# Chapter 6

## Socioeconomic Analysis: National Institute of Food and Agriculture–Conservation Effects Assessment Project

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Economic factors play a key role in the implementation of agricultural conservation practices in the United States. Farming is a business, after all. But most farms are run by families, and families are part of communities. They are influenced by social factors, including status in the community and feelings and commitment to natural resource stewardship. Corporate (nonfamily) farms must also be aware of community norms. This chapter examines how socioeconomic factors have influenced the adoption, use, and maintenance of conservation practices in the National Institute of Food and Agriculture–Conservation Effects Assessment Project (NIFA–CEAP) watersheds and draws lessons from those observations. This chapter begins with a brief literature review to summarize the current status of socioeconomic research relative to conservation practice adoption, and this is followed by an overview of the role of socioeconomic research and outreach in the 13 NIFA–CEAP watershed studies. Research conclusions, lessons learned, and recommendations are then identified based on activities in the projects and the literature review. Information drawn from the key informant surveys (Chapter 2) is integrated when appropriate.

### Economic Considerations of Conservation

Three basic types of economic analyses are commonly found in the conservation literature. The first type is a cost-benefit analysis (CBA) of a specific conservation practice regime. Costs and benefits of adopting a given practice or set of practices can be calculated at the farm, enterprise, or conservation practice (partial budgeting) level. Usually, this is accomplished using an enterprise or whole-farm analysis approach. The general purpose of this type of analysis is to indicate the cost or return of adopting a given practice or set of practices. Sometimes risk is tied to the CBA. Most of the studies can be grouped under the stochastic efficiency framework. Fathelrahman et al. (2011), for example, compared profitability and risk for conventional tillage to conservation and no-tillage systems using 14 years of corn and soybean plot data from the Northeast Research Station in Iowa. They reviewed and explained stochastic techniques for risk analysis, including stochastic dominance with respect to a function and stochastic efficiency with respect to a function. Stochastic techniques allow researchers to account for stochastic variations (fluctuations in results over time due to weather, for example) when comparing the desirability of one practice to another. The authors found that risk sometimes affected the rank-

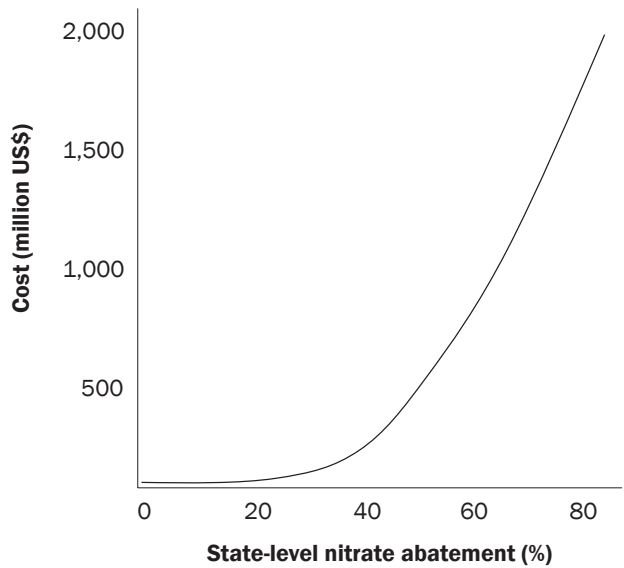
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ings and that the most preferred systems for corn and soybeans varied depending on whether the objective was returns over variable (operating) or total costs.

The second type of conservation study concerns optimization. Here, the objective can be based on economic costs or returns to reach some pollutant constraint or on the pollution that can be reduced given some level of cost or return. It is also possible to use multiobjective optimization techniques to maximize pollution reduction and profits simultaneously. A variant of optimization is to compare the tradeoffs between economic and pollution objectives, which can be identified at the farm or watershed scale. Usually, tradeoffs are mapped on a graph in a Pareto efficiency frontier (PEF). For example, Rabotyagov et al. (2010) used "modern multi-objective optimization tools, water quality modeling, and conservation practice cost data to develop a set of cost-efficient nonpoint source pollution reducing solutions." From this effort, the authors could build PEF at the watershed scale to help decision makers evaluate economic tradeoffs with pollution. For example, the PEF for nitrate reduction at the state level is presented in figure 6.1. A 50% reduction would cost about US$500 million, while an 80% reduction would cost nearly four times more (almost US$2 billion).

The third type of conservation study computes the amount a farmer would have to be compensated to be willing to adopt conservation practices; stated differently, what is the marginal economic incentive (MEI) required for change? Compensation can vary from cost sharing to direct subsidies. There are many studies on the economics of adoption (Lichtenberg 2004; Featherstone and Goodwin 1993; Noris and Batie 1987; Ervin and Ervin 1982), but very few examine how much financial incentive would be required to change a farmer's behavior. This

**Figure 6.1**
Production possibilities frontier of Iowa abatement costs curve for nitrates. Adapted from figure 4 of Rabotyagov et al. (2010).




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could be very important as Ryan et al. (2003) showed that subsidies alone were not enough to encourage adoption and that they did not create a long-term conservation ethic.

