

ASSESSMENT OF THE ADOPTION OF SUSTAINABLE AGRICULTURE PRACTICES: IMPLICATIONS FOR AGRICULTURAL EDUCATION

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Abstract

The study sought to determine the perceptions of selected farmers on issues related to sustainable agriculture practices. The study found farmers were positive about sustainable agriculture practices but still had several concerns about some practices within the concept. Farmers were trying several different practices and were open to experiment with new ideas. Most farmers appeared to be at an information gathering stage. The process of education used at this point in decision-making about new practices could be critical for the level of adoption. The results of this study indicated that the process of needs assessment and analysis was required on a continuous basis if information about sustainable agricultural practices were to be completely understood and fully implemented.

Farmer's adoption of modern agricultural technologies have played a prominent role in making American agriculture one of the most productive and dynamic systems of food and fiber production in the world. The high productivity of conventional agriculture is attested to be the fact in that at the beginning of the century one farmer's output could feed six other persons, whereas by 1980, this number had increased to over 60 others (Lacy & Busch, 1984). However, during the last decade, there has been a paradigmatic shift occurring within the agricultural community -- a shift from mere emphasis on higher productivity to include a concern for sustainability (Westra, 1990; Beus & Dunlap, 1990).

It is felt that the high productivity of conventional agriculture had been achieved at the cost of massive damage to the natural environment and troublesome social disruptions. For instance, Daubom (1986), Lacy and Busch (1984), Berry (1977), and Hightower (1973) are among those who have been critical of conventional agriculture, accusing it of what they termed the "unsettling of American agriculture."

Among the many negative consequences

attributed to conventional agriculture are the concentration of agricultural production and distribution under the control of a few large corporations, with the consequent displacement of family farmers; over-capitalization and huge farm debts; massive environmental degradation from non-point contamination of surface and groundwater with agricultural chemicals; and, the rapid depletion of non-renewable natural resources (Batie & Taylor, 1989; Daubom, 1986; Lacy & Busch, 1984; Berry, 1977; Hightower, 1973).

In order to reverse the negative consequences of conventional agriculture, different forms of sustainable agricultural systems have been recommended as alternatives for achieving the goal of an economically profitable and environmentally sound agricultural production system. Sustainable agricultural systems have been defined in different forms, ranging from alternative, low-input, bio-dynamic, to organic farming (Batie & Taylor, 1989). For the purpose of this paper, sustainable agriculture is represented by farming systems in which the use of purchased chemical-based inputs such as fertilizers and herbicides is significantly decreased in comparison with the conventional agricultural systems. There is, however, increasing

concern that, while many more farmers now seem to have a better awareness of the negative environmental and social consequences of conventional agricultural systems, this has not translated into a major shift towards the adoption of sustainable practices (Green & Heffernan, 1987).

Attempts to explain the low adoption rate have been many and varied (Batie & Taylor, 1989; Young, 1989; Swanson, Carboni & Napier, 1986; Pampel & van Es, 1977). Lovejoy and Napier (1986), for instance, blamed the little success achieved by past efforts to encourage farmers' adoption of sustainable agricultural innovations on what they termed the American penchant for attempting a technological fix for every problem. They contended that past efforts have concentrated on telling farmers of the negative environmental impact of their production systems in the hope of engendering attitudinal change and as a consequence the adoption of Best Management Practices. They pointed to the futility of such an approach, observing that findings of past research showed that farmers continued to use practices that degraded the environment even when they: 1) were aware of the negative environmental impact of their agricultural practices; 2) believed they had a social responsibility to protect the environment; and, 3) had favorable attitudes towards soil and water conservation (Lovejoy & Napier, 1986).

Such findings have raised questions about the relevance of the traditional diffusing model for explaining the adoption of conservation technologies (Lovejoy & Parent, 1982; Heffernan & Green, 1981; Pampel & van Es, 1977). Critics argued that while the study of the adoption and diffusion of technologies under the rubric of the classical adoption-diffusion model have contributed immensely to the understanding of the adoption process as they relate to commercial farm technologies and practices, the model may not provide full explanation of the adoption process when applied to sustainable agricultural practices (van Es, 1983).

