of our survey sites, majorities of the respondents--57% to 85%--reported making such adjustments (Table 3.1). This was the fertility measure used most frequently by members of the Whitman and Butte County samples, and it ranked second among the farmers surveyed in Livingston County. It may be surprising that more farmers did not use this commonsense practice. Adjustments need not be made every year, but it would be unfortunate if farmers failed to change out of habit or adherence to obsolete conventions.

This practice ranked high in importance to its users in Whitman, Butte, and Livingston counties. From 49% to 56% rated it first or second in importance for the production of their primary crop (Table 3.2). In Renville County, one-third ranked it as highly.

The analysis that relates use of this practice to different types of crops supports what intuition suggests--for virtually any crop farmers can profit from adjusting fertilization rates based on past performance. In our five survey sites, use varied little from crop to crop within sites or across sites. In all the groups of ten or more respondents with the same primary or secondary crop, majorities of the members used this practice (Table 3.9).

The regression analyses for this practice yielded no cases of statistically significant associations between the type of principal crop and use of the practice (Table 3.9), and very few of the other causal variables were significantly associated either. However, in Dooly County the higher the gross sales from farming, the more likely respondents were to adjust yield goals and fertilizer rates based on past performance. This income variable proved to be particularly important in the analyses for the Dooly County sample; it is associated with the use of five separate practices (Table 3.6).

Estimated the Efficiency of Nitrogen Use Based on Variations in Yields Relative to Timing, Source, and Amount Used

A more complex analytical approach to saving on nitrogen fertilizers is to base use decisions on estimates of how timing, source, and amounts of application will affect

yields. Many farmers fail to see that these three aspects of application are related. For example, if timing is improved to reduce the loss of nutrients to storm water runoff, leaching, or denitrification, the total volume applied can be reduced. In all five sites majorities of the respondents--56% to 68%--reported making these estimates (Table 3.1).

Despite the frequent use of this practice, relatively few respondents ranked it highly. Across the five sites only 3% to 21% rated it the most important fertility practice for producing their primary crop, and the combined first- and second-place rankings totaled just 6% to 39% (Table 3.2). These rankings may reflect the complexity of the practice. In the first place, it requires kinds of records--regarding the timing, source, and amounts of nitrogen applied--that many farmers may not keep. Second, the farmers or someone else must correlate those aspects of nitrogen use to crop yields. It is likely that many users guessed about these relationships, and the guesses may not have been accurate enough for the practice to be highly beneficial.

Use of this practice varied somewhat by crop and across sites by growers of the same crop. Use was most frequent among the relevant rice farmers in Butte County, followed by wheat growers in Dooly County and by both wheat and barley farmers in Whitman County (Table 3.10). Although the practice was equally popular among our two sets of wheat farmers (in Whitman and Dooly counties), there were differences among the three sets of soybean growers. More of the relevant soybean farmers in Dooly County used this potential tool for economizing on nitrogen fertilizer than did their counterparts in the two Midwestern sites.

The regression analyses for this practice found two types of statistically significant associations occurring in two or more samples. In the Renville, Livingston, and Dooly county sites, farmers of larger operations were more likely to make these kinds of estimates. These findings and those for soil tests and plant tissue tests suggest that relatively small size may be a barrier to the use of analytical tools important to saving on chemical inputs. Smaller operators may be more likely to lack the funds or managerial sophistication for such practices. They may need technical assistance or other special encouragement to adopt the tools.

An important association emerged in four of our five sites. Farmers who followed the recommendations of the Cooperative Extension Service were more likely to have made these estimates regarding the efficiency of nitrogen used. In two of the same four samples, taking the advice of the Extension Service was related to using a similar practice, estimating the contributions of nitrogen sources other than commercial fertilizers. Therefore, either the Extension Service was successful in promoting this general kind of analytical approach to fertilization decisions, or its county offices could reinforce an approach that its clients had adopted for other reasons.

Adopted Legume-Based Rotations to Help Meet Nitrogen Needs

In four of the five survey sites, from 22% to 37% of the respondents reported using legume-based rotations to help meet their nitrogen needs (Table 3.1). Besides potentially being a form of green manure, that is, a cover crop that is incorporated into the soil rather than being harvested, leguminous crops add nitrogen to the soil by transforming "atmospheric nitrogen (N_2) into forms available to plants for growth" (National Research Council 1989, p. 423). In the Butte county sample, only 10% followed such rotations.

For nearly every farmer in all sites, these rotations were less important than other sources of nitrogen. No more than 3% of the respondents across the five sites reported crop rotations as their primary source of nitrogen (Table 3.11). By far the most commonly reported source was some form of ammonia.

In analyzing use of legume rotations by principal crops, we found relatively low frequencies of usage except in the case of wheat farmers in Dooly County. Sixty percent followed rotations with legumes, compared to only 32% of the relevant wheat growers surveyed in Whitman County (Table 3.12). Dooly County farmers were able to rotate the wheat with either soybeans or peanuts, both of which are leguminous crops.

The regression analyses for the practice of legume-based rotations produced mostly scattered results. No variable was statistically significant in more than one sample except for respondents' classification as to the kind of farmers they were (Table 3.6) In both Whitman and Dooly counties, respondents calling themselves low-input or sustainable farmers were more likely than others to use legume-based rotations. Here were two of only five occasions out of 45 regression analyses we did on fertility practices (9 practices for each of the five sites) when the self-classification variable helped to explain the use of a practice (Table 3.6).

Used Nonlegume Cover Crops

When plowed under, nonlegume cover crops can be valuable sources of nutrients for crops. In the Whitman and Butte county survey sites, very few respondents (10% and 3%, respectively) used this practice. In the other three sites the proportion of farmers using the practice ranged from 21% in the Livingston County sample to 54% in Renville County (Table 3.1). However, nonlegume cover crops were almost never a farmer's principal source of nitrogen fertilizer. The only source of nitrogen respondents mentioned that might have included these crops was green manure, but that category is usually associated with leguminous crops. In any event, no respondents cited it in two samples, and only 1% to 8% in the other three (Table 3.11).

None of the respondents who used nonlegume cover crops in rotation with their primary crop rated them first or second among their fertility practices except in the Dooly County sample, where 13% ranked them second (Table 3.2). Usage varied little from crop to crop within sites or by crop except that significantly more of the relevant wheat farmers in Dooly County used the practice than did their counterparts in Whitman County (Table 3.13).

The regression analyses for this practice yielded mostly scattered findings, except in Renville and Dooly counties where farmers who followed the recommendations of the Extension Service were more likely to use nonlegume cover crops. Again Extension's advice may have made a difference in farmers' decisions to use a practice, or, alternatively, Extension at least had the opportunity to support such decisions.

Banded or Injected Fertilizer into Crop Rows

So far we have discussed fertility practices involving either analytical tools for assessing appropriate levels of fertilizer application or organic substitutes for synthetic fertilizers. The next two practices involve techniques of application that would enable farmers to use less fertilizer. The first technique is to increase the efficiency of fertilizer either by applying it in relatively narrow bands near where the seeds are

planted or by injecting it into the soil where it will have the greatest impact, rather than applying it over the entire surface of the soil. This was not a popular practice by either of our criteria, frequency of use or perceived importance. Across the five sites, only 17% to 39% of the respondents said that they used it on any of their crops (Table 3.1). In only one site (Whitman County) did at least a third of its users rank it first or second in importance for the production of their primary crop (Table 3.2).

This practice is most appropriate for crops planted in rows. Among the relevant farmers planting the same row crop as their largest or second-largest crop, usage varied from a low of 4% among soybean growers in Livingston County to a high of 31% among corn farmers in Renville County (Table 3.14).

Regression results were scattered except for the finding in three samples that recent participation in one of two USDA conservation programs (the Conservation Reserve Program or the Agricultural Conservation Program) was positively associated with banding or injecting fertilizer (Table 3.6). This relationship is intriguing. Only for banding or injecting fertilizer did participation in these programs relate to using a practice in more than one site (Table 3.6). Although we had hypothesized that such participation might reflect an underlying conservationist ethic, it is not clear why such attitudes would be especially important in influencing the use of this particular fertility practice.

Split Applications of Nitrogen

The second technique, splitting applications, involves spreading the total amount of fertilizer over two or more applications and scheduling them to coincide with times "when crops can most effectively use them" (National Research Council, 1989, p. 425). Split applications counter the waste that may occur in just one application because of runoff, leaching, and denitrification before the plants can use the nutrients. Majorities of the Butte and Dooly county respondents (71% and 53%, respectively) reported using this practice in 1988 (Table 3.1). A substantial minority, 43%, did so in the Whitman County survey area, but only 22% to 25% of the farmers in the two Midwestern sites used split applications.

Split applications of nitrogen were relatively important to users in Butte and Renville counties, where at least a third of the users rated them first or second among the fertility practices they applied to their primary crop (Table 3.2). In the other three sites, only 12% to 28% of the users rated them that highly.

The use of split applications varied significantly by crop within sites and by growers of the same crop across sites, especially soybean growers. Although 73% of our relevant group of rice farmers in Butte County applied it, the proportion of corn and soybean farmers in Renville and Livingston counties ranged from only 9% to 20% (Table 3.15). By contrast, 47% of the soybean farmers in Dooly County applied this practice. Proportionally more wheat farmers used the practice in Dooly County than in Whitman County, but the difference was only nine percentage points. However, we continue to see a pattern. When we hold crop constant, more often than not higher percentages of farmers in the Georgia site apply a practice with the potential for reducing the use of chemical fertilizers. We analyzed eight fertility practices by crop. For five of them use was more frequent among the relevant soybean and wheat farmers in Dooly County than in Whitman County or the two Midwestern counties (Tables 3.7 to 3.8 and 3.12 to 3.15). In some cases, the differences were small, but in seven of the ten comparisons the differences were ten percentage points or more.

The regression analyses suggest an explanation for many of these differences. Respondents in Dooly County who said they followed the fertilization recommendations of the Cooperative Extension Service were more likely to use four of those eight fertility practices (Table 3.6).

The regression analyses found the same kind of association in all the other samples for one to three practices. However, the relationship probably had a stronger impact on the frequency of using practices in Dooly County because proportionally so many more farmers there followed Extension's recommendations (Table 3.1). For example, 59% and 53%, respectively, of our groups of soybean and wheat farmers in Dooly County followed Extension's advice, compared to only 12% to 27% of their counterparts in the other three counties (Table 3.17).

Following the Recommendations of Fertilizer Dealers versus Following the Advice of the Cooperative Extension Service

The relationship between a source of advice and the use of a practice gives a potentially important indication of the behavior of interest to us--how farmers go about determining their crops' fertility needs. Many more of our respondents took the advice of fertilizer dealers than of the Cooperative Extension Service, except in the Dooly County sample, where the proportions were almost the same--70% and 66%, respectively (Table 3.1). In the other four sites, the disparities were very large. From 53% to 87% said they used the advice of dealers compared to only 12% to 32% reporting that they followed the recommendations of the Extension Service.

Small percentages of all farmers in a sample used both sources of advice--9% to 21%, except in the Dooly County site where 47% of all respondents followed both. However, across the five survey areas most of the clients of Extension--68% to 100%--also used dealers' recommendations. They may have used the other source for a second opinion, or they may have found one source more credible than the other on some issues.

Fertilizer dealers did better also on the criterion of how important their clients rated their advice. In four sites majorities or a near-majority (46% to 65%) who used dealers' advice for their primary crop ranked it first or second (Table 3.2). In the fifth survey area, Butte County, the combined percentage was only 32%. However, in that site Cooperative Extension did less well; just 18% of Extension's clients in Butte County rated it highly. Elsewhere, Extension's combined first- and second-place rankings were only 8% to 13% except in the Dooly County sample, where they totaled 39%.

Regardless of the source of recommendations farmers followed, use by crop varied little within sites (Tables 3.16 and 3.17). For example, close to the same percentages of relevant wheat growers followed dealers' advice in Whitman and Dooly counties as did the farmers of other crops. This pattern suggests that both the fertilizer dealers and the Extension Service in those counties offer advice that covers most or all the significant crops, not just one or two. Use differed relatively little among farmers of the same crop across sites except that proportionally more of the relevant farmers of soybeans, cotton, peanuts, and wheat in Dooly County followed Extension's recommendations than did growers in all the other sites.

We did not apply our regression model to explain why farmers used fertilizer dealers as a source of advice because the models were designed to explain use of practices with the potential for saving chemical inputs, and the dealer-use variable is positively re-

lated to such use in only two of 45 cases (nine practices times five sites, Table 3.6). By contrast, following Extension's advice was positively related to using a practice in ten cases.

The most significant finding from the regression analyses of the practice, using Extension's advice, is that in Whitman, Butte, and Renville counties the practice was associated with the respondent's level of education (Table 3.6). The more years of formal education, the more likely the farmer was to follow the recommendations of the Extension Service. For less educated farmers, particularly those without any college experience, Extension was not as influential. The agency may have to develop written materials or personal approaches that are more effective for such farmers.

Summary and Policy Inferences

Majorities of respondents in four to five survey areas used three fertility practices with the potential for saving on synthetic fertilizers. In all sites except Butte County 72% to 94% of the respondents conducted soil tests to determine nutrient levels. Across all sites 57% to 85% adjusted crop yield goals and the related fertilizer rates on the basis of past performance. Also in five sites 56% to 68% applied the analytical practice of estimating the efficiency of nitrogen use based on variations in yields relative to the timing, source, and amount of nitrogen used. At least a third of the respondents in four samples (37% to 63%) used the practice of estimating the contributions to soil fertility of sources other than commercial fertilizers. A practice applied with considerable frequency (43% to 71%) in three sites was the splitting of nitrogen applications.

Only the first two of these five practices ranked high by the criterion of how important their users perceived them to be for the production of their primary crop. Across the five sites 51% to 88% of the users of soil tests rated them first or second in importance for this purpose. In three sites, 49% to 56% of the farmers who related crop yield goals and fertilizer rates to past performance ranked it first or second in importance. Therefore, these two practices recommend themselves to farmers not yet using them because they are both frequently applied and highly regarded.

Use of fertility practices varied with type of crop, but in some cases it also differed among growers of the same crop in separate sites. We often found that proportionally more farmers of soybeans and wheat in Dooly County applied a practice than did growers of those crops in Whitman County or the two Midwestern sites. Part of the explanation for this difference may be the greater influence of the Cooperative Extension Service in the Georgia site. Many more farmers in Dooly County followed the recommendations of Extension, and doing so was associated with using more potentially reduced-input practices in that survey area than in any of the other four.

Overall the Extension-recommendations variable was important in explaining the use of fertility practices with the potential for saving on chemical fertilizers. It was positively related to using five separate practices in one to four survey sites per practice. Other things being equal, farmers who followed Extension's advice were four to 45 percentage points more likely to have used these practices (Table 3.6).

Findings that public programs can make significant, desirable differences in farming practices are encouraging. A plausible rival hypothesis was that the competition from fertilizer dealers and other agribusinesses, with their often superior budgets for visiting farmers and distributing attractive informational materials, had relegated

Extension to a negligible role. This was not the case. Extension appears to influence clients to use reduced-input practices, or at least Extension has clients who use such practices, and the agency is in a position to reinforce that use.