People place different values on what they need from conservation practices. Some people will install conservation practices even if it costs them to do so, while others require practices to pay for themselves. Most studies simply described what was known about adopters: younger, more educated farmers adopted more than their counterparts and farmers with more incentives adopted more than farmers with less incentives, etc. The extant economic literature has helped guide the decision-making process associated with conservation practice adoption. However, in some ways, the science must advance if it is going to inform projects as to what it will take to make conservation successful.

Little is known about the influence of costs on adoption or how farmers combine multiple practices. Some recent studies have estimated cost responsiveness. For example, Lohr and Park (1995), Cooper and Keim (1996), and Cooper (2003) used survey techniques that asked farmers to state their willingness to accept payments (such as government subsidies) to adopt farm management practices. Cooper and Sinorello (2008) found that farmers may require a supplemental premium to adopt a conservation plan, even when profits increased. The Lichtenberg (2004) study revealed preferences based on participation in a Maryland state cost sharing program. Revealed preference deduces a value from an action, while stated preference asks a person about that value. The Lichtenberg technique also facilitated examination of the adoption of multiple practices. He indicated that a 1% increase in the costs of waterways, strip cropping, and contour farming would reduce the probability of adoption on the order of 30% to 40%, while the same change in terraces and diversion would reduce the probability of adoption by 20% to 30%. The implication was that a subsidy would be very effective at encouraging farmers to adopt any of these practices.

All of these methods can benefit from or directly use information about the off-site costs of pollution. Costs or profits of adoption cannot be directly compared to the amount of pollution. However, off-site economic costs of many agricultural contaminants, such as sediment, nitrogen (N), and phosphorus (P), can be estimated. Hansen and Ribaudo (2008), for example, estimated the benefits that would occur from conservation practices by computing the off-site costs of erosion by dollar-per ton eroded for the entire United States. They estimated 14 different factors in three major categories: soil conservation impacts on water quality and the subsequent impacts on industries, municipalities, and households; the effect of wind erosion reductions on household cleaning costs; and soil productivity preserved through reductions in wind and water erosion. All 14 types of benefits from conservation practices are listed in table 6.1, along with the estimated cost per ton impact for each category.

Pulling together the economic factors relevant to conservation adoption implies the following three core considerations: (1) farmers are decision makers, but their actions impose costs on others through sediment, nutrients, and other pollutants; (2) farmers are more concerned with the impacts on their farms than with off-farm impacts, but this differential greatly varies between farmers; and (3) the typical farmer will require some financial incentive to adopt conservation practices. Economic studies have identified and measured the costs or profits of conservation practices, but little is known about the exact amount or type of assistance, financial or otherwise, that it would take to convince a farmer to use conservation practices.

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**Table 6.1**

Soil conservation benefits by category (adapted from Hansen and Ribaudo 2008)

| Categories | Consumer/farmer surplus | Level of aggregation | Range of value (US$ $tn^{-1}$)* | Year estimated |
|---|---|---|---|---|
| Reservoir services | Less sediment in reservoirs | HUC | 0 to 1.38 | 2007 |
| Navigation | Shipping industry avoidance of damages from groundings | HUC | 0 to 5.00 | 2002 |
| Water-based recreation | Cleaner fresh water for recreation | HUC | 0 to 8.81 | 1997 |
| Irrigation ditches and channels | Reduced cost of removing sediment and aquatic plants from irrigation channels | FPR | 0.01 to 1.02 | 2007 |
| Road drainage | Less damage to and flooding of roads | FPR | 0.20 | 1986 |
| Municipal water treatment | Lower sediment removal costs for water-treatment plants | FPR | 0.04 to 1.45 | 1989 |
| Flood damages | Reduced flooding and damage from flooding | FPR | 0.10 to 0.77 | 1986 |
| Marine fisheries | Improved catch rates for marine commercial fisheries | FPR | 0 to 0.93 | 1986 |
| Freshwater fisheries | Improved catch rates for marine recreational fisheries | FPR | 0 to 0.12 | 1986 |
| Marine recreational fishing | Increased catch rates for marine recreational fishing | FPR | 0 to 1.57 | 1986 |
| Municipal and industrial water use | Reduced damages from salts and minerals dissolved from sediment | FPR | 0.07 to 1.47 | 1986 |
| Stream protection | Reduced plant growth on heat exchangers | FPR | 0.04 to 1.05 | 1986 |
| Soil productivity | Reduced losses in soil productivity | FPR | 0.37 to 1.21 | 1990 |
| Dust cleaning | Decrease in cleaning due to reduced wind-borne particulates | FPR | 0 to 1.14 | 1990 |

Notes: HUCs = are watersheds defined by US Geological Survey's eight-digit hydrologic unit codes. FPRs = USDA's multistate Farm Production Regions.

* All US dollar values are per standard ton (not metric) and were adjusted to year 2000.

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## Social Considerations of Conservation

Many studies have looked at the socioeconomic factors that influence practice adoption. Three recent efforts reviewed and summarized the literature on the motives behind conservation adoption (Ahnstrom et al. 2009; Knowler and Bradshaw 2007; Prokopy et al. 2008). Ahnstrom et al. (2009) validated the idea that economic pressures worked against the application of conservation practices, as described above, and found one study that concluded profit motives were stronger than environmental motives. Economic cost or return was a factor widely mentioned in many sociological studies, but other factors can also influence adoption.

