# 8. Conclusions

The Area Studies Survey data set offered a unique opportunity to assess the usefulness of conducting a field-level survey linked to site-specific resource characteristics. We have incorporated many of the lessons learned into the ERS/NASS survey program.

The richness of the data set allowed a wide range of analyses. The lack of data on costs and prices, however, greatly handicapped the study. We assumed that a farmer's choice of inputs and outputs reflects an economic decision (i.e., profit maximization), but the lack of explicit cost data meant that we could not directly test the influence of technology costs, input costs, taxes, or cost-sharing policies. Other chemical use and management practices surveys conducted at this time also were not linked to financial data and could provide only incomplete analyses of the adoption of agricultural practices and technologies. Based on results from these survey efforts, ERS and NASS developed the Agricultural Resource Management Study (ARMS) Survey that combined elements of the Area Studies, Cropping Practices, and Costs of Production surveys. For a limited number of crops, the ARMS Survey ties the field-level practice and chemical-use data to the enterprise-level costs associated with producing a crop.

The preceding chapters described the use of selected nutrient, pest, soil, and water-management practices in the 10 watersheds surveyed as part of the Area Studies Project. We determined the factors that influenced the use of a range of management strategies and assessed the impact of technology on crop yields and chemical use. We used a unified analysis framework and a core set of variables in order to make comparisons.

## What We Learned About the Factors Influencing Farmers' Use of Management Practices

Several factors emerged as important influences across many agricultural management practices that we studied. Table 8.1 summarizes the findings from chapters 3-6 for the combined-area models.

Education has a significantly positive effect on the adoption of information-intensive technologies, such as the use of biological pest control or nitrogen testing. The increasing complexity of emerging technologies is a factor that agencies or technology providers should consider when targeting potential adopters. Technical assistance, demonstration, or consulting services may be necessary to promote adoption of certain preferred practices.

Information-intensive practices are less likely to be adopted by an experienced farmer, which may imply either that such operators have the knowledge they need to farm successfully or that they are less willing to change practices than younger, less experienced farmers.

Ownership of the surveyed field had less impact on practice adoption than we initially expected, based on the hypothesis that landowners would be more likely to invest in new practices than renters. Most practices included in this study, however, were not structural. Investment in irrigation technologies, which have high initial costs, was more likely for owners rather than renters, but the difference was small.

An enterprise with a livestock component was less likely to adopt information-intensive nutrient management practices, such as soil testing, split nitrogen application or micronutrient use, and more likely to use manure. This expected result may change in the future if livestock operations are required to implement nutrient-management plans that restrict applications of manure to land.

Investment in irrigation had a significant positive effect on the adoption of all pest and nutrient management practices that we considered. Water is the primary transport mechanism for chemicals to leave a root zone and travel to ground or surface water. Therefore, water and chemical management are expected to be complementary. Water management is less predictable for rain-fed agricultural production, so the use of chemical management strategies by such farms may be less effective than for farms that are irrigated.

The influence of the two variables, PROGRAM and ADVICE, warrant further discussion.[1] The policies represented by these variables had a strong positive influence on the adoption of virtually all the preferred soil, pest, and nutrient management technologies. The Area Studies Survey was conducted when conservation compliance was a condition of receiving benefits from a number of U.S. Department of Agriculture programs.

[1] The variable INSURE was meant to be a policy variable designed to capture the element of risk, but it is unclear exactly what the question (as it was worded) actually represents or how the coefficients should be interpreted.