However, except in the Dooly County site relatively few respondents were current clients. We recommend that the agency gear up to become a significant source of advice to many more farmers for two reasons. In the first place, our findings indicate that Extension's recommendations can make a desirable difference regarding the use of practices. Second, we apparently cannot rely on the source of advice that respondents used most frequently--fertilizer dealers--to promote reduced-input practices. Use was associated with following the advice of dealers for only two of the nine practices we investigated, and these associations occurred in only one sample per practice.

Another important predictor of the use of reduced-input practices was size of the farm operation. In one to three samples per practice for a total of eight practices, the smaller the operation (as measured by gross farm revenues), the less likely the farmer was to apply the practice. This association was especially important in the Renville and Dooly county sites, where it helped to explain the use of four to five different practices. If soil tests, plant tissue tests, and other analytical practices tend to be less attractive for smaller operations, Extension and other agencies charged with promoting such practices may have to design educational materials or incentives that enhance their appeal for smaller farms. Additionally, the tests may need some public subsidy where they currently are available only at commercial rates.

Tables for Chapter 3

Table 3.1

Farmers' Reports of 1988 Fertility Practices for Their Primary, Secondary and Other Crops[1]

Practices[2]	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Conducted soil tests to determine nutrient levels for:					
At least one crop	72	40	88	76	94
Their primary crop	72	39	74	72	94
Their secondary crop	51	23	74	68	91
Some other crop	26	17	61	7	62
Conducted plant tissue tests to determine nitrogen adequacy for:					
At least one crop	12	41	14	9	26
Their primary crop	11	37	10	9	23
Their secondary crop	7	36	9	6	16
Some other crop	5	8	2	0	12
Estimated contributions to soil fertility from other nitrogen sources (manure, rotations) for:					
At least one crop	37	22	63	54	41
Their primary crop	35	21	54	47	34
Their secondary crop	25	13	50	32	31
Some other crop	22	8	47	7	31
Adjusted crop yield goals and fertilizer rates based on past performance for:					
At least one crop	83	74	81	85	57
Their primary crop	82	73	75	84	57
Their secondary crop	75	48	74	73	52
Some other crop	45	17	64	10	40

Table 3.1 continues

Table 3.1 continued

Practices[2]	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Estimated efficiency of nitrogen use based on variations in yield relative to timing, source, and amount of nitrogen applied for:					
At least one crop	60	68	61	66	56
Their primary crop	58	67	43	50	51
Their secondary crop	54	52	49	39	46
Some other crop	36	17	39	3	35
Adopted legume-based rotations for:					
At least one crop	37	10	30	22	30
Their primary crop	33	8	32	17	26
Their secondary crop	23	16	28	20	30
Some other crop	29	8	25	14	25
Used nonlegume cover crops for:					
At least one crop	10	3	54	21	34
Their primary crop	9	3	25	12	31
Their secondary crop	7	7	22	10	31
Some other crop	5	0	45	0	15
Banded or injected fertilizer into rows for:					
At least one crop	30	37	39	17	19
Their primary crop	28	35	32	10	17
Their secondary crop	26	19	25	11	18
Some other crop	16	25	13	3	8
Split applications of nitrogen for:					
At least one crop	43	71	25	22	53
Their primary crop	41	68	15	15	44
Their secondary crop	27	32	17	12	36
Some other crop	12	42	9	3	33

Table 3.1 continues

Table 3.1 continued

Practices[2]	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Followed fertilizer dealer's recommendations for:					
At least one crop	71	53	85	87	70
Their primary crop	71	51	79	86	70
Their secondary crop	69	36	81	82	66
Some other crop	38	8	78	14	39
Followed recommendations of Cooperative Extension Service for:					
At least one crop	12	32	26	17	66
Their primary crop	12	28	25	17	66
Their secondary crop	11	23	25	18	58
Some other crop	0	25	22	0	39
Total respondents	(104)	(100)	(114)	(92)	(70)

[1]The primary crop is that crop which in 1988 was planted on the largest number of acres. The secondary crop is that crop which in 1988 was planted on the second largest number of acres. Entries are only for the farmers with at least two crops.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

Table 3.2

Farmers' Rankings of the Importance of Fertility Practices for the Production of Their Primary Crop

Practice[2]	Percentage of Farmers Ranking Each Practice[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Conducted soil tests to determine nutrient levels	48	23	46	5	74	14	67	14	82	6
Conducted plant tissue test to determine nitrogen adequacy	0	9	14	24	0	18	13[3]	12[3]	0	19
Estimated contributions to soil fertility from other nitrogen sources (manure, rotations)	3	8	19	5	7	14	12	7	4	17
Adjusted crop yield goals and fertilizer rates based on past performance	35	16	30	26	8	25	22	27	8	10
Estimated efficiency of nitrogen use based on variations in yield relative to timing, source, and amount of nitrogen applied	13	20	21	18	6	0	7	6	3	5
Adopted legume-based rotations	9	32	0	0	6	14	6	13	0	11
Used nonlegume cover crops	0	0	0[3]	0[3]	0	0	0	0	0	13
Banded or injected fertilizer into rows	27	10	17	11	8	11	11[3]	0[3]	0	8
Split applications of nitrogen	12	16	18	31	12	24	0	21	9	3
Followed fertilizer dealer's recommendations	13	33	12	20	17	48	18	38	4	49
Followed recommendations of Cooperative Extension Service	0	8	4	14	4	4	0	13	9	30

Table 3.2 continues

Table 3.2 continued

[1]For each survey site, the column labeled "1st" indicates the percentage of users of a practice who ranked it the most important in the cultivation of their primary crop. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

[3]Fewer than ten farmers used this practice.

Table 3.3

Use of Soil Tests to Determine Nutrient Levels

Crop	Percentage of Farmers Using Soil Tests[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	79	70	--
Soybeans	--	--	66	71	100
Cotton	--	--	--	--	96
Peanuts	--	--	--	--	92
Wheat	70	--	--	--	100
Barley	55	--	--	--	--
Rice	--	42	--	--	--

[1]Table 3.3 reports percentages only for relevant groups, that is, those where at least ten farmers reported an indicated crop as their primary or secondary crop. By crop, the relevant groups of farmers and the number in each group in each site are as follows:

corn:	Renville County (99 farmers)	peanuts:	Dooly County (51)
	Livingston County (91 farmers)	wheat:	Whitman County (101)
soybeans:	Renville County (102)		Dooly County (15)
	Livingston County (89)	barley:	Whitman County (66)
	Dooly County (17)	rice:	Butte County (89)
cotton:	Dooly County (48)		

Table 3.4

Farmers' Reports of Sources That Provided Information or Advice in 1988 for the Tillage and Cultivation Practices They Used

Sources[1]	Percentage of Farmers Using Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Staff member of Cooperative Extension Service (CES)	17	36	25	20	65
Publications, meetings, or field days of CES	30	54	49	42	36
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)	24	2	14	7	14
Publications, meetings, or field days of SCS or CD	24	9	29	29	7
Staff member of Agricultural Stabilization and Conservation Service (ASCS)	13	6	10	10	13
Publications, meetings, or field days of ASCS	19	10	25	27	7
Staff and publications of other public agencies	16	21	25	23	11
Farm organization personnel[2]	15	24	33	27	6
Fertilizer dealer	87	71	93	94	86
Herbicide or insecticide dealer	72	45	77	77	47
Fertilizer or pesticide applicator	43	29	47	42	25
Other farmers	73	70	74	67	64
Family members	67	58	61	55	36
Nonprofit, educational, or environmental organizations	7	8	18	19	3

Table 3.4 continues

Table 3.4 continued

Sources[1]	Percentage of Farmers Using Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Farm magazines, journals, radio and television programs	41	35	82	76	50
Other	13	17	7	3	4
Total respondents	(106)	(100)	(114)	(92)	(72)

[1]A list of information sources was provided, and farmers were asked to indicate which ones they used.

[2]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 3.5

Farmers' Rankings of the Sources That Provided Information or Advice in 1988 for Their Fertility Practices

Information Sources[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Staff member of Cooperative Extension Service (CES)	2	2	2	4	5	1	1	3	29	4
Publications, meetings, or field days of CES	1	4	13	6	1	4	3	1	3	10
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)	1	2	0	1	0	0	0	0	1	0
Publications, meetings, or field days of SCS or CD	1	6	0	0	1	1	1	1	1	0
Staff member of Agricultural Stabilization and Conservation Service (ASCS)	3	0	0	0	0	0	0	0	0	3
Publications, meetings, or field days of ASCS	0	2	1	0	1	0	1	1	0	0
Staff and publications of other public agencies	0	0	3	1	1	1	0	1	1	1
Farm organization personnel[3]	1	0	5	4	1	1	2	3	1	0
Fertilizer dealer	59	15	41	14	70	8	69	13	40	29
Herbicide or insecticide dealer	1	6	2	10	3	17	1	16	4	11
Fertilizer or pesticide applicator	0	4	1	3	0	4	0	7	3	0
Other farmers	11	26	8	27	4	25	9	14	7	24
Family members	10	15	12	9	6	11	8	7	4	6
Nonprofit, educational, or environmental organizations	0	1	0	2	0	0	1	2	0	0

Table 3.5 continues

Table 3.5 continued

Information Sources[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Farm magazines, journals, radio and television programs	0	4	0	3	2	23	4	22	3	6
Other	9	4	11	5	5	1	0	1	1	3
No response	2	4	1	1	0	0	1	2	0	0

[1]For each survey site, the column labeled "1st" indicates the percentage of respondents who ranked each information source first in importance. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of sources was provided, and farmers were asked to indicate which ones they used.

[3]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 3.6

Traits of Farmers or Their Operations Found to Be Associated with Whether They Used Fertility Practices[1]

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Soil tests to determine nutrient levels	CONSERVE (42)[3] EDUC (18) -EXTENS (25)	INCOME (13) -PCTINC (7)	INCOME (24)	DEALER (43) INCOME (5)	——
Plant tissue tests to determine nitrogen adequacy	——	EXTENS (45) LABOR (14)	INCOME (12) -PCTINC (6)	——	INCOME (10)
Estimated contributions of nitrogen sources other than commercial fertilizers	-AGE (9) LEGUMES (49) LVSTOCK (13)	AGE (15) CLASSIF (24) LEGUMES (37)	EXTENS (12) LABOR (3) LVSTOCK (18)	LEGUMES (9) LVSTOCK (30)	EXTENS (22) LEGUMES (34)
Adjusted crop yield goals and fertilizer rates according to past performance	-PCTINC (7)	-PCTINC (10)	FEDBEN (16)	——	INCOME (9)

Table 3.6 continues

Table 3.6 continued

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Estimated efficiency of nitrogen based on yield variations	DEBT (5) EXTENS (21) LABOR (2)	RICE (45)	-DEALER (13) EDUC (5) EXTENS (24) INCOME (13)	EXTENS (13) FEDBEN (10) INCOME (3)	-AGE (3) CLASSIF (9) EXTENS (4) FEDBEN (5) INCOME (3) -PCTINC (3)
Adopted legume-based rotations to help meet nitrogen needs	CLASSIF (6) -FEDBEN (44)	-CHMPRB (17) INCOME (1)	———	LVSTOCK (17)	-AGE (31) CLASSIF (28) -EDUC (10)
Used nonlegume cover crops	LVSTOCK (16)	-RICE (17)	DEALER (36) EXTENS (27) FEDBEN (41) INCOME (11)	PCTINC (18)	CONSERVE (30) EXTENS (29)
Banded or injected fertilizer into crop rows	CONSERVE (33) -AGE (24)	———	CONSERVE (31) FEDBEN (21)	CONSERVE (51)	INCOME (5)

Table 3.6 continues

Table 3.6 continued

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Split application of nitrogen	CONSERVE (26)	-AGE (14) RICE (31)	——	INCOME (11) -PCTINC (4)	CLASSIF (17) COTTON (7) EXTENS (7) INCOME (4) -PCTINC (7)
Followed recommendations of Coop. Extension	CONSERVE (24) EDUC (22)	EDUC (25) -DEBT (26)	EDUC (17)	——	——

[1]Associated means that logistic regression coefficients measuring the presence of a relationship between a trait and a practice were statistically significant in a t-test at the 0.1 level for one-tailed tests and at the 0.05 level for two-tailed tests.

[2]Traits are defined as follows:

AGE: farmers' age in years.

CHMPRB: farmers did or did not believe that agricultural chemicals had contaminated drinking water in their county.

CLASSIF: respondents did or did not classify themselves as low-input, organic, or sustainable farmers.

CONSERVE: farmers did or did not participate in recent years (1986-88) in either the Conservation Reserve Program or the Agricultural Conservation Program.

Table 3.6 continued

Table 3.6 continued

COTTON:	cotton was or was not farmers' primary crop in 1988.
DEALER:	farmers did or did not follow the recommendations of fertilizer dealers for both their primary and secondary crops in 1988.
DEBT:	farmers' debt as a percentage of farm assets.
EDUC:	farmers' years of formal education.
EXTENS:	farmers did or did not follow recommendations of the Cooperative Extension Service for both their primary and secondary crop in 1988.
FEDBEN:	farmers did or did not rank the availability of federal farm program benefits as the most or second-most important factor in their decisions regarding which crops to plant.
INCOME:	farmers' 1988 gross revenues from agriculture, including government payments.
LABOR:	number of family members who worked on the farm in 1988.
LEGUMES:	farmers did or did not use legume-based rotations.
LVSTOCK:	farmers did or did not raise, feed, pasture, or purchase at least ten animals for commercial purposes.
PCTINC:	percentage of farmers' 1988 family income derived from agriculture.
RICE:	rice was or was not farmers' primary crop in 1988.

[3]Numbers in parentheses indicate the percentage-point change in the estimated probability of using the indicated practice, when a dichotomous explanatory variable is changed from its positive to its negative value or when an interval-level variable is changed from its 25th- to its 75th-percentile value, with the other variables held constant.

Table 3.7

Use of Plant Tissue Tests to Determine Nitrogen Adequacy

Crop	Percentage of Farmers Using Tissue Tests[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	13	9	--
Soybeans	--	--	8	6	24
Cotton	--	--	--	--	19
Peanuts	--	--	--	--	14
Wheat	11	--	--	--	33
Barley	6	--	--	--	--
Rice	--	37	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.8

The Practice of Estimating Contributions of Nitrogen Sources Other Than Commercial Fertilizers

Crop	Percentage of Farmers Estimating Nitrogen Contributions[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	57	43	--
Soybeans	--	--	51	36	35
Cotton	--	--	--	--	33
Peanuts	--	--	--	--	27
Wheat	34	--	--	--	53
Barley	18	--	--	--	--
Rice	--	22	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.9

The Practice of Adjusting Crop Yield Goals and Fertilizer Rates Based on Past Performances

Crop	Percentage of Farmers Adjusting Yield Goals[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	78	80	--
Soybeans	--	--	71	76	53
Cotton	--	--	--	--	56
Peanuts	--	--	--	--	57
Wheat	79	--	--	--	60
Barley	85	--	--	--	--
Rice	--	76	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.10

The Practice of Estimating the Efficiency of Nitrogen Use Based on Variations in Yield Relative to Timing, Source, and Amount of Nitrogen Applied

Crop	Percentage of Farmers Estimating Nitrogen Efficiency[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	55	55	--
Soybeans	--	--	37	35	47
Cotton	--	--	--	--	54
Peanuts	--	--	--	--	49
Wheat	58	--	--	--	60
Barley	58	--	--	--	--
Rice	--	72	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.11

Farmers' Reports of Their Primary Source of Nitrogen in the Previous Five Years

Nitrogen Sources	Percentage of Farmers[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Ammonia	88	83	74	97	74
Ammonium sulfate	2	10	0	0	0
Urea	1	12	24	0	5
Commercial fertilizers	9	5	3	1	14
Crop rotations	3	1	3	0	1
Green manure	0	0	3	1	8
Animal manure	0	0	1	0	0
(Total in sample)	(106)	(100)	(114)	(92)	(72)

[1]Percentages add up to more than 100 percent because some respondents gave more than one source as their primary nitrogen source in the past five years.