These three studies found few variables capable of describing adoption on a consistent basis. Prokopy et al. (2008) divided factors into four groups, as shown in table 6.2. Most variables did not have conclusive results. For example, 21 studies found that the size of farm had a positive influence on adoption, seven found it to be negative, and 21 found no influence. The few variables tending towards a strong correlation with adoption included education, farm size, access to information, and financial incentives. All three summary studies found social networks were important, and environmental awareness and attitudes toward stewardship and the environment were consistently associated with adoption. Knowler and Bradshaw (2007) concluded that "efforts to promote conservation agriculture will have to be tailored to reflect the particular condition of individual locales." Ahnstrom et al. (2009) agreed that conservation was best understood in the context of individual farmers. They provided a model that could inform decision makers about individual characteristics that influenced adoption. The model consisted of the farmers' characteristics, circumstances, and attitudes; available agricultural and environment schemes; and natural surroundings.

All of these studies share a focus on characteristics of adopters and nonadopters. Much like the economic literature, they generally do not address how socioeconomic variables would have to change in order to motivate a farmer to adopt conservation practices. However, as with the economic literature, a few examples could be found. For example, Ahnstrom et al. (2009) described who might be most receptive based on their interpretation of the literature. In a more rigorous effort, Hoag et al. (2004) used a traditional logit estimation approach to estimate the adoption of

**Table 6.2**
Hypothesized factors affecting adoption of conservation measures (adapted from Prokopy et al. 2008).

| Category | Subcategory |
|---|---|
| Capacity | [+] Farm size, education level, farm diversity, income, ownership, networking<br>[-] Age |
| Attitude | [+] Incentives, assistance, profitability, stewardship attitude, willingness to take risks |
| Environmental awareness | [+] Understanding of agriculture's impact on environment, consequences of degraded system, and knowledge to improve systems |
| Farm characteristics | [+] Proximity to rivers, slope<br>[-] Soil quality |

Note: A [+] or [-] sign indicates an expected positive or negative influence, respectively.

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**Table 6.3**
Predicted probability of manure use under various pressure and preference scenarios (adapted from Hoag et al. 2004).

| | Pressure variables combination | | | |
|---|---|---|---|---|
| **Preference variables combination** | **High corn/ high cattle** | **No corn/ high cattle** | **High corn/ no cattle** | **No corn/ no cattle** |
| High benefits/low problems | 0.985 | 0.898 | 0.920 | 0.612 |
| High benefits/high problems | 0.964 | 0.786 | 0.829 | 0.398 |
| Low benefits/low problems | 0.913 | 0.590 | 0.655 | 0.206 |
| Low benefits/high problems | 0.815 | 0.376 | 0.443 | 0.098 |
| Low versus high benefits effect* | 0.110 | 0.358 | 0.325 | 0.353 |
| Low versus high problems effect† | 0.059 | 0.163 | 0.152 | 0.161 |

* The entries in this row are the means, within the column, of the difference in predicted probability of row 1 versus row 3 and row 2 versus row 4. This gives an indication of the typical increase in predicted probability associated with the move from low benefits to high benefits, with other variables being equal.

† The entries in this row give the analogous computation for a move from high problems to low problems.

using manure for fertilizer. They computed the marginal change in probability for two economic variables, demand and supply, and two sociological variables, perceived positives and perceived negatives about using manure. The results (shown in table 6.3) indicate the probability of adoption for someone that has the most negative economic and social views of manure use (in the lower right corner), someone who has the best economic reasons and social views (in the upper left corner), and several combinations in between. The probability of adoption ranges from 0.16 to 0.98, respectively. The authors also computed the marginal change in probability given a change in any of the variables. They found that education about the positive benefits of manure could potentially move adoption more than education refuting any negative perceptions.

## Role of Socioeconomics in the National Institute of Food and Agriculture–Conservation Effects Assessment Project

All but two NIFA–CEAP watershed studies conducted either an economic study, a sociological survey, or both. The underlying socioeconomic theme was drawn from one of the core NIFA–CEAP objectives: What social and economic factors within the study watershed either facilitate or impede implementation or proper maintenance of conservation practices?

Eight of the thirteen projects conducted some type of economic analysis. Four studies estimated a PEF that mapped tradeoffs between an economic objective and a conservation objective, such as reducing nutrient delivery. Four studies conducted a CBA to evaluate a given set of practices for a given farming and land ownership scenario. Two of those studies used stochastic efficiency to examine the impact of risk. Eight studies also conducted sociological surveys. All of these studies looked at attitudes and adoption, and all but one focused on the watershed level. One project did not conduct any socioeconomic analysis. Another created a decision support system that included socioeconomic factors indirectly because the project was focused on determining the variables that influenced adoption and their relative weights.

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A summary of socioeconomic activities in the 13 NIFA–CEAP watershed studies is presented in table 6.4. Activities are broken down into economic and social projects where possible. A more comprehensive treatment of the details for each project can be found in Part II: Chapters 9 to 21 of this book.

## Results: Contributions to Knowledge/Science from Socioeconomic Research

### Economic

Three types of economic studies were found in the literature: CBA, PEF, and MEI. A study could also expand the scope of a CBA to include risk analysis with several stochastic efficiency methods, like stochastic dominance or stochastic efficiency with respect to a function. Many of the NIFA–CEAP studies applied CBA, stochastic efficiency, or PEF, but none looked at the MEI. In addition, none accounted for off-site costs.