**Table 8.1—Change in predicted adoption: Combined area models**

| Variables | Any soil cons | Soil-water quality | No-till | Rotat. | Resid. | Biolog. | Scout | Modern nutrient | N test | Split N | Legumes | Manure | Decision to irrigate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COLLEGE | + * | | | | - ** | + ** | + ** | + ** | | + ** | | | + ** |
| EXPERIENCE | | | | | - ** | - * | - * | - ** | - ** | | | | - ** |
| WORKOFF | | | + * | | + * | | | - ** | | - ** | | - ** | - ** |
| TENURE | - ** | | | - * | | | - ** | | | | - ** | + ** | + ** |
| ACRES | + ** | | + ** | | | + ** | + ** | + ** | + ** | | - * | - ** | - ** |
| ROTATION | + ** | + ** | + ** | na | na | na | na | na | na | na | na | na | + ** |
| ROWCROP | + ** | + ** | - ** | + ** (soy) | + ** (cotton) | + ** (cotton) | + ** (cotton) | + ** | + ** | + * | na | + ** | + ** (corn) |
| GRAIN | - ** | | | - ** | - ** | + ** (frt/veg) | na | | - ** (sm-grn) | + ** (rice/soy) | na | | + ** (frt/veg) |
| MANURE | | + ** | + * | na | na | na | na | - ** (animal) | - ** (animal) | | ** (animal) | + ** (animal) | na |
| IRRIGATION | | | - ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | na |
| PROGRAM | | + ** | + ** | + ** | | | + ** | + ** | + ** | + ** | + ** | | + ** |
| ADVICE | + ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | + ** | | | na |
| INSURE | + ** | | | | | | + ** | + ** | + ** | | - ** | | |
| SLP | | | | - ** | | | | + ** | + ** | | - ** | | + ** |
| PISOIL | + ** | + * | | + ** | | | - * | | + ** | - ** | + ** | + ** | - ** (slope) |
| EROTON | | + ** (RKLS) | | na | - ** | na | na | + * | | | | + * | + ** (wind) |
| RAIN | + ** | + * | + ** | | + ** | | | + ** | | + ** | | na | - ** |
| TEMP | + ** | | + ** | | + ** | + ** | | | | + ** | na | - ** | + |

** Significant at the 5-percent level.
* Significant at the 10-percent level.

Farms with an erosion potential in excess of a critical level were required to adopt conservation practices to be eligible to participate in the programs. The availability and use of technical assistance appear to be significant influences on the decision to use the set of practices reviewed in this study. Those subject to conservation compliance likely used some resource-conserving practices, but the significance of ADVICE suggests that technical assistance influenced the choice of the particular practices. The result is an affirmation that extension and education efforts are important components to effect technological change in agriculture. In particular, these activities have an impact on the adoption of information-intensive technologies and on practices that provide offsite benefits.

In the combined-area model for most practices, a regional dummy performed as well as the more precise resource characteristics. The greater significance of the dummies in the combined-area model should be expected because of the usual result that dummies absorb many undistinguishable effects. In the single-area models, however, the resource variables were often significant determinants of adoption, confirming the idea that site-specific information is critical to modeling and explaining resource-conserving efforts. The resource measures that we chose may not have captured the important resource characteristics expected to influence the adoption of all technologies in all watersheds. We did not expect the generic resource characteristics we used to play an important part in a farmer's choice of pest-management strategy. An estimate of pest infestation is a critical resource characteristic in this case. Information on pest pressures is now gathered in current ERS/NASS surveys when possible. We had hoped, however, that constructing site-specific indices would improve the aggregate modeling of adoption for soil, nutrient, and water management practices. We conclude that the value of using field-level resource data is in the single-area or watershed-level modeling efforts. In addition, the chosen index should reflect the environmental circumstances of the specific area and technology, rather than a one-size-fits-all index. For example, in modeling the decision to irrigate, the single attribute, slope, had more explanatory power than did the index of soil productivity.

Assessing the influence of resource characteristics on adoption (i.e., the production-impact) was only one reason to include site-specific resource information in the Area Studies Survey. These data were gathered to provide the link between the economic and physical fate and transport models. That work has not been completed, so it is still unclear whether the micro data are useful to assess aggregate models. The site-specific resource information at the watershed level is important for both *production-impact* and *environmental-impact* analysis.

The combined-area models represent the aggregation across distinct watersheds. From a policy perspective, these results can be misleading. For example, for the adoption of soil-conserving practices, a farmer's experience and whether he or she works off-farm have significant positive effects in the Susquehanna River Basin, but the aggregate model results show no significant effects of these factors. A policy decision to encourage adoption of conservation technologies in Susquehanna would be more efficient if based on site-specific information. On the other hand, in some cases, the combined-area model results are dominated by a single area. The data allow fairly precise environmental-policy modeling to use for targeting. The unified modeling approach that we used shows that important information can be lost in the process of aggregation. Incentives developed to address factors identified in the aggregate model may be appropriate for only one area and counterproductive for others. We recognize that this averaging problem exists for all policies to some extent. However, our comparison of the combined-area and single-area models illustrated the magnitude of the differences between the Area Studies regions.