Table 3.12

The Practice of Adopting Legume-Based Rotations to Help Meet Nitrogen Needs

Crop	Percentage of Farmers Adopting Legume-Based Rotations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	34	21	--
Soybeans	--	--	28	16	35
Cotton	--	--	--	--	25
Peanuts	--	--	--	--	25
Wheat	32	--	--	--	60
Barley	15	--	--	--	--
Rice	--	9	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.13

The Practice of Rotating the Primary or Secondary Crop with Nonlegume Cover Crops

Crop	Percentage of Farmers with Nonlegume Cover Crops[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	24	13	--
Soybeans	--	--	25	9	29
Cotton	--	--	--	--	35
Peanuts	--	--	--	--	29
Wheat	8	--	--	--	27
Barley	9	--	--	--	--
Rice	--	1	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.14

The Practice of Banding or Injecting Fertilizer into Crop Rows

Crop	Percentage of Farmers Banding or Injecting Fertilizer[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	31	16	--
Soybeans	--	--	24	4	12
Cotton	--	--	--	--	23
Peanuts	--	--	--	--	16
Wheat	29	--	--	--	20
Barley	27	--	--	--	--
Rice	--	36	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.15

Use of Splitting the Applications of Nitrogen[1]

Crop	Percentage of Farmers Splitting the Application of Nitrogen				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	20	19	--
Soybeans	--	--	12	9	47
Cotton	--	--	--	--	50
Peanuts	--	--	--	--	50
Wheat	42	--	--	--	53
Barley	29	--	--	--	--
Rice	--	73	--	--	--

[1]See the *footnote to* Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.16

Following the Recommendations of Fertilizer Dealers

Crop	Percentage of Farmers Following Dealers' Recommendations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	80	86	--
Soybeans	--	--	76	84	76
Cotton	--	--	--	--	69
Peanuts	--	--	--	--	71
Wheat	71	--	--	--	67
Barley	74	--	--	--	--
Rice	--	54	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 3.17

Following the Recommendations of the Cooperative Extension Service

Crop	Percentage of Farmers Following Extension's Recommendations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	26	18	--
Soybeans	--	--	27	17	59
Cotton	--	--	--	--	67
Peanuts	--	--	--	--	59
Wheat	12	--	--	--	53
Barley	14	--	--	--	--
Rice	--	29	--	--	--

[1]See the footnote to Table 3.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Chapter 4

Pest Management Practices with the Potential for Saving on Chemical Inputs

Chapter Overview

Substantial proportions of our respondents used four pest-control practices with the potential for economizing on chemical pesticides. Two were weed-control practices:

1. Timed plantings of crops.

2. Crop rotations.

Two other practices were insect-control measures:

1. Use of integrated pest management (IPM) programs.

2. Deciding "in most years" to apply no insect controls.

The IPM approach to pest management is often thought to include nonchemical controls such as using biological pesticides, planting insect-resistant crop varieties, and other practices. However, this study's findings suggest that farmers use IPM practices in a limited sense. Most often, to farmers IPM meant scouting and monitoring to detect the need for pesticide use more accurately. More effort must be directed toward use of additional IPM practices by farmers.

As we found when we examined tillage and cultivation practices, our results showed that pest control practices with the potential for economizing on pesticides varied by crop and by region of the country.

In one to four sites per practice, farmers who received the personal advice, attended public meetings, or used the literature provided by the Cooperative Extension Service were more likely to use five insect-control practices with the potential for saving on chemicals. The Cooperative Extension Service appears to have made a difference in farmers' use of these practices. The Extension Service should strengthen its efforts to provide farmers with information about unfamiliar farming practices and reinforce their willingness to adopt such practices.

Introduction

The total volume of pesticides applied to American farms increased by 170% between 1964 and 1982 and then declined somewhat (14%) to an estimated 430 million pounds of active ingredients by 1987 (National Research Council, 1989). Evidence suggests that high rates of pesticide application contribute to both surface- and groundwater pollution. Somewhere between 3.5 million and 21 million pounds of pesticides may be entering surface waters each year before degrading (Anderson, 1987). In December 1988, the U.S. Environmental Protection Agency reported that residues from 46 separate agricultural pesticides had been detected in the groundwater of 26 states (Bureau of National Affairs, 1988). Pesticide application rates may be excessive (Hallberg, 1986; Shields, 1987). Some farm-

ers follow wasteful rules of thumb; others deliberately choose heavy applications as a form of insurance against extraordinary infestations. Therefore, management practices that help farmers to reduce their use of pesticides may yield both financial savings for their operations and benefits to the environment. The monetary savings could be significant; on average farmers find that pesticides account for about 20% of their total input costs (National Research Council, 1989).

Our survey focused on weed- and insect-control practices. The interviewers gave farmers lists of both kinds and asked them if in 1988 they had applied any to their primary, secondary, and/or other crop.

Weed-Control Practices

Single versus Multiple Cultivations per Season for Weed Control

In four of the five survey sites, large majorities of the respondents (70% to 97%) reported that on at least one crop they combatted weeds with multiple cultivations rather than with just one pass per field during the growing season (Table 4.1). The exception was the Livingston County site, where only 41% used multiple cultivations. By contrast 83% in that site reported just a single pass for at least one crop.[1] Renville County was the only other site where the practice of a single cultivation was relatively popular--reported by 49% of the respondents. In the other three sites just 6% to 14% reported using this practice on any one of their crops.

At least in the two survey sites where it was popular, users rated the practice of single cultivations per crop rather highly. Forty-three percent and 56% of the respondents in the two Midwestern sites who applied the practice to their primary crop ranked it first or second in importance among the weed-control measures for that crop (Table 4.2). By comparison, across all five sites 50% or more of the farmers using multiple cultivations ranked that practice first or second.

Analyzing usage by crop, we find that 35% to 73% of our comparison groups of row crop farmers in the two Midwestern sites applied the practice of one cultivation (Table 4.4), but only 2% to 6% of their counterparts in the Dooly County sample used it. This contrast derives at least in part from climatic differences. Dooly County's warmer, wetter climate tends to make weeds more formidable pests.

Weed Control through Hand Cultivation

The Renville and Livingston county sites were the only ones where majorities of respondents, 85% and 84%, respectively, cultivated by hand to control weeds (Table 4.1). Forty-six percent of the Dooly County Sample used this practice, but only 8% and 14% did so in the two remaining sites. If carried out extensively in fields, hand cultivation may yield significant savings on herbicides. However, many of the farmers who reported

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[1]Although these two percentages add up to more than 100%, there is no conflict because the figures related to overall use rather than to individual crops. For example, for their primary crop, 66% of the farmers in the Livingston County sample said they used one cultivation, and the other 34% reported multiple cultivations (33%) or did not answer (1%). There is some overlap in answers to the same questions in the Renville County site, but it is limited to 8% of the sample.

using this practice may have limited their hand work to uprooting relatively few weeds or volunteer crop plants. Whatever the level of effort expended, the users of this practice in the Renville, Livingston, and Dooly county samples did not rank it highly, at least for their primary crop. In those three sites only 5% to 23% of the farmers who applied hand cultivation to their primary crop rated it first or second in importance for weed control (Table 4.2).

Weed Control through the Use of Herbicides

By contrast, virtually all respondents, 96% to 100%, reported that they combatted weeds through the use of herbicides (Table 4.1), and almost all who did so (91% to 98%) ranked it first or second in importance (Table 4.2). Appropriately chosen and applied, herbicides can offer farmers several yield-increasing benefits: eliminating weeds within rows where mechanical cultivators do not reach, suppressing weeds when crop plants are too young to compete, and permitting reductions in the number of tillage operations so that there is less soil compaction and perhaps less soil erosion (Council for Agricultural Science and Technology, 1980). However, where chemicals substitute for tillage operations, the quality of surface and groundwater may be degraded. Shields (1987, p. 24) posed this dilemma in question form: "Should groundwater be sacrificed to save topsoil?"

We found no significant variations in the use of herbicides across different crops in the same site or across farmers of the same crop in different sites (Table 4.6).

Timed Planting to Avoid Weed Problems

Now we turn to three practices that can substitute, at least partially, for the application of herbicides: timing crop plantings, rotating crops, and narrowing the space between rows. If crop planting is timed to avoid peak periods for weed growth, less herbicide is needed because the seedlings do not have to compete with thriving weed growth. In the Whitman, Renville, and Livingston county sites, more than a third of the respondents (35% to 49%) said they timed planting to avoid weed problems. In the remaining sites users comprised just 16% and 21% of the samples (Table 4.1). Only in the Butte County site did as many as a third of the users rank this practice first or second in importance for the production of their primary crop (Table 4.2).

Use of timed planting varied little by crop except in the case of wheat and barley farmers in the Whitman County site (Table 4.7). Proportionally more of those two groups applied the practice than did any of the farmers in the other four sites.

The logistic regression analyses for this practice and those discussed later in the chapter used the hypothesized explanatory variables presented in the Appendix. Those variables were selected to help explain why farmers apply practices with the potential for reducing the use of chemical inputs. We did not subject the first four practices covered in this chapter to regression analysis because either they obviously did not have such potential or their status in that respect was unclear.

The regression results for the practice of timed planting were scattered. However, the variable measuring participation in conservation programs was statistically significant for two samples (Whitman and Renville counties, Table 4.8). Such participation was also associated with the use of four fertility practices in one to three sites (Table 3.6). Perhaps, farmers' participation in conservation programs indicates a general concern about protecting soil and water resources, and this concern increases the likelihood that they will adopt practices that minimize the use of chemicals.

Crop Rotations Designed for Weed Control

In four of the five survey sites, majorities (54% to 84%) of the respondents reported that they followed crop rotations in order to control weeds (Table 4.1). The exception was the Butte County site, with only 13%. Though rather widely used in four sites, only in one of those four (Whitman County) did a majority of the users rank crop rotations as first or second in importance among the weed-control practices applied to their primary crop (Table 4.2). In the other three sites, not even a third rated it that highly.

Relating the use of crop rotations to type of crop produced no surprises, except that rotations were much more common among corn and soybean farmers in the Renville County site compared to their counterparts in Livingston and Dooly counties (Table 4.11). We hoped that the regression analyses might suggest reasons for these differences, but the findings from those analyses were too slim and scattered to be helpful (Table 4.8).

Narrow Spacing of Rows

The practice of narrowing the spacing between rows to crowd out weeds was employed with considerable frequency only in the Renville and Livingston county samples, where 58% and 45%, respectively, of the respondents reported using it on at least one of their crops (Table 4.1). Elsewhere, use ranged from only 9% to 29%. We expected low rates in the Whitman and Butte county areas because closely sown crops predominate there. However, almost all the respondents in Dooly County grow row crops, but just 9% said they applied this practice on any of their crops. There is an intriguing contrast between this low percentage and the high rate of usage reported in Chapter 2 for the cultivation practice of spacing rows, which 70% of the Dooly County sample said they followed (Table 2.1). The difference appears to be the qualifying adjective "narrow."

Although respondents in the Renville and Livingston county sites used narrow row spacing rather frequently, they did not rate it highly as a weed-control practice for their primary crop. Only 5% and 11% ranked it first or second in importance (Table 4.2).

The regression findings for this practice are scattered except in two samples, Whitman and Livingston counties. There, use of the practice was positively associated with farmers ranking USDA sources as first or second in importance for information and advice on pest management (Table 4.8).

Across the five sites, from 21% to 76% of the respondents said that their 1988 sources of information included staff members of Cooperative Extension, and 33% to 53% reported reading Extension publications or attending Extension meetings (Table 4.9). Farmers also consulted staff and publications or attended meetings of other USDA agencies. However, in all sites the information source most frequently used was herbicide or insecticide dealers. They were consulted by 83% to 91% of the respondents (Table 4.9). Moreover, respondents ranked these dealers their most important source of information. Dealers received the largest percentages of first- and second-place ratings, 46% to 68% (Table 4.10). By comparison, 16% to 40% ranked a USDA agency first or second.

Insect-Control Practices

Applied Insecticides

Majorities of respondents (55% to 97%) in four sites used insecticides for insect control in 1988 (Table 4.13). In Renville County, a third of the respondents used them. It is interesting to compare rates of insecticide and herbicide use. Across all five sites nearly every respondent (96% to 100%) used herbicides (Table 4.1). By comparison, only 34% of the respondents in Renville County applied insecticides on any crop in 1988, and in Whitman and Livingston counties, use was limited to 61% and 55%, respectively.

In Butte and Dooly counties, on the other hand, 96% and 100% of the respondents used herbicides and 94% and 97% applied insecticides. The high frequency of insecticide use in Butte County relates to the kind of crop that predominates there. Rice weevil infestations have required insect-control measures, and the most common measure has been the application of the insecticide, carbofuran. In the case of Dooly County crop differences may not be critical. Soybeans and wheat are grown in Dooly County, but they are also grown in Renville, Livingston, or Whitman County, where farmers of those crops used pesticides much less frequently (Table 4.15). The main factors appear to be that Dooly County's longer growing season and higher levels of rainfall provided more hospitable environments for pests, and the farmers believed those pests are best controlled through chemicals.

The respondents who used insecticides tended to rank them highly. Across the five survey sites, large majorities of 76% to 99% of the farmers applying insecticides to their primary crop in 1988 rated them first or second in importance for producing that crop (Table 4.14).

Using No Measures to Control Insects

In three of our survey sites (Whitman, Renville, and Livingston counties), majorities of respondents (62% to 80%) believed that for at least one of their crops neither pesticides nor any other insect control was needed "in most years" (Table 4.13). That is, instead of applying pesticides as a form of insurance or a matter of habit, these farmers refrained from all controls, presumably because their own observations of fields or information from other sources (like Cooperative Extension) indicated that insect problems were nonexistent or negligible.

When we analyzed which farmers refrained from insect controls and which did not, we found interesting differences. Very few rice growers in Butte County felt that they could dispense with control measures. We found the same pattern for the Dooly county farmers of soybeans, cotton, peanuts, and wheat. On the other hand, majorities or a near-majority of relevant wheat and barley growers in Whitman County and corn and soybean farmers in the two Midwestern sites reported that those crops could do without controls most of the time (Table 4.16).

We were also struck by the variation among growers of the same crops in different sites. Majorities of the wheat farmers in Whitman County and soybean growers in Renville and Livingston counties believed they could dispense with controls in most years; however, very small percentages of their counterparts in Dooly County agreed (6% and 13%). The differences are probably due at least in part to climate. It is likely that the colder and drier sites in the state of Washington and in the Midwest are more frequently free of insects or have populations too small to warrant control measures.

Regression Analyses of Insect-Control Practices

In the regression analyses of insect-control practices, we used new variables for measuring the influence of USDA and of pesticide dealers. The interview schedule included a set of questions about how farmers determined whether an insect problem existed in their fields. Among the seven options were:

> I refer to Extension Service publications or agents who inform me of potential insect outbreaks.
>
> I get advice from my pesticide dealer who warns me of the need to protect my crops.