The Cannonsville Reservoir Project in New York conducted a traditional CBA with increasing amounts of wet areas converted to buffers. While the practices were effective at reducing dissolved and particulate P loads, none of the practices were profitable over a 10-year horizon, and losses increased as more wet areas were set aside. Losses were understated because the project included government payments as a benefit. The Goodwater Creek Watershed Project in Missouri also conducted a traditional CBA by applying conservation practices to a representative farm consistent with what farmers reported in a 2007 survey of Goodwater Creek (Murphy et al. 2010). A grassed waterway on 2% of the farm reduced net income by 20%. These studies, by themselves, show that conservation practices can be effective but costly.

Both the Cheney Lake Watershed in Kansas and the Lincoln Lake Watershed in Arkansas project teams added risk to their CBA analyses. The Kansas team applied Target Minimization of Total Absolute Deviations (MOTAD) to typical farm scenarios. Target MOTAD is a programming technique that ranks consistently with second-degree stochastic dominance. Risk could be reduced by nearly 60%, with a loss in profit of about 2%. However, this reduction was associated with an increase in water yield, sediment, and total P. The Arkansas Project completed two different types of risk studies. In a study that ranked systems by stochastic dominance, the Arkansas team was able to delineate systems by risk, return, and either total P or total N loss. The differences were very small for total P but were larger for total N loss. A stochastic efficiency with respect to a function analysis showed that risk preferences held by farmers had no impact on rankings. In general, most systems involved tradeoffs between risk, profit, and the environment. It is difficult to find "win-win" cases where profit can be increased, while risk and environmental loadings are reduced. However, including risk did make a difference in some of the studies that chose to include it.

Several studies chose to review environmental and economic tradeoffs more directly. The Lincoln Lake Watershed in Arkansas, Paradise Creek Watershed in Idaho, Eagle Creek Watershed in Indiana, Walnut Creek Watershed in Iowa, and Calapooia Watershed in Oregon developed explicit PEFs. Arkansas and Iowa used genetic algorithms to analyze a large domain of possible land uses, conservation practices, weather events, soil types, and other factors in a watershed. The Idaho Project examined a smaller set of options that varied only sediment delivery rates. The Indiana Project used mixed integer programming to consider a large combination of practices, while the Oregon Project built a model that could evaluate up to four types of tradeoffs at a

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**Table 6.4**
Summary of the socioeconomic elements of the principal water quality monitoring activities of the National Institute of Food and Agriculture–Conservation Effects Assessment Project.

| Project | Principal activities |
|---|---|
| Arkansas | Economic<br>• SE risk frontier: used to rank 54 BMPs in the watershed based on total P, normalized by cost of conservation practice, including two levels of tillage, three fertilization rates, and three filter strip widths. Used SWAT to estimate total P.<br>• SE: used stochastic dominance to rank conservation practices based on total P and then on net returns.<br>• PEF: used genetic algorithm to develop Pareto efficiency frontier of cost and pollution (total P and N) reduction.<br>Social<br>• Surveyed 63 farmers and 62 nonfarmers in the watershed to compare attitudes and perceptions across different stakeholder groups, including local to federal, toward water quality problems and solutions. |
| Georgia | • Decision support system: built field-scale multicriteria decision support system to reconcile economic and environmental criteria and expose the practices in each field that were most consistent with the priorities of farmers. |
| Idaho | Economic<br>• PEF: constructed Pareto efficiency frontier for cost-sediment, based on four levels of reduction (0, 30, 50, 70) and representative costs based on an in-person survey of four farmers.<br>Social<br>• Interviewed four farmers in person about their farming operation costs and returns. Performed telephone survey of rural and urban residents in the watershed or in a nearby watershed about conservation attitudes. |
| Indiana | Economic<br>• PEF: Used mixed-integer programming watershed model to minimize cost of conservation practices to achieve pollution targets for N, P, *E. coli*, sediment, and atrazine.<br>Social<br>• Interviewed 32 farmers in person in the watershed to examine factors that affected adoption of conservation practices. Performed additional survey of horse farms. |
| Iowa | Economic<br>• PEF: modeled optimal placement of conservation practices in the Squaw Creek Watershed for 33 total BMP combinations. Then developed Pareto efficiency frontier for cost and pollutants (N and P). |
| Kansas | Economic<br>• CBA: targeted MOTAD analysis of risk and return to BMPs. Looked at financial risk related to hitting environmental constraints<br>Social<br>• Performed in-person interviews with watershed farmers (28 in year one and 21 in year two) about their attitudes and about factors that influenced adoption. Also interviewed seven Citizen Management Committee members: three in Wichita and sevent USDA Natural Resources Conservation Service employees. |
| Missouri | Economic<br>• Cost-benefit analysis: built enterprise and partial budgets for a representative farm, based on a survey, and used budgets to estimate the cost of BMPs (matching those used in the APEX modeling effort). Budgeted cost of adopting conservation practices on representative farm at same proportions found in survey.<br>Social<br>• Performed in-person surveys of 18 farm operators in the watershed. Identified conservation practices used and attitudes for adoption. |