## What We Learned About the Effects of Adoption on Chemical Use and Crop Yield

In chapter 7, we used several cases from the Area Studies Survey data to analyze whether the adoption of selected practices had an effect on chemical use or on crop yield. Proponents of many of the technologies included claim that adoption will result in a decrease in pesticide or fertilizer use. Others claim that farmers do not adopt these practices because crop yields are lower than those obtained using current technologies. We show that, in general,adoption of new technologies results in little reduction in chemical loadings and no yield decreases. In fact, five cases recorded yield increases. Table 8.2 summarizes the results of the impact analysis.

Our conclusions may apply only to the Area Studies Survey data that we analyzed. We had too few observations in most cases to obtain robust results. In particular, the input demand equations have large, unexplained variation. The adoption of certain technologies may reduce loadings somewhat for some producers,

**Table 8.2—Effects of adoption on chemical use and yield:**
**Case studies of selected practices, crops, and regions**

| Practice | Herbicide use | Insecticide use | Nitrogen use | Crop yield |
|---|---|---|---|---|
| **Soil management practices** | | | | |
| Conservation tillage — Soybeans | ns | na | na | ns |
| Water quality practices — Corn | ns | + | ns | ns |
| **Pest management practices** | | | | |
| Biological controls — Cotton | na | ns | na | ns |
| Scouting — cotton | na | + | na | ns |
| Destroying crop residue — Cotton | na | ns | na | ns |
| Crop rotation — Cotton | na | ns | na | ns |
| Scouting — Corn | na | ns | na | + |
| Destroying crop residue — Corn | na | - | na | ns |
| Crop rotation — Corn | na | ns | na | ns |
| **Nutrient management practices** | | | | |
| Modern practices — Corn | na | na | ns | ns |
| Legumes in rotation — Corn | na | na | ns | + |
| **Irrigation practices** | | | | |
| Sprinkler irrigation — Corn | ns | ns | ns | + |
| Gravity irrigation — Corn | ns | + | ns | + |
| Irrigation — Cotton | + | + | + | + |

na is used to indicate that no model was included for that practice/chemical combination.
+ indicates that the adoption of the practice would lead to an increase in the use of the chemical.
- indicates that the adoption of the practice would lead to an decrease in the use of the chemical.
ns indicates that there was no statistically significant effect of practice adoption on the use of the chemical.

but the average effects are not large enough to show up in the results. The chosen technologies were not all designed with chemical-input reduction as the primary attribute. An exception was crop residue destruction, which directly affects pest populations. Use of this practice did result in a reduction of insecticide use. Use of conservation tillage did not result in an increase in herbicide use, at least in the soybean case that we studied. More site-specific observations are necessary to conduct a thorough analysis of adoption impacts.

## Summary

The data-gathering stage of the Area Studies Survey was completed in 1995,[2] but several important activities followed. Researchers used the data to analyze selected technologies and regions in depth. This report synthesizes what was learned in those studies and reports a comprehensive study of the entire data set. The results of the Area Studies Project contributed to the decision to merge the ERS Farm Costs and Returns and the Cropping Practices Survey. This integrated survey is the Agricultural Resource Management Study (ARMS) Survey. Now, the adoption modeling can include technology costs and input prices. Many questions used on the Area Studies Survey instrument were incorporated in the integrated survey. In addition, location variables now are included in all ERS survey instruments, which facilitates the use of resource data with more specificity than county averages. The benefits of using a survey at a national level similar to the Area Studies Survey have been incorporated within the current ERS survey program.

The greatest contribution of an Area Studies survey based on field-level characteristics could be to help answer a watershed-specific question. A unified modeling framework was used to compare the results of aggregate and regional studies. Resource characteristics are an important component of producers' decisions. The analyses of farming systems (combinations of agricultural practices) also will be enhanced by site-specific resource data. Both economic and physical modeling efforts can be supported with the data that is produced through the survey. Agricultural water-quality problems are inherently site-specific. Surveys designed to capture national (or even State) averages are not as useful for analysis as those that sample extensively in an area of interest. For environmental problems, analyses will be most efficient if conducted at a geographically relevant scale whenever possible. The Area Studies Project succeeded in developing and conducting a survey that has contributed to our understanding of agricultural-practice adoption and of survey design. During the analysis of the data, we were able to incorporate the lessons that we learned into the current survey program.

[2] The final set of data was received by ERS in March 1995.