Across the five sites, from 27% to 61% of the respondents reported that they used Extension for this purpose, and 50% to 82% consulted pesticide dealers (Table 4.17). The interview did not present either Extension or the dealers as a source of recommendations for action. However, we assume that it was in the dealers' interest to provide such recommendations, and we know that historically Extension has provided such advice. Moreover, since the 1970s Extension has operated an integrated pest management program (IPM) that features the scouting of fields to determine whether a significant pest problem exists. We discuss IPM at greater length in the next section of this chapter.

The regression analysis for the Renville County sample found a statistically significant association between farmers' use of Extension to help determine the extent of insect problems and their belief that most of the time insect-control practices were not needed (Table 4.18). For the four other insect-control practices we analyzed, the same association proved significant in one to four sites per practice (Table 4.18). Extension appears to have influenced growers' choice of practices. Alternatively, it had the opportunity to reinforce use of practices initially adopted because of other influences.

Integrated Pest Management Programs

The interview defined integrated pest management programs (IPM) to include practices such as "scouting for pests and applying pesticides when needed and using insect traps to monitor pest levels." In other words, we presented IPM as an analytical approach to insect control whose central features involve directly observing and counting pests before and after control measures are applied. Integrated pest management programs may use chemical pesticides, if really needed, and a variety of less conventional practices (Bird, 1987), including five that we covered in the interviews: using biological pesticides, releasing beneficial insects, following crop rotations, planting insect-resistant crop varieties, and scheduling planting to avoid problems. Ideally, integrated pest management programs consist of more than just scouting fields, although basing the use of pesticides on actual observations is preferable to standardized responses that produce excessive applications of chemicals.

Table 4.19 reports the percentages of farmers who had integrated pest management programs and also used any of these other five insect-control practices. In three sites (Whitman, Butte, and Dooly counties), a majority or close to half of the IPM farmers did not apply *any* of those other practices. Only in the two Midwestern sites did as many as 45% of the IPM programs include two or more such practices. Elsewhere, IPM appears to have amounted mostly or exclusively to scouting fields and, hopefully, restricting pesticide applications to levels no greater than what careful field observations indicate are needed.

Across the five survey sites, respondents who reported following an integrated pest management program ranged from 38% in both the Whitman and Renville county sites to 94% in Dooly County (Table 4.13). The Georgia site's rate of 94% probably reflects the facts that so many farmers in that sample grow cotton and that pest management programs have been particularly popular among U.S. cotton farmers because the boll weevil and bollworm pose serious threats to yields.

Besides being rather popular, the IPM approach to insect control tended to be highly rated by its users. Across the five sites, majorities of 65% to 89% of the farmers who applied them to their primary crop ranked them first or second in importance among their insect-control practices for that crop (Table 4.14).

As intuition would suggest, the IPM approach to insect control can be applied to a wide variety of crops. In three of our survey sites, it was used by majorities of the growers of rice, corn, soybeans, cotton, peanuts, and wheat (where those crops were the farmers' primary or secondary crop, Table 4.20). Usage was much less frequent among wheat growers in Whitman County and corn and soybean farmers in Renville County, in part because so may respondents in those two sites believed that they could refrain from all insect controls, presumably because of the colder, drier conditions.

We found from our regression analyses that in Butte and Renville counties farmers who obtained help from the Cooperative Extension Service were more likely to use an IPM approach than farmers who did not consult with Extension (Table 4.18). Other variables held constant, the probability increased an estimated 33 percentage points in the Butte County sample and 24 percentage points in Renville County (Table 4.18).

Biological Pesticides

The IPM approach to insect control does not preclude chemical pesticides; rather, it advocates them only when and where necessary and at the lowest feasible rates (Council for Agricultural Science and Technology, 1980). However, some strains of insects have emerged that are resistant to synthetic insecticides. Biological pesticides, such as bacteria, rotenone, garlic spray, and insect extracts may be more effective against these pests or equally useful, and at lower environmental costs. The list of possible insect-control practices that we presented to respondents included a biological pesticides option with these four alternative insect killers given as examples. However, across the five sites almost no one reported using them: just 3% of the respondents in Whitman County, 1% each in Butte and Renville counties, and 0% in the other two sites (Table 4.13).

Release of Beneficial Insects

Virtually the same pattern of responses emerged for a similar set of biological controls of insects, the release of insects that prey on crop-destructive bugs. As examples of such "good" insects, the interview listed lady beetles and parasitic wasps. Only 3% of the Whitman County sample used such predators, 2% in Butte County, 0% in Renville County, and 1% each in the remaining two sites (Table 4.13). Our findings that virtually no farmers in five survey sites used either of these practices support Youngberg and Ridgway's observation that few producers, especially of major cash crops, have been persuaded of "the efficacy and dependability of biologically based pest controls" (1988, p. 50).

Crop Rotations Designed to Control Insects

Crop rotations designed to control insects (by interrupting their reproductive cycles) were used often in two survey areas. In Renville County 83% of the respondents and 76% of those in Livingston County reported using them (Table 4.13), and large majorities rated them highly. The percentages of users ranking them first or second in importance for producing their primary crop--90% and 81%--were larger than the corresponding totals for insecticide users in the same sites (Table 4.14). However, in the other three sites only 2% to 20% of the respondents used crop rotations to control insects (Table 4.13).

Corn and soybean growers in the Renville County site applied this practice about as frequently as did their counterparts in Livingston County--70% to 82% (Table 4.21). Interestingly, only 29% of the soybean farmers in the Dooly County sample used rotations to combat insects. By contrast, 65% of the soybean farmers in Dooly County followed rotations to control weeds (Table 4.11). In fact, rotations to control weeds were quite popular with all Dooly County groups of farmers (Table 4.11), but few used them to control insects (Table 4.21). It appears that something about the insect problems in the Georgia site made farmers regard rotations as inappropriate controls.

The regression findings for this practice were scattered except that in three sites, younger farmers were more likely than older operators to follow rotations to control insects (Table 4.18).

Insect-Resistant Crop Varieties

Another practice that can substitute for chemical pesticides is the planting of pest-resistant varieties of crops. For example, scientists have developed wheat that is resistant to the Hessian fly and the wheat stem sawfly (National Research Council, 1989). However, in three of our survey sites, only 14% to 20% of the respondents planted insect-resistant crop varieties. In the two Midwestern sites use was more frequent but still below a majority of the respondents--40% and 48% (Table 4.13). Since at least some members of our groups of relevant farmers used insect-resistant varieties of crops (Table 4.22), we suspect that the problem is not an absence of such varieties on the market. Either the products have not proven themselves, or they have not been well marketed. We assume that Extension offices keep informed of the evaluations of such varieties and recommend the ones that have proven to be effective.

In all sites except Dooly County, at least a third of the farmers who used insect-resistant varieties for their primary crop ranked them first or second in importance for insect control (Table 4.14). In the Whitman and Renville county samples, the relevant percentages were 45% and 62%, respectively.

In two of our survey sites, farmers who used Cooperative Extension for information about insect problems were more likely to plant insect-resistant crop varieties than farmers who did not use this source of information. According to our regression analyses, Whitman County farmers were 17 percentage points and Butte County farmers were 24 percentage points more likely to use the practice (Table 4.18).

Plantings Timed to Avoid Insect Problems

Extension's influence emerged in four sites in the regression analyses regarding the last insect-control practice to be discussed, the timing of planting dates to avoid in-

sect problems. Except in Dooly County farmers who consulted Extension for help in understanding insect problems were more likely to use this practice (Table 4.18). Either Extension helped them learn enough about their insect problems to schedule planting to minimize those problems, or they had already decided to do so and at least Extension had the opportunity to reinforce the decision.

However, across the five survey sites, the timing of planting was not a very popular insect-control practice; the highest percentages of users were in Livingston and Dooly counties--both 24% (Table 4.13). Elsewhere, only 8% to 17% of the respondents reported using it. Timed plantings ranked high in importance in only two sites; 67% of its users in the Whitman County sample and 45% in Livingston County rated it first or second in importance for insect control in producing their primary crop (Table 4.14).

Summary and Policy Inferences

Substantial proportions of our respondents used two weed-control and two insect-control practices with the potential for reducing the use of chemical pesticides. That is, at least one-third in at least three sites applied the practice. In all survey areas except Butte County, majorities of 54% to 84% followed crop rotations designed for weed control, and in the Whitman, Renville, and Livingston county sites, from 35% to 49% timed plantings to avoid weed problems.

Despite their frequent use neither timed plantings nor rotations were highly important to their users compared to other weed-control practices. Except for rotations in the Whitman County sample, neither practice was used by at least a third of the respondents and ranked first or second in importance by farmers who applied it to their primary crop.

The findings for insect-control practices were somewhat more positive. One widely used practice--applied by 62% to 80% of the respondents in three sites--was the decision in most years to apply no insect controls. A related practice, also relatively popular, was the use of integrated pest management programs. At least a third of the respondents in all five sites had such programs, and in three survey areas majorities of 53% to 94% used them. Moreover, in all sites most of the IPM users ranked the practice first or second in importance. An integrated pest management program may include nonchemical pest controls, but in three of our five sites 42% to 64% of the followers of this approach used no such controls. In the other two sites only 46% and 47% of such farmers applied more than one. These findings suggest, therefore, that integrated pest management has been limited mostly to scouting and monitoring.

When we analyzed pest management practices by type of crop, we discovered little significant variation beyond what we found in Chapter 2 regarding rotations. Few rice farmers in Butte County used rotations, whether to add nitrogen to the soil or to combat weeds or insects. Another parallel finding was that the warmer, wetter climate of the Georgia site appeared to encourage the use of herbicides as well as to discourage conservation tillage. These findings illustrate what many experienced observers already knew. Farming practices with the potential for economizing on chemical inputs are not uniformly applicable across crops and regions of the country. Climatic conditions may present critical barriers.

The logistic regression analyses yielded some encouraging findings for readers who believe that government agencies should help farmers to adopt reduced-input practices. In almost every site the personal advice, public meeting presentations, or literature

that the Cooperative Extension Service provided appears to have made a difference in whether farmers used insect-control practices with the potential for economizing on chemicals. We questioned respondents about five such practices, and the Extension-information variable was positively associated in the Livingston County site with using one practice and in the Whitman, Butte, and Renville samples with three each. When this research project began, it seemed plausible that Extension would emerge as largely ineffectual in shaping farmers' behavior because of the competition from agribusinesses with their often superior budgets for personal visits to farmers and attractive literature to distribute them. However, with both insect-control and fertility practices we found that Extension either helped farmers to decide to apply the practices or at least it was in a position to reinforce such decisions.

What policy inferences should be drawn from this record? A program with these indications of success should be continued if not expanded. Competitors for the resources that expansion would consume may argue that farmers who are susceptible to Extension's influence comprise only small, loyalist groups. Therefore, resources to help producers reduce their use of chemicals should be assigned to more competitive agencies.

Our findings show that Extension's clients were not tiny, captive groups. From 51% to 61% of our respondents used Extension for insect problems except in one site, which had only 27%. Moreover, across the five sites most of the respondents (69% to 89%) who used Extension also obtained information from their pesticide dealers. The same pattern prevailed for fertility practices; 67% to 100% of the respondents who used Extension also took advice from fertilizer dealers. In other words, Extension's clients tend to have information from both private- and public-sector sources, and where the agency exerts influence, it appears to be in a competitive situation.

We are not apologists for Extension. In another study, we found evidence of relatively poor performance in one of its educational missions (Esseks and Kraft, 1986). However, here we have indications that the agency is helping farmers to adopt a number of farming practices with the potential for economizing on chemical inputs. It is usually prudent to build on such established capabilities.

Respondents' classification of themselves as conventional or nonconventional farmers (low-input, sustainable, or organic) proved to be a poor predictor of whether they used low-input practices. In our four sets of regression analyses for identifying variables that were associated with usage of practices, the classification variable was statistically significant in the predicted direction in few cases (see Tables 2.11, 3.6, 4.10, and 4.18). Many more respondents used potentially reduced-input practices (such as legume-based rotations, banding or injecting fertilizers into rows, splitting applications of nitrogen, timing plantings to avoid weed problems, and adjusting pesticide applications to the results of scouting fields) than classified themselves as low-input or sustainable farmers. We should either develop more accurate labels or perhaps dispense with labels altogether. The concepts "low-input," "sustainable," and "organic" farming may have negative connotations that discourage farmers from applying the practices.

The farmers in four of our survey sites tended to view low-input/sustainable agriculture (LISA) as impractical. We asked each respondent to choose from a list of five phrases, "the phrase that best describes your opinion regarding low-input/sustainable agriculture." Except in the Whitman County site, half or more of the farmers (50% to 63%) chose the phrase, "a good idea, but economically unfeasible" (Table 4.24). Across all five sites 1% to 10% selected the option, "a crackpot notion." Only in the Washington study area did a majority (54%) choose one of the three positive phrases, "a reasonable

option," "important for the future of American agriculture," or "the only way to farm." Given the apparently widespread skepticism about the concept "low-input/sustainable," agencies that promote LISA-type practices may do better without mentioning the concept. Such practices could be presented as "recommended practices"--recommended because of their potential for achieving savings in chemical inputs and for protecting against groundwater contamination.

Tables for Chapter 4

Table 4.1

Farmers' Reports of 1988 Weed-Control Practices for Their Primary, Secondary, and Other Crops[1]

Practices[2]	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Multiple cultivations for:					
At least one crop	88	70	85	41	97
Their primary crop	78	69	69	33	94
Their secondary crop	79	26	69	30	90
Some other crop	59	33	45	3	62
One cultivation for:					
At least one crop	14	7	49	83	6
Their primary crop	9	7	39	66	1
Their secondary crop	13	3	40	71	8
Some other crop	12	0	29	3	4
Hand cultivation for:					
At least one crop	14	8	85	84	46
Their primary crop	14	6	58	38	44
Their secondary crop	10	19	46	56	40
Some other crop	5	8	31	0	29
Weed control through use of herbicides for:					
At least one crop	99	96	99	99	100
Their primary crop	99	93	98	98	97
Their secondary crop	97	52	97	97	93
Some other crop	79	25	90	7	67
Timed planting to avoid weed problem for:					
At least one crop	49	16	35	39	21
Their primary crop	47	16	25	35	19
Their secondary crop	41	10	23	33	21
Some other crop	28	0	28	3	12

Table 4.1 continues

Table 4.1 continued

Practices[2]	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Crop rotations designed for weed control for:					
At least one crop	63	13	84	54	63
Their primary crop	61	13	80	53	59
Their secondary crop	61	13	81	52	61
Some other crop	48	8	79	14	42
Narrow row spacing for:					
At least one crop	29	10	58	45	9
Their primary crop	28	10	52	39	6
Their secondary crop	29	7	49	38	8
Some other crop	28	0	37	0	8
Other practices for:					
At least one crop	9	14	4	2	1
Their primary crop	9	14	4	1	0
Their secondary crop	8	13	4	1	0
Some other crop	12	0	3	0	0
All farmers with crops	(104)	(100)	(114)	(92)	(70)
Those with two or more crops	(100)	(31)	(113)	(90)	(67)
Those with three or more crops	(58)	(12)	(98)	(29)	(52)

[1]The primary crop is that crop which in 1988 was planted on the largest number of acres. The secondary crop is that crop which in 1988 was planted on the second-largest number of acres.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

Table 4.2

Farmers' Rankings of the Importance of the Weed-Control Practices They Used for the Production of Their Primary Crop

Practices[2]	Percentage of Farmers Ranking Each Practice[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Multiple cultivations	24	29	6	71	15	46	17	33	6	72
One cultivation	0[3]	0[3]	0[3]	43[3]	0	43	10	46	0[3]	0[3]
Hand cultivation	7	7	0[3]	0[3]	0	5	0	23	3	7
Weed control through use of herbicides	65	26	87	11	80	14	84	12	91	7
Timed planting to avoid weed problem	4	12	19	19	7	0	3	6	8	0
Crop rotations designed for weed control	9	42	15	46	4	26	2	22	0	27
Narrow row spacing	0	3	0	0	5	0	3	8	0[3]	0[3]
Other practices	33[3]	22[3]	21	50	0[3]	25[3]	0[3]	1[3]	0	0
Total respondents	(104)		(100)		(114)		(92)		(70)	

[1]For each survey site, the column labeled "1st" indicates the percentage of users of a practice who ranked it the most important in the cultivation of a primary crop. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

[3]Fewer than ten respondents used this practice for their primary crop.