**Continued**

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**Table 6.4 Continued**

| Project | Principal activities |
|---|---|
| Nebraska | • No new economic or social studies conducted. |
| New York | Economic<br>• Cost-benefit analysis: performed a cost-benefit analysis on a 164 ha farm in the Cannonsville Basin. Considered 75 BMPs, including barnyard management, nutrient management, crop rotation, filter strips, and cattle crossings. |
| Ohio | Social<br>• Surveyed farmers by mail and elicited attitudes and awareness about conservation, as well as participation with farm agencies. |
| Oregon | Economic<br>• PEF: built a "large, complex, computationally expensive model" to evaluate alternative conservation practices at the watershed level to develop four-dimensional Pareto efficient production possibility frontiers for farm-level profit, environmental quality, program efficiency, and location within the watershed. |
| Pennsylvania | Social<br>• Combined mail and in-person surveys of watershed landowners. Three types of landowners were surveyed in person: five in-person of traditional farmers, six of hobby farmers, and five of nonagricultural landowners. The same groups of people were surveyed with 175 mail surveys. |
| Utah | Social<br>• Conducted a series of field visits and extended structured interviews with the approximately 55 landowners who participated in official Little Bear River Watershed protection projects. Focused on practices installed and reasons for adoption. |

Notes: SE = stochastic efficiency. BMP = best management practices. SWAT = Soil and Water Assessment Tool. P = phosphorus. N = nitrogen. PEF = Pareto efficiency frontier. MOTAD = Target Minimization of Total Absolute Deviations. APEX = Agricultural Policy/Environmental eXtender.

time, including farm-level profit, environmental quality, program efficiency, and location in the watershed. Neither the Oregon nor Indiana models had been extensively applied to the program watersheds at the time of this report. These studies were promising since they could identify tradeoffs of a large variety of conservation practices for different conditions found in the watershed.

One current limitation of all the economic tradeoff models is reliance on the assumption that adoption was consistent with what was prescribed by the model for the entire watershed. The models did not account for the voluntary nature of conservation adoption but instead prescribed what was optimal for each field in the watershed. In addition, while the flexibility of seeing tradeoffs was desirable, it did not generate a concrete conclusion. That is, what was an acceptable tradeoff for one person may not have been for another. None of the studies went to the next step to show how farmers and other stakeholders could or would work to agree on the appropriate level of tradeoff.

## Social

Surveys were conducted in eight studies. All examined attitudes toward conservation. Some interviewed farmers only, while others included urban residents, government officials, and other stakeholders. In some cases, only a few people were personally interviewed. Other projects broadened the scope to include the entire watershed or more and implemented mail surveys. In

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many cases, surveys were used to help collect data for the economic and/or modeling efforts of this project (e.g., Chapters 9 and 12).

Almost all of the projects' surveys included sociodemographic information, such as farm size and owner characteristics. Many inventoried the use of conservation practices. The most commonly mentioned conservation practices included nutrient management, buffer and filter strips, conservation tillage or no-tillage, grassed waterways, and terraces. Each is discussed in more detail in Chapter 3.

Many projects included nonfarmers in their surveys. Farmers tended to think their contributions toward degrading water quality were smaller than others thought they were. Idaho farmers, for example, believed they applied appropriate conservation practices and that they were not polluting. An Arkansas survey across stakeholder groups found that the nonagricultural group thought the people contributing the most to water quality problems was agriculture and ranked the other groups as follows (from most to least): agriculture, construction, city sewer system, and then industry. The agricultural group ranked contributors as follows (from most to least): new construction, industry, city sewer, households, and then agriculture.

Most of the projects focused on how farmers felt about conservation and their motivations for adopting or avoiding conservation practices. Results from the eight projects using surveys (table 6.5) were both consistent with the literature, as summarized in table 6.2, and among themselves. However, the NIFA–CEAP studies, along with site visits and the key informant interviews, did add some new perspectives. Findings that are not commonly mentioned are italicized in table 6.5. Farmers consistently said they did not want to adopt conservation practices when the practices reduced profits. This reduction could result from increased costs or reduced income, either of which could reflect concerns with the practice or with an impact the practice had on production. For example, many farmers cited lost land or added time as a reason not to adopt conservation practices. Another finding was that farmers or landowners were less willing to adopt conservation practices without financial assistance the more they thought of the farm as a business, but felt that they had a good understanding about what conservation practices were and when they were beneficial. On the other hand, nonfarmers were less aware of water quality problems and how to resolve them but were more willing to adopt conservation practices as they were less likely to think of the farm as a business.

The importance or role of government has been examined in previous literature but mostly as a source of information or of financial assistance. The NIFA–CEAP watershed studies found concern about government programs when the approach was government directed with little or no opportunity for farmer input. Farmers felt that they knew a lot about their own farms and that this knowledge needed to be respected. Farmers indicated that government officials would get more cooperation if they could offer flexible conservation plans that accounted for local knowledge and that did not feel prescribed and/or forced.

## Key Informant Interviews

A great deal of information about socioeconomics was revealed in the key informant interviews, which were covered in Chapter 2. It is worthwhile to reiterate some of those issues and to discuss them in the context of this chapter.