Table 4.3

The Practice of Multiple Cultivations for Weed Control

Crop	Percentage of Farmers Using Multiple Cultivations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	65	24	--
Soybeans	--	--	75	39	94
Cotton	--	--	--	--	96
Peanuts	--	--	--	--	94
Wheat	78	--	--	--	100
Barley	89	--	--	--	--
Rice	--	70	--	--	--

[1]Table 4.3 reports percentages only for relevant groups, that is, those where at least ten farmers reported an indicated crop as their primary or secondary crop. By crop, the relevant groups of farmers and the number in each group in each site are as follows:

corn: Renville County (99 farmers)
Livingston County (91 farmers)
soybeans: Renville County (102)
Livingston County (89)
Dooly County (17)
cotton: Dooly County (48)
peanuts: Dooly County (51)
wheat: Whitman County (101)
Dooly County (15)
barley: Whitman County (66)
rice: Butte County (89)

Table 4.4

The Use of Just One Cultivation per Season for Weed Control

Crop	Percentage of Farmers Using One Cultivation[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	45	73	--
Soybeans	--	--	35	66	6
Cotton	--	--	--	--	2
Peanuts	--	--	--	--	6
Wheat	9	--	--	--	7
Barley	9	--	--	--	--
Rice	--	7	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.5

The Use of Hand Cultivation for Weed Control

Crop	Percentage of Farmers Using Hand Cultivation[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	35	26	--
Soybeans	--	--	69	69	41
Cotton	--	--	--	--	48
Peanuts	--	--	--	--	47
Wheat	13	--	--	--	7
Barley	11	--	--	--	--
Rice	--	6	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.6

The Application of Herbicides for Weed Control

Crop	Percentage of Farmers Applying Herbicides[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	98	99	--
Soybeans	--	--	98	98	100
Cotton	--	--	--	--	98
Peanuts	--	--	--	--	96
Wheat	99	--	--	--	93
Barley	98	--	--	--	--
Rice	--	98	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.7

Timing the Planting of Crops to Avoid Weed Problems

Crop	Percentage of Farmers Timing Planting[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	23	33	--
Soybeans	--	--	25	36	24
Cotton	--	--	--	--	19
Peanuts	--	--	--	--	22
Wheat	48	--	--	--	13
Barley	50	--	--	--	--
Rice	--	17	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.8

Traits of Farmers or Their Operations Found to Be Associated with the Use of Weed Control Practices[1]

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Timed Plantings to avoid weed problems	CHMPRB (32)[3] CONSERVE (19) -LABOR (12)	——	EDUC (13) CONSERVE (30)	——	——
Followed rotations for weed control	CLASSIF (22)	——	BEANS (14)	——	-AGE (33)
Narrow row spacing	USDA (17)	——	——	USDA (27)	-AGE (3) -COTTON (56) -EDUC (2) INCOME (3)

[1]Associated means that logistic regression coefficients measuring the presence of a relationship between a trait and a practice were statistically significant in a t-test at the 0.1 level for one-tailed tests and at the 0.05 level for two-tailed tests.

Table 4.8 continues

Table 4.8 continued

[3]Traits are defined as follows:

AGE:	farmers' age in years.
BEANS:	soybeans were or were not the farmer's primary or secondary crop in 1988.
CHMPRB:	farmers did or did not believe that agricultural chemicals had contaminated drinking water in their county.
CLASSIF:	respondents did or did not classify themselves as low-input, organic, or sustainable farmers.
CONSERVE:	farmers did or did not participate in recent years (1986-88) in either the Conservation Reserve Program or the Agricultural Conservation Program.
EDUC:	farmers' years of formal education.
INCOME:	farmers' 1988 gross revenues from agriculture, including government payments.
LABOR:	number of family members who worked on the farm in 1988.
USDA:	farmers did or did not rank USDA agency personnel as the most or second most important source of information for weed control for their primary crop.

[3]The numbers in parentheses indicate the percentage-point change in the estimated probability of using the indicated practice, when a dichotomous explanatory variable is changed from its positive to its negative value or when an interval-level variable is changed from its 25th- to its 75th-percentile value, with the other variables held constant.

Table 4.9

Farmers' Reports of Sources That Provided Information or Advice in 1988 for the Weed- and Insect-Control Practices They Used

Information Sources[1]	Percentage of Farmers Selecting Each Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Staff member of Cooperative Extension Service (CES)	27	38	39	21	76
Publications, meetings, or field days of CES	33	50	47	40	53
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)	13	4	11	4	10
Publications, meetings, or field days of SCS or CD	18	6	23	26	7
Staff member of Agricultural Stabilization and Conservation Service (ASCS)	9	3	9	11	10
Publications, meetings, or field days of ASCS	14	9	22	25	7
Staff and publications of other public agencies	18	21	20	22	14
Farm organization personnel[2]	17	28	33	33	10
Fertilizer dealer	73	45	77	75	50
Herbicide or insecticide dealer	91	83	83	91	85
Fertilizer or pesticide applicator	53	26	47	51	26
Other farmers	71	65	81	71	81
Family members	65	54	68	53	43

Table 4.9 continues

Table 4.9 continued

Information Sources[1]	Percentage of Farmers Selecting Each Source				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Nonprofit, educational, or environmental organizations	8	12	18	24	1
Farm magazines, journals, radio and television programs	43	36	77	73	51
Other	6	16	5	2	4
Total respondents	(106)	(100)	(114)	(92)	(72)

[1]A list of information sources was provided, and farmers were asked to choose.

[2]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 4.10

Farmers' Rankings of the Importance of Sources That Provided Information or Advice in 1988 for the Weed- and Insect-Control Practices They Used

Information Sources[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Staff member of Cooperative Extension Service (CES)	5	8	7	5	4	3	5	7	22	8
Publications, meetings, or field days of CES	1	5	4	10	4	5	2	2	6	3
Staff member of Soil Conservation Service (SCS) or local conservation district (CD)	0	1	0	1	0	0	0	0	0	0
Publications, meetings, or field days of SCS or CD	1	0	1	0	0	0	0	1	0	1
Staff member of Agricultural Stabilization and Conservation Service (ASCS)	2	0	0	0	1	0	0	0	3	0
Publications, meetings, or field days of ASCS	0	1	0	0	0	1	0	0	0	1
Staff and publications of other public agencies	0	1	0	3	0	1	0	0	1	0
Farm organization personnel[3]	1	1	6	2	1	0	1	1	1	1
Fertilizer dealer	29	9	9	3	25	10	27	4	4	4
Herbicide or insecticide dealer	34	15	42	15	33	13	46	22	43	25
Fertilizer or pesticide applicator	3	9	4	2	6	6	2	4	1	0
Other farmers	5	27	5	27	8	26	4	24	10	32
Family members	9	7	6	11	6	14	3	7	4	7

Table 4.10 continues

Table 4.10 continued

Informations Sources[2]	Percentage of Farmers Using Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Nonprofit, educational, or environmental organizations	0	1	0	3	0	0	0	0	0	0
Farm magazines, journals, radio and television programs	1	3	0	3	4	18	7	22	0	10
Other	2	1	11	3	5	0	1	1	3	3

[1]For each survey site, the column labeled "1st" indicates the percentage of farmers using each information source who ranked it first in importance. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of sources was provided, and farmers were asked to choose.

[3]The examples given were the Farm Bureau, Corn Growers Association, and Cattlemen's Association.

Table 4.11

The Use of Crop Rotations Designed for Weed Control

Crop	Percentage of Farmers Using Crop Rotations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	81	54	--
Soybeans	--	--	82	53	65
Cotton	--	--	--	--	63
Peanuts	--	--	--	--	63
Wheat	61	--	--	--	60
Barley	64	--	--	--	--
Rice	--	13	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.12

Narrow Row Spacing for the Purpose of Weed Control

Crop	Percentage of Farmers Using Narrow Row Spacing[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	46	38	--
Soybeans	--	--	50	39	24
Cotton	--	--	--	--	0
Peanuts	--	--	--	--	6
Wheat	29	--	--	--	27
Barley	26	--	--	--	--
Rice	--	8	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.13

Farmers' Reports of 1988 Insect-Control Practices for Their Primary, Secondary, and Other Crops[1]

Practices[2]	Percentage of Farmers Reporting Practices				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Insecticide applications for:					
At least one crop	61	94	34	55	97
Their primary crop	39	90	25	42	96
Their secondary crop	44	52	20	38	87
Some other crop	53	33	17	3	64
Believed that no insect control needed in most years for:					
At least one crop	67	13	80	62	14
Their primary crop	57	10	75	57	11
Their secondary crop	54	16	75	51	12
Some other crop	57	8	71	7	6
Applied an integrated pest management program (such as scouting for pests and applying pesticides when needed, and using insect traps to monitor pest levels) for:					
At least one crop	38	53	38	66	94
Their primary crop	25	48	34	63	93
Their secondary crop	27	61	32	62	84
Some other crop	45	25	29	7	58
Used biological pesticides (bacteria, rotenone, garlic spray, insect extracts) for:					
At least one crop	3	1	1	0	0
Their primary crop	2	0	1	0	0
Their secondary crop	2	3	1	0	0
Some other crop	3	0	1	0	0

Table 4.13 continues

Table 4.13 continued

Practices[2]	Percentage of Farmers Reporting Practices				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Release of beneficial insects such as lady beetles or parasitic wasps to control insect pests for:					
At least one crop	3	2	0	1	1
Their primary crop	2	1	0	1	1
Their secondary crop	2	3	0	1	2
Some other crop	3	0	0	0	0
Crop rotations designed to control insects for:					
At least one crop	13	2	83	76	20
Their primary crop	10	2	75	74	20
Their secondary crop	10	3	76	71	19
Some other crop	7	0	67	14	15
Used insect-resistant crop varieties for:					
At least one crop	19	20	40	48	14
Their primary crop	19	18	37	41	11
Their secondary crop	19	13	32	44	8
Some other crop	19	17	21	7	8
Timed planting dates to avoid insect problems for:					
At least one crop	17	8	15	24	24
Their primary crop	16	9	11	22	23
Their secondary crop	15	10	13	18	24
Some other crop	14	0	10	3	14
Other practices for:					
At least one crop	3	7	0	0	1
Their primary crop	3	7	0	0	1
Their secondary crop	3	0	0	0	0
Some other crop	5	1	0	0	0
All farmers with crops:	(104)	(100)	(114)	(92)	(70)
Those with at least two crops:	(100)	(31)	(113)	(90)	(67)
Those with at least three crops:	(58)	(12)	(98)	(29)	(52)

Table 4.13 continues

Table 4.13 continued

[1]The primary crop is that crop which in 1988 was planted on the largest number of acres. The secondary crop is that crop which in 1988 was planted on the second-largest number of acres.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

Table 4.14

Farmers' Rankings of the Importance of the Insect-Control Practices They Used for Producing Their Primary Crop

Practices[2]	Percentage of Farmers Ranking Each Source[1]									
	Whitman County (WA)		Butte County (CA)		Renville County (MN)		Livingston County (IL)		Dooly County (GA)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Insecticide applications	68	13	88	11	38	38	46	31	83	16
Believed that no insect control needed in most years	42	2	20	0	13	12	14	2	22[3]	0[3]
Applied an integrated pest management program (such as scouting for pests and applying pesticides when needed, and using insect traps to monitor pest levels)	33	52	17	71	26	39	19	47	15	74
Used biological pesticides (bacteria, rotenone, garlic spray, insect extracts)	0[3]	50[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Release of beneficial insects such as lady beetles or parasitic wasps to control insect pests	0	0	0	0	0	0	0	0	0	0
Crop rotations designed to control insects	40	40	0[3]	50[3]	69	21	62	19	0	0
Used insect-resistant crop varieties	25	20	11	22	19	43	3	34	0	22
Timed planting dates to avoid insect problems	11	56	11[3]	11[3]	0	17	10	35	0	12
Other practices	33[3]	0[3]	43[3]	29[3]	0	0	0	0	0[3]	100[3]
Total respondents	(104)		(100)		(114)		(92)		(70)	

Table 4.14 continues

Table 4.14 continued

[1]For each survey site, the column labeled "1st" indicates the percentage of users of a practice who ranked it the most important in the cultivation of their primary crop. The column labeled "2nd" indicates the percentage who ranked it second.

[2]A list of practices was provided, and farmers were asked to indicate which ones they used.

[3]Fewer than ten farmers used this practice for their primary crop.

Table 4.15

Applying Pesticides for Insect Control

Crop	Percentage of Farmers Applying Pesticides[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	19	38	--
Soybeans	--	--	25	40	88
Cotton	--	--	--	--	98
Peanuts	--	--	--	--	88
Wheat	41	--	--	--	87
Barley	36	--	--	--	--
Rice	--	96	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.16

The Belief That No Insect Control Is Needed in Most Years

Crop	Percentage of Farmers Believing No Insect Control Needed[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	72	49	--
Soybeans	--	--	76	58	6
Cotton	--	--	--	--	8
Peanuts	--	--	--	--	16
Wheat	57	--	--	--	13
Barley	59	--	--	--	--
Rice	--	10	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.17

Farmers' Methods for Determining Whether an Insect Problem Existed in Their Fields

Methods[1]	Percentage of Farmers Using Each Method				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Go by the crop history in my fields	24	43	59	38	26
Refer to Extension Service publications or agents who inform me about potential insect outbreaks	52	27	61	58	51
Treat the fields preventively every year according to a spray schedule	3	31	5	13	49
Get advice from my pesticide dealer, who warns me of the need to protect my crops	82	55	64	77	50
Treat the fields as soon as I see evidence of an insect problem	37	68	33	74	76
Follow the advice of a pest management scout	41	53	25	24	76
Scout the fields myself to estimate the level of insect infestation	91	93	95	97	74
(Total in sample)	(104)	(100)	(114)	(92)	(70)

[1]A list of methods was provided, and farmers where asked to indicate which ones they used.