An overwhelming message from the key informant interview was that farmers were not willing to adopt conservation practices that reduce profits or that interfere with production, in terms of the cost and return of the practice as well as how it influenced normal cropping activi-

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**Table 6.5**
Summary of factors found to increase or decrease adoption of conservation practices in National Institute of Food and Agriculture–Conservation Effects Assessment Project surveys.

| Category | Increase adoption | Decrease adoption |
|---|---|---|
| Farm business | | |
| Profit | Practice improves profits | Reduces profits |
| Yield | Practice increases crop yields | Practice decreases yields |
| Production cost | Lowers cropping costs | Increases cropping costs |
| Conservation cost | | Practice is expensive to install and maintain |
| Other | Government financial incentives, cost share | *Lost farm land, time, attitude that farming is a business, high commodity prices, lack of equipment* |
| Conservation efficacy | | |
| On farm | Can see the result on-farm (e.g., reduced erosion) | |
| Off farm | Can see off-site results | Don't see off-farm consequences |
| Other | | Difficult to install and maintain |
| Stewardship | | |
| | Belief that conservation is doing the right thing | Belief that water quality problems are someone else's fault or problem, *lack of knowledge or awareness of conservation practices or assistance*, idea that conservation is not acceptable to farming community |
| Government or nongovernmental organization | | |
| Relationship | Personal attention (time) from experts (e.g., USDA NRCS, extension) Networking and feedback, trust (knowledge, local) | *Lack of trust* |
| Approach | *Encouraging farmer-to-farmer information sharing and cooperation, not being told* | *Government-directed, prescribed, inflexible practice recommendations or requirements, lost control of property or decisions, additional paperwork* |
| Other | | *Regulations* |

ties. Practices that took substantial time or removed land from production would be accepted by only a minority of farmers unless there is sufficient compensation. As one Ohio respondent put it, "One of the things is always economics. That always hits the top of the list of everything I can think of. If the farmers don't see the economics behind it, then they're not prone to even give it a try."

A Missouri respondent commented about the importance of costs in his explanation about why farmers were more willing to consider N planning for conservation, which could help increase profits, as compared to pesticide planning, which might reduce profits. He said that the

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pesticide "alternatives are more expensive and not as effective." A farmer in Oregon lamented about how riparian buffers just took land from production.

There can be tensions between the importance of economic returns and government programs designed to help increase conservation practices that may reduce practice adoption by reducing profits or failing to help farmers understand where conservation practices do and do not increase returns. The USDA Natural Resources Conservation Service (NRCS), for example, was criticized for making cost-share practices difficult and conservation practices too expensive. A participant commented that "conservation practices fail because paperwork is frustrating, money runs out, and agencies want to replace a Chevy with a Cadillac." Cooperative extension was criticized in some places for not knowing enough to be helpful.

## Discussion

It is abundantly clear that farmers are not going to adopt extensive conservation practices that are not profitable. The subjects of the key informant surveys, the site visits, and the studies reviewed in this text tended to agree that both subsidies (e.g., cost share) and educational and technical assistance would have to be increased commensurately to encourage conservation practice adoption of practices perceived to reduce profit or increase time. While it was not the focus of this study or review, one obvious alternative is to regulate farmers, but that option is not considered here because it is rarely used for off-site pollution problems related to farms.

Conservation practices need to be profitable; the surveys revealed some interesting perspectives. The direct cost of the practice was the most critical component for farmer use, followed by the need for cost to be defrayed by some government program. A second category of concern was indirect expenses, including the amount of paperwork required to qualify for government assistance and to meet reporting requirements, the time required to monitor or maintain the practice, and the impact of a conservation practice on crop production. The issues most frequently mentioned regarding conservation practice effects were lost productive land and yield loss from conservation tillage practices.

The NIFA–CEAP studies underscored the fact that researchers could identify socioeconomic factors that affected conservation adoption. However, these factors did not contribute to robust conclusions about how to best affect conservation adoption. That is, researchers were better at ex-post, descriptive analysis than at prescriptive analysis. A few economic studies have attempted to measure the MEI; those that did found that one can measure the predicted stimulus required to motivate adoption. However, none of the NIFA–CEAP studies looked at how marginal changes in economic or sociological factors could affect conservation adoption.

Another issue that became apparent was the importance of accounting stance. The solution for water quality protection or remediation in the watershed may directly conflict with what is best for a farm. The opinion about what is best may differ between the farmer and the downstream residents who are affected by pollutants and discharge from the farm. While it is attractive in many ways, the PEF technique could actually increase conflict because it offered tradeoffs that could lead to disagreements in a highly contentious public policy process. None of the NIFA–CEAP studies attempted to value the off-site impacts of sedimentation, nutrients, and pesticides, which might lead to unfounded biases when it came to judging how much conservation needed to be applied and at what cost.

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Finally, most of the economic information came from secondary studies or from expansion from a small sample of interviews. As a result, the quality of data generated from these studies has some limitations.

## Lessons Learned

Economic incentives were required for conservation practice use by most farmers. Possibly the most important lesson learned was that most farmers required some sort of financial incentive to adopt conservation practices. Many comments like the following were heard: "conservation is important but has to be cost effective or conservation competes with the time he [a farmer] could be using to make money." People expressed a willingness to adopt conservation practices but also a need for the government to offer more cost sharing. In the Cannonsville Reservoir Watershed in New York, 100% cost share was critical to the implementation and maintenance of practices. Most NIFA–CEAP watershed studies determined that cost share was a necessary but not a sufficient condition for adoption of many conservation practices.