Table 4.18

Traits of Farmers or Their Operations Found to Be Associated with the Use of Insect Control Practices[1]

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Believed that no insect control needed in most years	——	-PCTINC (4)[3]	-AGE (11) *EXTENS* (1) PCTINC (10)	——	INCOME (7)
Integrated pest management (such as scouting for pests and applying pesticides when needed)	——	EXTENS (33) INCOME (13)	-BEANS (30) EDUC (16) EXTENS (24)	-AGE (23) -CLASSIF (26)	COTTON (19)
Crop rotations for controlling insects	EXTENS (7)	——	-AGE (1) CHMPRB (7)	-AGE (14)	-AGE (42) DEALER (25)
Used insect-resistant crop varieties	EXTENS (17)	*CONSERVE* (51) EXTENS (24) -PCTINC (8)	-AGE (20) DEALER (20) EDUC (9)	——	CONSERVE (20)

Table 4.18 continues

Table 4.18 continued

	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Timed planting dates to avoid insect problems	EXTENS (16) -PCTINC (8)	EXTENS (13)	-DEALER (24) EXTENS (10) INCOME (4)	EXTENS (33) -LABOR (19)	CHMPRB (32)

[1]Associated means that logistic regression coefficients measuring the presence of a relationship between a trait and a practice were statistically significant in a t-test at the 0.1 level for one-tailed tests and at the 0.05 level for two-tailed tests.

[2]Traits are defined as follows:

AGE: farmers' age in years.

BEANS: soybeans were or were not the farmer's primary or secondary crop in 1988.

CHMPRB: farmers did or did not believe that agricultural chemicals had contaminated drinking water in their county.

CLASSIF: respondents did or did not classify themselves as low-input, organic, or sustainable farmers.

CONSERVE: farmers did or did not participate in recent years (1986-88) in either the Conservation Reserve Program or the Agricultural Conservation Program.

COTTON: cotton was or was not the farmers' primary crop in 1988.

DEALER: farmers did or did not consult pesticide dealer (s) to determine whether they had an insect problem.

EDUC: farmers' years of formal education.

Table 4.18 continues

Table 4.18 *continued*

EXTENS:	farmers did or did not consult the Cooperative Extension Service to determine whether they had an insect problem.
INCOME:	farmers' 1988 gross revenues from agriculture, including government payments.
LABOR:	number of family members who worked on the farm in 1988.
PCTINC:	percentage of farmers' 1988 family income derived from agriculture.

[3]Numbers in parentheses indicate the percentage-point change in the estimated probability of using the indicated practice, when a dichotomous explanatory variable is changed from its positive to its negative value or when an interval-level variable is changed from its 25th- to its 75th-percentile value, with the other variables held constant.

Table 4.19

Percentages of Farmers Using Particular Practices Likely to Be Components of an Integrated Pest Management Program

Practices	Farmers Using IPM Practices				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
	Percentage Using Each Practice				
Biological pesticides	0	2	0	0	3
Release of beneficial insects	9	2	0	0	2
Crop rotations to control insects	12	2	83	78	22
Planted insect-resistant crop varieties	21	26	51	47	15
Timed planting to avoid insect problem	39	15	20	22	25
	Percentage in Each Category				
Used none of the above	42	64	10	13	54
Used only one	39	25	44	40	33
Used two	12	11	26	33	8
Used three	6	0	20	13	5
Used more than three	0	0	0	0	0
(Total in subsample)	(33)	(53)	(41)	(60)	(67)

Table 4.20

Use of an Integrated Pest Management Program (Such as Scouting for Insects and Applying Pesticides Only When Needed)

Crop	Percentage of Farmers Using IPM Program[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	31	62	--
Soybeans	--	--	31	64	82
Cotton	--	--	--	--	96
Peanuts	--	--	--	--	88
Wheat	27	--	--	--	80
Barley	17	--	--	--	--
Rice	--	53	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.21

The Use of Crop Rotations Designed to Control Insects

Crop	Percentage of Farmers Using Crop Rotations[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	82	76	--
Soybeans	--	--	72	70	29
Cotton	--	--	--	--	21
Peanuts	--	--	--	--	16
Wheat	10	--	--	--	27
Barley	11	--	--	--	--
Rice	--	2	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.22

Planting Insect-Resistant Crop Varieties

Crop	Percentage of Farmers Planting Insect-Resistant Crops[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	32	44	--
Soybeans	--	--	36	40	6
Cotton	--	--	--	--	13
Peanuts	--	--	--	--	8
Wheat	20	--	--	--	7
Barley	23	--	--	--	--
Rice	--	18	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.23

Timed Plantings to Avoid Insect Problems

Crop	Percentage of Farmers Who Timed Plantings[1]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Corn	--	--	14	21	--
Soybeans	--	--	13	19	24
Cotton	--	--	--	--	25
Peanuts	--	--	--	--	27
Wheat	15	--	--	--	24
Barley	17	--	--	--	--
Rice	--	10	--	--	--

[1]See the footnote to Table 4.3 for the number of farmers in each site reporting each crop as their primary or secondary crop.

Table 4.24

Farmers' Choices of the Phrase That Best Describes Their Opinions of Low-Input/Sustainable Agriculture

Phrases[1]	Percentage of Farmers Choosing Each Phrase				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
A crackpot *notion*	3	9	3	1	10
A good idea, but economically unfeasible	39	63	52	50	53
Total with negative assessments	42	72	55	51	63
A reasonable option	19	15	21	21	10
Important for the future of American agriculture	33	9	20	23	21
The only way to farm	2	0	1	5	1
Total with positive assessments	54	24	42	49	32
Other	3	3	1	0	1
No response	1	1	2	0	4
Total respondents	(109)	(100)	(114)	(92)	(73)

[1]*Farmers* were provided with a list of phrases and were asked to indicate which ones best fit their opinion.

Chapter 5

Farmers' Opinions of Proposed Policies for Reducing the Use of Chemical Fertilizers and Pesticides

Chapter Overview

This study collected information about farmers' attitudes toward possible changes in federal policies that might lead to reduced use of chemical fertilizers and pesticides. Of the 13 policy options presented, the most popular suggestion (favored by majorities of 75% to 90%) was to change the commodity programs to permit farmers to plant more land to rotational crops without losing the acreage base from which financial benefits are calculated. Across the five survey sites, from 88% to 97% of the respondents participated in one or more of the commodity programs sometime during 1986-88.

Majorities in all five sites also supported proposals to (1) increase the share of the total federal budget devoted to research into economical ways to reduce the use of agricultural chemicals and (2) have the Cooperative Extension Service give farmers more information on ways to improve farm profitability through decreasing the use of chemical inputs.

In general, the least popular policy options were those that called for regulatory approaches to preventing excessive use of agricultural chemicals and fertilizers.

A client relationship with the Cooperative Extension Service was associated with a higher probability of support for nine of the 13 policy options in the Butte County sample, four in Whitman County, and three in Livingston County. It is difficult to know whether this relationship is a result of the openness of certain farmers to considering new ideas when making production decisions or the proclivity of the Extension Service to deliver certain types of information. The Extension Service should have the information and expertise to reinforce this openness.

In four of the five sites, 38% to 62% of the respondents expressed a concern about the negative effects of agricultural chemicals on groundwater quality in their counties. In those same four sites, awareness of groundwater pollution from agriculture was associated with support of from two to five of the possible policy changes presented in the interview.

As we found in our analysis of pest management practices, farmers' classification of themselves as conventional or nonconventional (low-input, sustainable, or organic farmers) proved to be a poor predictor of whether they supported a proposed policy. The labels are not helpful enough in explaining either the use of farming practices or farmers' attitudes.

Introduction

The survey included a series of 13 questions about proposed federal policies for reducing the use of chemical fertilizers and pesticides. Farmers could choose among four responses: oppose strongly, oppose moderately, favor moderately, or favor strongly. The questions fell into four groups. The first dealt with research and technical assistance

policies, the second with incentive policies (bonuses, insurance), the third with policies restricting the use of chemicals, and the fourth with changes in the federal commodity programs that would promote the planting of rotational crops.

The purpose of these questions was to determine whether significant support existed for any of the options. Administrators and legislators are more likely to develop or advocate a new policy if there is evidence that the farmers to be affected favor it. Ideally, the evidence would come from a national survey that also captured important regional variations in American agriculture. Financial constraints led to a compromise research design. We interviewed random samples of producers in five localities that are agronomically or climatically diverse or both. We assumed that, from the point of view of national policymakers, parallel findings in most or all sites would be the most important. Coming from diverse local contexts, such findings would probably reflect broad conditions in American agriculture. It is unlikely that common findings emerging from very different sites would be limited to those localities and a few others like them.

Therefore, if majorities or near-majorities (45% to 50%) of respondents from four to five diverse sites favored policy proposals, it is likely that many farmers elsewhere in the country would also be supportive. We did find that level of support; 45% or more of the respondents in at least four sites favored six of the 13 policies.

For most of the incentive and regulatory options, the expected leverage for shaping farmers' behavior was their participation in one or more of the federal commodity programs. Farmers' benefits from the programs would be increased or decreased (if not terminated) according to whether they responded appropriately to the incentive or regulation. Given the importance of participation in the programs to the policy options we evaluated, we aimed to limit the survey to current or recent participants. Across the five survey sites, from 88% to 97% of the respondents had participated in one or more commodity program sometime during 1986-88 (Table 5.1).

Explaining Variations in Farmers' Support of Policies

Findings from logistic regression analyses tell us whether support of a policy varied with traits of the farmers or their operations that we hypothesized would affect how farmers responded. Knowing at least some of the conditions that shape opinions about policy proposals, proponents (or opponents) should be better equipped to advocate (or oppose) them.

With two exceptions we used the same explanatory variables for these analyses as the variables we reported in Chapters 2 through 4 (see the Appendix for a discussion of why we chose these variables). First, we hypothesized that support for the policy options would tend to be higher among current clients of the Cooperative Extension Service. Many farmers followed Extension's recommendations for fertilizing their fields or took its advice in assessing insect problems. It seemed plausible that clients would be more willing than nonclients to approve of research, technical assistance, incentive-giving, and even regulatory roles for USDA agencies because they were currently receiving help from such an agency.

Second, we hypothesized that farmers would be more willing to accept regulations designed to reduce use of chemicals if they currently had a significant capacity to soften the effects of such regulations through the use of alternative practices: for example,

planting leguminous crops, using animal manure, and applying various analytical techniques (such as an integrated pest management program) that permit economizing on chemical inputs. A limitation of our tests of this hypothesis is that we measure the presence of these capacities with dichotomous variables--farmers did or did not follow a specified alternative practice.

Results

Proposed Policies to Increase Federal Research and Technical Assistance to Help Farmers Reduce Chemical Inputs

The first proposal (Policy Option 1), increasing the share of the federal budget allocated for research into economical ways to reduce chemical inputs, turned out to be popular.[1] In all five survey sites, majorities of the respondents (54% to 83%) favored the proposal, either strongly or moderately (Table 5.2). The regression analyses of these responses found that in the Whitman, Butte, and Livingston county sites, current clients of Cooperative Extension for advice on fertility or pest-control practices were more likely to support the proposal, other variables held constant (Table 5.3). Presumably, these farmers were more supportive because they currently benefited from the results of federal research, as communicated to them by Extension. An opposite result would have suggested either that clients thought little of the assistance they received or that they were the wrong farmers to target with advice on reducing chemical use. Instead, our analyses for three sites indicate that Extension is a good vehicle for disseminating research findings because many of its current clients are receptive to it. The agency will not have to cultivate an entirely new clientele for practices that reduce the use of chemicals.

In two sites (Whitman and Dooly counties), the respondent's educational level also made a significant difference. The more years of formal education, the more likely the farmer was to favor the proposal. Presumably, better-educated farmers were more likely to appreciate the potential usefulness of dollars spent on research.

The second proposal (Policy Option 2) addressed the question of access to information. Half or more of the respondents in all five sites felt that the Cooperative Extension Service should provide farmers with better access to information on ways to improve farm profitability through reducing their use of agricultural chemicals and fertilizer (Table 5.2). In four sites "favor moderately" or "favor strongly" responses came from 77% to 84% of the respondents. In the case of Butte County, they came from 50%. The regression analyses found that in two survey sites (Butte and Livingston counties), current clients of Extension were more likely to approve the proposal. These findings suggest that clients wanted information on how to economize on chemicals because as current clients they trusted Extension to provide useful information.

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[1]The exact wording of the interview questions we asked for each policy option is provided in Tables 5.2, 5.4, 5.5, and 5.6. Some of our questions about policy options were long and complex. However, since the interviews were conducted in person, we used visual aids to help farmers understand the statements of the options. Respondents received each question on a card and could follow along as the interviewer read the question aloud.

In two sites (Livingston and Dooly counties), the predicted relationship between age and interest in reduced-input practices emerged. Younger farmers were more likely to support the proposed policy.

The third proposal (Policy Option 3) was a follow-up to the second. We asked farmers whether they would support Extension's efforts to provide more information about reducing chemical inputs even if the advice resulted in lower crop yields. This option was much less popular. In all five sites majorities of 51% to 82% opposed it moderately or strongly (Table 5.2). The highest levels of support came from Whitman, Renville, and Livingston counties (43% to 49%). Support might have been greater if the question had included the qualifier that net profits might not go down if lower input costs compensated for lower yields (Shearer et al., 1981). Alternatively, farmers may be willing to accept some loss of profit in exchange for nonmonetary benefits, such as protection from groundwater contamination, but we found evidence that farmers were interested in that type of trade-off only in the Whitman County site. There, respondents who believed that the county had groundwater pollution problems were more likely to support a program of technical assistance even if the advice resulted in reduced yields (Table 5.3).

Incentives for Reducing Chemical Inputs

We asked farmers to respond to two positive incentives for reducing chemicals. The first incentive (Policy Option 4) was a bonus that the federal government would pay farmers on top of the benefits they currently received from the commodity program if they reduced their use of chemicals. The bonus proved to be moderately popular. In Renville and Dooly counties, majorities of 56% and 62%, respectively, supported it. Elsewhere, substantial minorities of 37% to 49% favored it (Table 5.4). Given the same respondents' apparent enthusiasm for research and technical assistance for reduced-input practices, we are somewhat puzzled by the modest degree of approval for the bonus. Perhaps some farmers are suspicious of tinkering with the commodity program benefits. They may fear that dollars allocated to promoting economies in the use of chemicals will be taken away from existing benefits.

The regression findings are too scattered to help much in explaining the farmers' attitudes towards the bonus proposal, except that in Whitman and Butte counties, recent clients of Extension were more likely to support the policy (Table 5.3).

The second incentive (Policy Option 5) was a form of crop insurance that federal programs would provide to protect farmers against potential declines in yields if they reduced their use of agricultural chemicals. The insurance proposal was somewhat more popular than the bonus; 51% to 60% of the respondents in four sites reacted favorably (Table 5.4). This level of support is probably high enough to justify exploring the proposal further. Farmers probably want details, such as what the premiums will cost and what circumstances will trigger insurance payments. Obviously, farmers need not be compensated when savings from reducing the use of chemicals offset the money lost from lower yields.

Results of our regression analyses were scattered except that in Whitman and Butte counties recent clients of Cooperative Extension were more likely than nonclients to support the insurance proposal. Possibly, clients had more exposure to discussions of the need for action, or they had greater trust that USDA action would yield something useful.

Proposed Regulatory Approaches to Preventing Excessive Use of Chemicals

Four questions dealt with regulatory approaches to limiting the use of agricultural chemicals and fertilizers. The first (Policy Option 6) asked respondents whether they would favor a policy that withdrew federal farm program benefits from farmers who used chemicals excessively. Committees of farmers and agronomists would determine regional standards for excessive applications. Potentially a very restrictive policy, this option received substantial support only in the two Midwestern sites, where 49% to 52% favored it. Elsewhere, support ranged from 21% to 27% of the respondents (Table 5.5).

Our regression analyses suggest two reasons that farmers supported the withdrawal of benefits for excessive use of chemicals (Table 5.3). Approval was more likely in Butte and Renville counties if farmers believed that agricultural chemicals had contaminated groundwater somewhere in the county. Perhaps such farmers were willing to lose some operational independence to prevent the pollution problem from becoming worse.

In Whitman and Butte counties support was relatively higher among older farmers. Perhaps they were mollified by the provision that the regulations would be made by committees whose farmer membership would probably consist of experienced operators like themselves.

The next two questions concerned regulatory policies that would go into effect only if agricultural chemicals were actually found in groundwater. First, we asked respondents whether eligibility for farm program benefits should depend on farmers' having an approved plan for managing pesticide use when tests disclosed pesticides in their wells (Policy Option 7). Even though this option was conditional on the discovery of pesticides in the farmer's own drinking water, majorities of respondents opposed it in all five survey sites (52% to 79%, Table 5.5). However, substantial minorities in Renville, Livingston, and Dooly counties supported in (41% to 48%).

The next regulatory option (Policy Option 8), which was similar but more specific, received greater support in all five sites. We asked farmers whether they would favor government restrictions on the use of chemicals on farms with "clear evidence" of groundwater contamination. Sixty-five percent of the Livingston County sample favored this option, as did 38% to 51% of the respondents in three other sites (Table 5.5). The fact that approval levels were slightly higher for this regulatory option than the first one in Renville and Dooly counties may represent random influences. However, the differences of nine to 23 percentage points in the other three samples probably indicate that farmers there really found the wording of the second option more to their liking. Perhaps, the key difference is that the second option called for regulation based on clear evidence of groundwater contamination, but the first based regulation on an unspecified level of pesticides in the well. That level could be so small that farmers might go to the trouble of developing a plan, obtaining approval, and implementing it without significant benefit to their families.

Our regression findings indicate that Butte and Renville county farmers were more likely to accept regulation if they believed that groundwater in their counties was contaminated from agricultural chemicals. Such farmers were also more likely to accept the first regulatory option (Table 5.3). This association emerged in another study of farmers (Esseks et al., 1989) and suggests that, in areas where regulations are really needed to protect groundwater, farmers can be persuaded to accept restrictions on their use of chemicals if they are first persuaded that the threat to public health is significant.

Related to the three regulatory options was a fourth question (Policy Option 9), which asked farmers whether they favored systematic federal testing of all drinking water wells on all farms. Majorities of 51% to 62% supported this policy in Renville, Livingston, and Dooly counties, but only 31% and 28%, respectively, favored it in Whitman and Butte counties (Table 5.5). Some farmers may oppose comprehensive testing out of concern that they would end up paying for it; others may see it as a basis for unwanted government regulation. The question's placement in the interview clearly indicated that the testing would be used for regulating.

Regression analyses in two sites (Whitman and Livingston counties) indicate that recent clients of Cooperative Extension were more likely to support systematic testing of wells. Perhaps clients were more trusting of USDA's purposes in doing the testing.

Modifying the Commodity Programs to Encourage Planting Rotational Crops

The last four policy options we presented concerned modifications in the federal commodity programs designed to encourage farmers to reduce their use of chemicals by planting rotational crops such as alfalfa. Farmers know that if they plant rotational crops on more land than is required for set-asides, they will normally lose part of their crop base. The loss in base is not just for the one year. It affects as many years as are used for computing the base, generally the average of the previous five years' acres planted to the crop in question. The commodity program benefits of deficiency payments and loans (with crops as collateral) are based on those averages plus the proven yields for those acres. These disincentives to planting rotational crops may cause higher applications of synthetic fertilizers, because nitrogen is not added through rotations, and greater use of pesticides, because of the need to cope with pests that thrive in monocultural environments (U.S. House of Representatives, 1988).

The first modification to the commodity programs (Policy Option 10) asked farmers whether they would favor a policy that allowed them to plant more acreage in rotational crops without losing their base. This option proved to be the most popular of all. Across the five sites from 75% to 90% of the respondents supported it, and in four sites majorities favored it strongly (Table 5.6).

The second proposal was somewhat less popular (Policy Option 11). We asked farmers whether they would favor a bonus on top of their program benefits if they planted more of their base acreage in rotational crops than is already required for set-asides. In four sites majorities of 59% to 79% favored this proposal, and 36% did in the California site (Table 5.6). The regression findings for this option indicate that in three sites support was greater among younger farmers (Table 5.3). Perhaps they were more supportive because, compared to older farmers, especially those near retirement, they were more willing to change their own mixes of crops. Another variable associated with support of this option in more than one site was level of education. In the two Midwestern survey areas, the higher the level of education, the more likely the farmer was to favor the bonus.

The third proposal for modifying the commodity programs proved to be very unpopular (Policy Option 12). Respondents did not favor a policy that would penalize farmers for failing to plant part of their base acreage in rotational crops. Across the five survey sites 69% to 93% of the respondents opposed this proposal (Table 5.6).

By contrast, the fourth proposal received considerable support (Policy Option 13). In four sites majorities or a near-majority (47% to 70%) believed that payments under the commodity program should be made on some other basis than the volume of a commodity produced. In Butte County a third approved of this policy, sometimes called decoupling. We assume that the supportive farmers particularly liked the idea of greater freedom to choose the crops to plant. However, further survey work will probably be needed. Since farmers' acceptance of decoupling will ultimately depend on the criteria for determining income support that will replace base acreage and proven yields, future surveys should obtain farmers' reactions to a selection of such criteria.

The limited support for decoupling in the California site was consistent with its responses to other policy options. Farmers in the Butte County sample gave the lowest combined percentages of "moderately favor" and "strongly favor" responses to 12 of the 13 policy proposals presented in the interviews, and they were second lowest in the one others. This pattern may reflect a conservative political culture or a strong reluctance to alter the financial status quo. Farmers in this sample relied very heavily on one federally protected crop, rice. Two-thirds of them grew only that crop.

In the two Midwestern sites, support for decoupling was greater among farmers who believed that agricultural chemicals contaminated groundwater in their counties (Table 5.3). These findings suggest that at least some farmers wanted a change for the possible environmental benefits, not just for the greater degree of freedom in deciding what crops to plant.

The variable that measured awareness of agricultural contamination of groundwater proved to be rather helpful in explaining farmers' support of the proposed policies. It was significantly associated in the predicted direction in Renville County for five policies, in Butte County for three, and in Whitman and Livingston for two (Table 5.3). These associations suggest that environmental concerns are shaping at least some farmers' assessments of policy proposals. Public agencies trying to promote policy changes may be able to tap into those concerns in order to marshall sufficient support for the changes.

Summary and Policy Inferences

Our survey found substantial support from farmers for six proposed federal government policies. In at least four of our five sites, majorities or near-majorities of the respondents (45% to 50%) favored the proposals. In all five sites majorities (54% to 83%) supported the proposal to increase the share of the federal budget devoted to research into economical ways to reduce the use of agricultural chemicals. A second policy received support from half or more of the respondents in all five sites (50% to 84%)--the proposal that the Cooperative Extension Service give farmers more information on ways to improve profitability through decreasing their use of chemical inputs.

Another proposal with substantial support--from 51% to 60% of the respondents in four survey areas--provided for the creation of an insurance program that would encourage farmers to reduce their use of chemicals. Compensation would be paid if producers suffered financially from yield losses caused by decreases in the amount of chemicals they applied. Another incentive proposal that was popular in four sites--supported by majorities of 59% to 79%--was a bonus program to encourage farmers voluntarily to increase the amount of their base acreage for federal commodity programs planted to rotational crops such as alfalfa or other crops that are not high users of chemicals.

The most popular option, favored in all sites by majorities of 75% to 90%, was to change the commodity programs to permit farmers to plant more land to rotational crops without losing the acreage base from which financial benefits are calculated. Another proposal with largely the same purpose--to divorce income-support payments from the volume of commodities produced--was considerably less popular, although it gained the support of majorities of 54% to 70% in three sites and a near-majority (47%) in a fourth. The decisive difference in the popularity of these two proposals may be that farmers do not think that the first will significantly affect levels of support, but the second would throw out a basis for calculating payments that many producers have built up over time and whose demise would introduce considerable uncertainty.

In explaining why farmers favored proposals, we note the importance of being a recent client of the Cooperative Extension Service (Table 5.3). Clients of Extension were more likely to support nine of the 13 policies in Butte County, four in Whitman County, and three in Livingston County. Either contact with Extension encourages a positive orientation towards such practices, or, in the event that this orientation predates contact, Extension can build on it. Either way, these findings indicate that Extension should contribute significantly to the promotion of reduced-input technologies.

Another trait associated with support for proposed policies was a concern about the negative effects of agricultural chemicals on local groundwater. In four of the five sites 38% to 62% of the respondents had this concern, and in those four sites it was associated with support of from two to five of the policies proposed in the interview. Since groundwater contamination from farming is not that rare (Hallberg, 1987; Lee and Nielsen, 1987), agencies trying to marshall support among farmers for programs to economize on the use of chemical inputs may be able to build upon the concern that many farmers have about it.

One trait that explained little about attitudes towards the proposed policies was the respondents' classification of themselves as low-input, sustainable, organic, or conventional farmers. In none of the sites was self-classification as a nonconventional farmer associated with support of more than two policies; in the Dooly County sample, it was related to *opposing* four policies. For none of the proposals (not even the ones to increase government research and technical assistance for reduced-input practices) were nonconventional farmers significantly more supportive in more than one of the five sites. Since these labels were no better predictors of attitudes than they were of the use of farming practices, we should either develop new ones or perhaps dispense with them altogether. This subject may be too complex and may stir too many emotions for labels to be consistent guides to behavior or opinions.

Tables for Chapter 5

Table 5.1

Respondents' Participation in Federal Commodity Programs, 1986-1988

Commodity Program	Percentage of Participants				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Wheat program	97	15	70	1	49
Corn program	0	1	95	97	23
Other feed grains programs	93	5	13	0	11
Cotton program	0	0	0	0	81
Rice program	0	90	0	0	0
Honey program	0	0	0	0	0
Other commodity-specific programs	4	2	4	1	11
Participated in any of the above	97	94	97	97	88
Total respondents	(109)	(100)	(114)	(92)	(73)

Table 5.2

Farmers' Opinions of Research and Technical Assistance Policy Options for Reducing the Use of Agricultural Chemicals and Fertilizers

Policy Options	Percentage of Farmers				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 1. Would you support a proposal that a greater portion of the U.S. government's total budget be devoted for research into economical ways to reduce the use of agricultural chemicals (herbicides, insecticides, and nematocides)? By economical ways, we mean ways to reduce use without reducing farm profitability.					
Oppose strongly	5	27	7	5	18
Oppose moderately	17	18	10	12	15
Favor moderately	51	41	62	58	37
Favor strongly	26	13	21	25	30
No response	1	1	0	0	0
Favor mod./strong	76	54	83	83	67
Policy Option 2. Some people think that government agencies such as the Cooperative Extension Service should provide farmers with more information on economical ways to reduce their agricultural chemical use. Do you think the Cooperative Extension Service should provide farmers with better access to information on ways to improve farm profitability by reducing their agricultural chemical and fertilizer use?					
Oppose strongly	4	29	5	7	12
Oppose moderately	19	19	11	14	7
Favor moderately	57	37	61	52	47
Favor strongly	20	13	23	26	34
No response	0	2	0	1	0
Favor mod./strong	77	50	84	78	81
Policy Option 3. Would you support the Cooperative Extension Service's efforts to provide this information [on ways to economize on chemicals] even if the advice they provided regarding reduced agricultural chemical and fertilizer use resulted in lower crop yields?					
Oppose strongly	21	56	25	16	57
Oppose moderately	34	21	32	35	25
Favor moderately	35	17	34	47	15
Favor strongly	11	4	9	2	3
No response	0	2	0	0	0
Favor mod./strong	46	21	43	49	18
Total respondents	(109)	(100)	(114)	(92)	(73)

Table 5.3

Traits of Farmers or Their Operations Found to Be Associated with Support of Proposed Government Policies for Reducing the Use of Agricultural Chemicals and Fertilizers[1]

Policy Options	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 1. Greater federal funding of research into economical ways to reduce use of agricultural chemicals.	EDUC (10)[3] EXTENS (13)	EXTENS (12) -LVSTOCK (25)	-INCOME (1) LVSTOCK (13)	CHMPRB (12) EXTENS (10)	EDUC (4) -CLASSIF (54)
Policy Option 2. Extension provides better access to information on ways to improve farm profitability through reduced use of chemical inputs.	CLASSIF (28)	EXTENS (21)	——	-AGE (12) EXTENS (11) -INCOME (4) -LVSTOCK (5) PCTINC (10)	-AGE (27) -CLASSIF (40)
Policy Option 3. Extension provides such information even if the consequence is lower crop yields.	CHMPRB (27) CLASSIF (34) -LVSTOCK (24)	EXTENS (13)	——	-PCTINC (16)	-EDUC (6)
Policy Option 4. U.S. government pays bonus on top of current commodity program benefits if farmer reduces use of chemical inputs.	EXTENS (25)	CHMPRB (16) EXTENS (19)	-INCOME (9)	——	-CLASSIF (40)

Table 5.3 continues

Table 5.3 continued

Policy Options	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 5. Government establishes specific crop insurance to protect against yield losses because of reductions in chemical inputs.	EXTENS (17)	EXTENS (23) -INCOME (22)	CHMPRB (25) -EXTENS (20) -PCTINC (11)	——	——
Policy Option 6. Farmer becomes ineligible for commodity program benefits if chemical applications exceed set limits.	AGE (19) CONSERVE (17)	AGE (23) CHMPRB (33)	CHMPRB (17) -INCOME (19)	-PCTINC (13)	ROTATE (25)
Policy Option 7. If pesticides found in well water, farmer must have an approved plan for managing pesticides or lose farm program benefits.	——	CONSERVE (37) -EDUC (31) EXTENS (45)	-AGE (19)	——	——
Policy Option 8. Government restricts fertilizer and pesticide use if clear evidence of groundwater contamination.	CONSERVE (16) IPM (15)	CHMPRB (27) EXTENS (22)	CHMPRB (16) CLASSIF (3) -ROTATE (36)	CLASSIF (26) -IPM (19)	-PCTINC (10)

Table 5.3 continues

Table 5.3 continued

Policy Options	Statistically Significant Traits[2]				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 9. Systematic testing by federal government of all drinking wells on all farms.	EXTENS (25)	CLASSIF (34)	-INCOME (13)	EXTENS (16)	AGE (6) CHMPRB (27)
Policy Option 10. Change commodity program to permit planting more acreage in rotational crops without losing base.	——	-AGE (5) EXTENS (21)	EDUC (5)	——	-AGE (11)
Policy Option 11. Bonus on top of program benefits if farmers plant more base acreage to rotational crops.	-AGE (17) LVSTOCK (63)	-AGE (45) EXTENS (49)	CHMPRB (18) -CONSERVE (21) EDUC (11)	EDUC (6)	-AGE (40) -CLASSIF (10) CONSERVE (20)
Policy Option 12. Penalties if farmers do not plant more base acres to rotational crops.	CHMPRB (12)	——	CLASSIF (16)	LEGUMES (17) -LVSTOCK (35)	CONSERVE (14)
Policy Option 13. Commodity program payments based on criteria other than volume of crops produced (decoupling).	-AGE (14) CONSERVE (16)	-PCTINC (11)	CHMPRB (11)	CHMPRB (29)	EXTENS (26)

Table 5.3 continues

Table 5.3 continued

[1]Associated means that logistic regression coefficients measuring the presence of a relationship between a trait and a practice were statistically significant in a t-test at the 0.1 level for one-tailed tests and at the 0.05 level for two-tailed tests.