There were, of course, exceptions. Some farmers were simply not interested in conservation practices. For example, even with 100% or near 100% cost-share potential due to matching offered by the city of Wichita, many priority farms in the Cheney Lake Watershed in Kansas chose not to participate in conservation programs. On the other hand, some farmers adopted conservation practices without any need for financial incentives elsewhere in the study sites.

### Government Agencies Influenced Conservation Profitability

Many conservation practices were installed with cooperation from the government so that farmers could receive cost shares or other aid. This meant that the government had significant influence over the impact a practice would have on farm profitability. The authors heard that conservation practices were inflexible and were overengineered to do the job they were meant to accomplish, thus raising costs beyond what farmers were willing to incur, even with cost sharing. Plans were criticized as being broader than farmers wanted or were willing to accept, especially when presented as an all-or-nothing choice. Working with government agencies, such as the USDA NRCS, was made more costly in time and money due to excessive rules and paperwork.

Perception about efficacy also mattered to conservation practice adoption. Advocates of conservation would be more effective if they were to demonstrate or at least discuss how conservation practices directly helped farmers. For example, forgone income from land removed from production reduces the benefit of conservation incentives. However, yield monitoring may help show where degradation was occurring, where the cost of best management practices could be reduced, or even how to make money where yields were not covering costs. Even a discussion about the off-site impacts would be helpful for those farmers who value stewardship.

Government agencies sometimes changed cost-share availability to increase adoption. For example, two trends have been driving change from furrow irrigation to sprinkler irrigation in Nebraska: increases in labor costs and an increase in cost share. Initially, the USDA NRCS would only cost share one center pivot per farmer per lifetime for US$3,000. After adoption leveled off, the USDA NRCS increased the cost-share limitations to one center pivot per farmer per year for a maximum of US$7,500 per lifetime. There was little incentive for farmers to change to center pivot because the groundwater was available and was relatively shallow, meaning

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pumping costs were fairly low. The combination of increased cost share and rising fertilizer costs contributed to increased adoption.

Finally, government policies or market forces that increase commodity prices could curtail conservation efforts. An Idaho farmer and a dairy farmer in New York felt that they adopted more conservation practices when their incomes rose, but they were largely referring to farm security that occurred over time. Incomes go up when commodity prices rise, but this was a short-term gain, which most farmers told us that they had to seize profit when they could. Therefore, financial security may increase conservation adoption, but opportunities to gain income in the short run may work against adoption.

## Off-Site Costs Were Not Considered

In theory, off-site costs from sediment, nutrients, pesticides, and other contaminants should drive conservation efforts. However, none of the projects computed these costs. Most projects focused on reducing contaminants or reaching government targets, such as water quality standards or total maximum daily load allocations. It might be more convincing for all concerned to know the tradeoffs between contaminant loading, economic impacts on farms, and economic impacts off the farm.

## Economic Modeling Should Be Improved

Economic modeling varied from simple budgeting to complex "super" models that could map four-dimensional PEFs. Two of the three economic modeling approaches found in the literature were used, CBA (including some that considered risk) and optimization (including PEF). No project measured marginal economic incentives. Also, no study accounted for off-site costs. Data for the models were collected by farm interviews or were obtained as secondary data.

Researchers could estimate the cost and returns of individual conservation practices with modeling. The data were questionable, however, when expanded to many farmers. In addition, accounting for interactions, such as yield impacts from terracing, was weak if it was done at all.

There was little progress made to extend economic modeling results to useable applications by farmers. Lessons from farm-level studies were difficult to apply to other farms. In addition, modelers typically applied a common cost to all farms, which provided no information about individual costs. Very little economic information was repackaged and provided to farmers.

Finally, economic efforts needed to be integrated into other modeling efforts, such as land treatment, monitoring, and watershed modeling, that permitted and encouraged feedback among these components. None of these critical activities should be conducted in isolation, with respect to time, space, and personnel.

## Some Sociological Factors Increased Conservation Adoption

The literature suggested that very few variables explained conservation adoption on a consistent basis. However, a list of practices that often influenced adoption, either for or against it, was developed. A comprehensive list is provided in table 6.5. Five themes emerged that warrant reiteration. The following items increased the chance of adoption:

- Practices that increased profits. These include increased product sales or reduced costs, whether caused directly or indirectly by adopting the conservation practice. It would also include government subsidies or regulations if they applied.

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- Practices that had on-farm benefits that were easy to observe. Some practices, like soil conservation, have direct benefits to a farmer that he/she can observe. Others, like reduced nutrient runoff, are more difficult to get a farmer to adopt because the impact occurs outside his/her sphere of recognition. A strong belief in stewardship or conservation ethic held by the farmer. Many people adopted conservation practices on their own, either believing it was profitable in the short or long run or because they believed they had a responsibility to protect the environment. Sometimes the responsibility extended from their commitment to practicing stewardship on the farm; other times it emanated from understanding the off-site consequences of actions on the farm.
- A strong network of support (financial, technical, and peers). Adopting conservation without assistance did not appear to stimulate conservation adoption. Farmers liked to have peers that they could discuss problems with and to have financial or technical help when they needed it. Farmers in Oregon told us that the experts did not know how to help them when burning was banned and they had to learn how to use reduced tillage. They learned how to get better seed contact from other farmers, not experts. Farmer-to-farmer contact needs to be an integral part of USDA NRCS and USDA Farm Service Agency efforts to make payments and of extension efforts to educate.
- Flexibility and inclusion in the solutions. In many times and in many ways, surveys revealed that farmers felt the government too often approached conservation with expectations for farmers to make changes without listening to input or feedback from farmers. This diminished inclusion of ideas from farmers and did not allow them flexibility to make adaptations they felt were appropriate at the local level.

## Some Sociological Factors Reduced Conservation

Reasons not to adopt conservation practices are also listed in table 6.5. Many were simply the reverse of reasons to adopt, like conservation practices being costly or unprofitable. A few additional themes were the following:

- Lack of control. Farmers were afraid or annoyed when their decisions were made by someone else. Adopting conservation practices could mean giving up productive farmland or the farmers' ability to make decisions about what can be grown on their land. Some farmers also feared government regulation creeping in if they yielded too many decisions to government agency staff. Farmers thought that adopting practices could also cost time and involve paperwork. Worst of all, they thought it could mean having to let the government tell them how to farm.
- Lack of trust. Many people did not trust government agencies for one reason or another. They were concerned that reasonable interference would turn into unreasonable interference. Some expressed concern about having to pay back cost-share money.

## Outside Factors Can Influence Local Factors

One of the most interesting economic lessons was that not all solutions had to come from within. Three of the NIFA–CEAP watershed studies had heavy outside influence that helped them gain better results. In the New York Cannonsville Reservoir and the Kansas Cheney Lake Watershed, large, nearby metropolitan cities helped the watersheds by infusing money into the system to increase adoption in order to help keep drinking water clean and safe. The money they provided, and their cooperation with local farmers and others to plan how to use these funds,

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increased the use of conservation practices and generally improved the attitudes of farmers about conservation. In the Lincoln Lake Watershed in Arkansas, the threat of a lawsuit motivated change. High amounts of nutrients from poultry litter had been targeted due to perceived impacts on water quality in Oklahoma.

### Institutional Influences Were Significant

The mixtures of people, businesses, and agencies that were trying to influence outcomes in any one watershed had a profound impact. They could work together well or they could send mixed messages that undermined each other and confused farmers.

## Recommendations: What Would Make Socioeconomic Research Better?

### Improve Socioeconomic Modeling

Research has progressed greatly in the past decade, largely due to improved model(s) and data availability. However, many relationships are still assumed or ignored. Researchers should improve on the gains already made. Data about farmer behavior and the costs and returns associated with conservation practices need to be targeted to actual farmers if we are to learn more about what influences farmers to adopt conservation practices. Furthermore, more studies need to be conducted regarding what it would take to motivate change, rather than focusing on the characteristics of people who already made a change. Finally, there needs to be better coordination among researchers across disciplines to formulate realistic and meaningful research questions, as well as to make specific plans about how results could be used to stimulate change.

### Define Objective

What is best for a farmer is not always what is best for a watershed. The NIFA–CEAP modelers did not account for the inevitable public debate that surrounds the question: how much should profits fall to accommodate conservation? A model at the watershed scale will not account for each farmer's individual discretion to farm. Likewise, conservation at the field or farm level may not have significant impacts at the watershed scale. Projects need to conduct research in a way that facilitates positive public debate about proper tradeoffs.

### Reconsider Incentives

Governments can implement regulations or take other actions that require, rather than request, increased adoption. Government action should be considered alongside the current approach of offering incentives in the form of cost share, direct payments, or education. If incentives are to be offered, they need to be offered more effectively. This means approaching farmers with information that shows how conservation benefits them, involving farmers in planning, and coordinating education with technical assistance and financial incentives.

### Reconsider Application Process

The process of getting help, whether it is technical or financial, appears to be difficult for many people. This process needs to be streamlined and made simpler and more flexible to allow for innovation on the part of farmers. For example, conservationists could preapprove a menu

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of allowable practices. This might result in some efficiency loss as farmers would not be customizing their practices, but at the same time, there could be some gain since the practices are easier to learn and adopt.

### Coordinate Efforts

Significant sums of money are likely wasted with duplicative, conflicting, and uniformed efforts made by multiple entities that fail to communicate and cooperate regarding conservation research. In addition, rates of adoption are diminished when farmers are not given a clear, consistent message. Watershed or other planning teams should make real efforts to coordinate. In addition, federal or central offices should make accommodations to allow for local cooperation.

### Prioritize Efforts

Prioritizing efforts in areas that contribute the most pollution could lower the cost of prevention. However, prioritizing conservation practices has to be handled carefully so as not to imply that farms being targeted were managed improperly.

### Find Outside Partners

Though it may appear to be unlikely and it will not work for everyone, having an outside partner can boost conservation adoption. Every conservation group should ask themselves: who benefits from conservation? Often, the answer is someone off site. In some cases, such stakeholders can be approached to help with the problem, as in the cases of New York City, New York, and Wichita, Kansas, which both helped farmers adopt conservation practices.

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