[2]The numbers in parentheses indicate the percentage-point change in the estimated probability of supporting the indicated proposal, when a dichotomous explanatory variable is changed from its positive to its negative value or when an interval-level variable is changed from its 25th- to its 75th-percentile value, with the other variables held constant.

[3]Traits are defined as follows:

AGE:	farmers' age in years.
CHMPRB:	farmers did or not believe that agricultural chemicals had contaminated drinking water in their county.
CLASSIF:	respondents did or did not classify themselves as low-input, organic, or sustainable farmers.
CONSERVE:	farmers did or did not participate in recent years (1986-88) in either the Conservation Reserve Program or the Agricultural Conservation Program.
EDUC:	farmers' years of formal education.
EXTENS:	farmers did or did not consult the Cooperative Extension Service on insect problems or fertility practices.
INCOME:	farmers' 1988 gross revenues from agriculture, including government payments.
IPM:	farmers did or did not follow an integrated pest management program in 1988.
LEGUMES:	farmers did or did not have legume-based rotations.
LVSTOCK:	farmers did or did not raise, feed, pasture, or purchase at least 10 animals for commercial purposes in 1988.
PCTINC:	percentage of farmers' 1988 family income derived from agriculture.
ROTATE:	farmers did or did not supply nitrogen to primary or secondary crop at least in part through rotating it with a leguminous crop or some other kind of rotational crop.

Table 5.4

Farmers' Opinions of Proposed Positive Incentives for Reducing Use of Agricultural Chemicals and Fertilizers

Policy Options	Survey Site				
	Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 4. Would you be in favor of a proposal that the federal government would pay farmers a bonus on top of their current commodity program benefits if they apply practices that reduce their use of agricultural chemicals and fertilizers?					
Oppose strongly	30	47	16	17	21
Oppose moderately	33	10	28	34	17
Favor moderately	24	28	38	35	36
Favor strongly	13	10	18	14	26
No response	0	5	0	0	1
Favor mod./strong	37	38	56	49	62
Policy Option 5. Would you reduce your agricultural chemical use if federal programs provided specific crop insurance to protect against potential declines in yields on that acreage because of the reduced agricultural chemical use?					
Oppose strongly	15	48	22	12	22
Oppose moderately	33	19	24	37	18
Favor moderately	37	20	37	33	35
Favor strongly	14	8	17	18	25
No response	1	5	0	0	0
Favor mod./strong	51	28	54	51	60
Total respondents	(109)	(100)	(114)	(92)	(73)

Table 5.5

Farmers' Opinions of Proposed Regulatory Approaches for Reducing Use of Agricultural Chemicals and Fertilizers

Policy Options	Survey Site: Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 6. Would you be in favor of a proposal in which the federal government penalizes farmers who apply excessive amounts of agricultural chemicals? A committee of farmers and agronomists from each production region would decide what constitutes an excessive amount of chemicals. The penalty would be withdrawing farmer's eligibility for federal farm program benefits.					
Oppose strongly	45	64	24	27	59
Oppose moderately	26	15	24	24	15
Favor moderately	23	12	29	33	15
Favor strongly	4	9	23	16	11
No response	1	0	0	0	0
Favor mod./strong	27	21	52	49	26
Policy Option 7. Do you favor the proposal that a farmer's eligibility to receive federal farm program benefits should require that he/she have an approved plan for managing pesticide use if pesticides have been found in his/her well water?[1]					
Oppose strongly	42	73	35	36	41
Oppose moderately	29	6	24	22	11
Favor moderately	22	14	26	25	26
Favor strongly	7	2	15	17	22
No response	0	5	0	0	0
Favor mod./strong	29	16	41	42	48
Policy Option 8. Would you favor government restrictions of fertilizer and pesticide use on farms where there is clear evidence of groundwater contamination?					
Oppose strongly	25	52	19	10	22
Oppose moderately	36	20	38	25	27
Favor moderately	24	22	31	43	29
Favor strongly	14	3	12	22	22
No response	1	3	0	0	0
Favor mod./strong	38	25	43	65	51

Table 5.5 continues

Table 5.5 continued

Policy Options	Survey Site: Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 9. Do you favor systematic testing by the federal government of all drinking water wells on all farms?					
Oppose strongly	41	58	24	18	20
Oppose moderately	28	14	25	27	18
Favor moderately	28	24	36	35	37
Favor strongly	3	4	15	20	25
Favor mod./strong	31	28	51	55	62
Total respondents	(109)	(100)	(114)	(92)	(73)

[1]The statement below was given to respondents as a preface to this question and the following one.

> In response to concern about drinking wells being contaminated from agricultural chemicals, some people suggest that USDA require mandatory testing of any commodity producer's well for pesticide contamination before he can receive any benefits from federal farm programs. If the test identifies pesticides in the water, the farmer would have to adopt an approved plan for managing pesticides in order to retain his eligibility for federal programs.

Table 5.6

Farmers' Opinions of Proposed Policies to Promote Higher Plantings of Rotational Crops by Participants in Federal Commodity Programs

Policy Options	Survey Site: Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 10. Would you favor a change in the USDA commodity programs which would permit farmers to plant more acreage in rotational crops without losing their base?[1]					
Oppose strongly	7	17	3	3	6
Oppose moderately	5	6	8	7	7
Favor moderately	23	30	33	25	34
Favor strongly	65	45	56	65	53
No response	0	2	0	0	0
Favor mod./strong	88	75	89	90	87
Policy Option 11. Would you favor a change in the USDA commodity programs that offers farmers a bonus on top of their program benefits if they plant more of their base acreage in rotational crops than is already required for set-asides?					
Oppose strongly	14	42	11	6	12
Oppose moderately	25	16	10	21	11
Favor moderately	39	24	46	39	47
Favor strongly	20	12	33	34	30
No response	2	6	0	0	0
Favor mod./strong	59	36	79	73	77
Policy Option 12. Would you favor a change in the USDA commodity programs that would penalize farmers for failing to plant part of their base acreage in rotational crops? (That is, farmers would be required to plant a rotational crop to avoid any penalty.)					
Oppose strongly	52	79	33	38	69
Oppose moderately	33	14	36	35	23
Favor moderately	10	1	25	17	7
Favor strongly	5	2	6	10	1
No response	0	4	0	0	0
Favor mod./strong	15	3	31	27	8

Table 5.6 continues

Table 5.6 continued

Policy Options	Survey Site: Whitman County (WA)	Butte County (CA)	Renville County (MN)	Livingston County (IL)	Dooly County (GA)
Policy Option 13. Some people believe that the government should use a different approach to farm support programs. Today, farmers receive payments based on the volume of a commodity produced. Under the alternative, farmers would receive payments on some different basis--possibly based on past payments or some other criteria--thus allowing the farmer to plant whatever he wishes. (This is sometimes referred to as "decoupling.")					
Oppose strongly	11	42	15	18	40
Oppose moderately	29	19	15	28	12
Favor moderately	48	26	48	44	26
Favor strongly	9	7	22	10	21
No response	4	6	0	0	1
Favor mod./strong	57	33	70	54	47
Total respondents	(109)	(100)	(114)	(92)	(73)

[1]The statement below was given to respondents as a preface to the four questions in Table 5.6.

> Some people believe that the current USDA commodity programs discourage farmers from planting rotational crops like alfalfa or other legumes that use little chemicals because, if they plant them on more land than is already required for set-asides, the farmer loses part of his/her crop base.

Appendix

Explanation of Variables Used in Logistic Regression Analysis

1. **Type of Primary and Secondary Crop** (Table 2.3).

2. **Age** (Table 2.4). Intuition suggests that interest in nonconventional farming practices may be more likely among younger farmers, who we assume are less set in their ways. Moreover, farmers close to retirement may believe that they could not realize an adequate return on their investment of time and money in new practices before they quit farming.

3. **Years of Formal Schooling** (Table 2.4). We included this variable because reduced-input practices may require more management skill than do conventional farming techniques (Carlson and Dillman, 1988), and educational attainment was our only available proxy variable for such skill. The key ingredient for success in alternative or sustainable agriculture may be the substitution of management skills for chemical inputs (Lockeretz, 1988; Madden, 1989).

4. **Size of Operation Measured by Gross Farm Revenues** (sales plus government payments, if any). Since low-input practices may require relatively high managerial skills, and farmers of larger operations may be more likely to have or to hire such skills, we hypothesized that the larger the farm operation, as measured by gross farm revenues, the more likely certain low-input practices would be used.

5. **Percentage of Family Income Derived from Agriculture** (Table 2.4). Compared to conventional farming methods, certain reduced-input practices may involve some loss of income. Therefore, we hypothesized that the less operators depend on farm income, the more likely they are to risk such losses because they have revenues from alternative sources.

6. **Number of Family Members Working on the Farm** (Table 2.4). Certain practices with the potential for reducing chemical inputs may require relatively high labor inputs. For example, hay or forage crops may have to be harvested at the same time as cash crops. We took the number of family members who worked on the farm in 1988 to be a measure of the availability of cost-effective labor. Of course, a farmer may hire labor, but since family workers tend to cost less, we assumed that their availability would influence farmers to use labor-intensive practices more than would the availability of the same number of nonfamily wage workers.

7. **Debt as a Percentage of Total Farm Assets** (Table 2.4). Since the use of certain potentially low-input practices carries financial risks, we assumed that farmers with relatively low debt-to-assets ratios would consider themselves better able to run such risks.

8. **Presence or Absence of a Commercial Livestock Component to the Farm Operation** (Table 2.4). Use of rotations to control pests or increase fertility may be more likely if the farm operations include a livestock enterprise because the animals provide a commercial use for certain rotation crops. Of course, farmers may follow rotations that involve only cash crops such as corn and soybeans.

9. **Attitude towards Conservation** (Table 2.4). We measured this attitude by whether respondents had recently (1986-88) participated in either of two voluntary conservation programs: the Conservation Reserve Program (CRP), whereby landowners retire highly erodible land for ten years in exchange for annual rents paid by USDA, or the Agricultural Conservation Program (ACP), under which farmers receive cost-sharing assistance for applying approved conservation measures independent of the CRP. A previous survey indicated that participants in the CRP tended to be motivated at least in part by conservationist values (Esseks and Kraft, 1986). Similar motives may shape participation in the ACP. Even if they do not, farmers taking part in either program normally have contacts with USDA personnel and literature that should heighten their awareness of soil and water conservation problems.

10. **Concern about Agricultural Contamination of Local Groundwater** (Table 2.4). We measured such concern by whether the respondent believed that agricultural chemicals or fertilizers had polluted drinking water anywhere in the county. Across the five survey sites, from 17% to 62% believed that they had. A prior survey found that farmers with such perceptions were more likely to favor research and technical assistance for reducing the use of chemical inputs (Esseks et al., 1989).

11. **Type of Farmer** (Table 2.5). We asked farmers to place themselves in one of the following categories:

> **Low-Input Farmer.** Farmers who attempt to reduce their use of inputs such as chemicals and fertilizers purchased off the farm.
>
> **Sustainable Farmer.** Farmers who attempt to develop a balanced agricultural system by adjusting their use of inputs, their crops, and their livestock in recognition of the ecology of their farmland.
>
> **Organic Farmer.** Farmers who avoid use of any synthetic or manufactured substances in growing their crops and managing their land.
>
> **Conventional Farmer.** Farmers who follow standard recommended practices in tillage systems, fertility management, and the control of pests.

Across the five survey sites from 55% to 86% of the farmers we interviewed classified themselves as conventional farmers. Only one operator in one site (Renville County) called himself an organic farmer. In only one survey area, Whitman County, did the respondents labeling themselves low-input or sustainable farmers comprise as much as one-third of the sample. Elsewhere, these two groups ranged from 12% to 19%. We hypothesized that respondents classifying themselves as low-input, sustainable, or organic farmers were more likely to use practices that substitute for chemical inputs or to use analytical methods (such as plant tissue tests) that provide information for minimizing chemical applications.

12. **The *Information Sources on Farming* Practices That Respondents Rated Highly** (Table 2.6). Previous studies indicated that the most influential change agents in the adoption of new technologies tend to be individuals with whom farm operators talk or whose directly observed examples they follow (Brown, 1981; Rogers, 1983). Therefore, we hypothesized that farmers who rated USDA personnel as their most- or second-most important source of information on tillage and cultivation practices for their primary crops were more likely to use practices with the potential for reducing chemical inputs than

were respondents for whom USDA personnel were less important.[1] In Whitman and Dooly counties, significant percentages of the respondents--25% and 43%, respectively--ranked USDA personnel first or second in this respect. Elsewhere only 5% to 19% ranked USDA staff so highly (Tables 2.4 and 2.7). Although we lacked data on the extent that USDA personnel in these five counties were providing information on low-input methods, we assumed that they were more likely to provide it than were private sources, especially fertilizer and pesticide dealers or applicators. Across the five sites, 31% to 65% of the respondents ranked these private-sector sources first or second in importance (Tables 2.4 and 2.7).

For the regression analysis of fertility and insect control practices, we use more direct indicators of the information roles of both dealers and the Cooperative Extension Service. Those indicators are discussed in Chapters 3 and 4.

13. **The Importance of Federal Farm Program Benefits to the Farmer** (Table 2.8). A recent study by the National Research Council (1989) on alternative agriculture argued that current federal commodity programs are obstacles to the adoption of alternative agricultural practices. Since program benefits are based on the average number of acres planted in recent years and on proven yields, program participants are encouraged to maximize plantings of the program's cash crops and the yields realized with those crops. We could not use program participation as a causal variable because there was almost no variation in the variable. That is, 88% to 97% of our respondents participated. We used another variable, instead. We provided respondents with a list of eight factors and asked which ones had influenced their decision about which crops to grow on their farms. From 73% to 82% said that the availability of federal farm program benefits was an influential factor (Table 2.8). From 9% to 29% reported it to be the single most important factor, and 13% to 29% ranked it second (Table 2.9). For the regression analyses, we used the dichotomous variable, did or did not rank these benefits first or second.

For each statistically significant variable, we report our best estimate of its quantitative impact on the use of a practice. That impact can be measured as the change in the probability of using a farming practice when we vary the statistically significant variable and hold constant all the others in the final equation. For example, if being a client of USDA makes a difference, we compare the estimated probability of using a practice if farmers were clients (let us say, it is 50%) to the probability if they were not (let us say, 40%), while not changing any of the other variables, The difference in those two probabilities would be the estimated effect of the change in the one variable that was allowed to vary (in this hypothetical case, that effect would be 10 percentage points; being a USDA client made an estimated 10 percentage point difference in the likelihood of using the practice).

[1]USDA personnel include staff of the Cooperative Extension Service, the Soil Conservation Service, and the Agricultural Stabilization and Conservation Service.

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