Hence, the need for new perspectives has been called for in the study of the adoption and diffusion of sustainable agriculture, with focus on access to, and quality of information (Lovejoy & Napier, 1986), the perception of innovations (Miranowski, 1982), and the institutional and economic factors related to adoption. Smathers (1982) contended that farmers' attitudes toward conservation practices may be important in explaining why particular practices are currently used, observing that change is more easily accepted when viewed favorably by those it affects. He, therefore concluded, that it was likely that the successful adoption of conservation practices would be influenced more by a farmer's attitude and perception, than any other factor.

Another issue requiring further research attention is the question of the profitability and compatibility of sustainable agricultural systems within the existing structure of American agriculture. While some attempts have been made to provide information on this subject, what has emerged is a bipolar body of evidence from proponents and opponents of sustainable agriculture (Tweeten & Helmers, 1990; Olson, Frank, Graboki, & Rehm, 1982; Lockeretz, Shearer & Kohl, 1981; Klepper, Lockeretz, Commoner, Gertler, Fast, O'Leary, & Blobaum, 1977). Hence, there is a need to find out what farmers' perceptions are with regards to the profitability and compatibility impacts of selected sustainable agricultural practices.

Purpose and Objectives

The main purpose of the study, therefore, was to determine the perceptions of selected Iowa farmers about the profitability and compatibility of selected sustainable agricultural practices, and to determine the degree to which the practices have been adopted within their farming systems. Finally, the study sought to determine the relationships between farmers' socio-demographic, attitudinal, communication and innovation perception variables, and their adoption of the selected sustainable agricultural practices. Specifically, the

study had the following objectives:

1. To determine the degree to which selected sustainable agricultural practices had been adopted by Iowa farmers.
2. To determine the perceptions of Iowa farmers with regard to the profitability and compatibility of selected sustainable agricultural practices within their farming systems.
3. To determine the farmers' personal, farm firm, communication, and innovations perception variables that were predictive of their levels of adoption of selected sustainable agricultural practices.

Methodology

Research Design

The study adopted a descriptive survey design. The study was undergirded by a conceptual model which incorporated relevant elements of Ervin's General Decision-Making Model (Ervin, 1982, p. 72) and the Behavioral Adoption Model developed by Nowak and Korsching (1983).

Population and Sample

A database containing a list of 545 adult and young farmers was accessed from the State Department of Education for sample selection. A sample of 150 farmers was generated using an Apple computer random number generating program.

Instrumentation

A self-administered fixed-response mail questionnaire was the instrument used for data collection. The instrument was validated by a team

of experts consisting of two professors in the Iowa State University's Department of Agricultural Education and Studies and an Area Extension Crop Specialist with working and research experience in sustainable agriculture. Instrument pretesting was done with selected graduate students in the Iowa State University Department of Agricultural Education and Studies.

Farmers' adoption of sustainable agriculture was assessed using the innovation adoption stages developed by Rogers (1983). The selected practices included soil nitrogen testing, banded application of herbicides, crop rotation, reduced herbicide and nitrogen fertilizer rates, taking credit for manure in determining nitrogen input, use of nitrification inhibitor, mechanical weeding, and spring/summer application of nitrogen. The instrument also contained items on farmer's perceptions of the innovations, their access to information, and their personal and farm firm characteristics.

Data Collection

A total of three mailings, which included two follow-up contacts, resulted in a total of 115 usable questionnaires, representing a total response rate of 76.7 percent. No statistically significant difference was discovered in the response pattern of early and late respondents.

Data Analysis

Data analysis was carried out on a computer mainframe using the Statistical Package for Social Science (SPSS). Descriptive and inferential statistical treatments such as percentages, means, standard deviations, and multiple regression were applied to the data. A Post-Hoc reliability coefficient of 0.97 was obtained for the instrument.

Results

Demographic and Farm Firm Characteristics

An analysis of the demographic and farm firm

characteristics of the respondents showed that they were very well educated and fairly young. For instance, 69.5 percent of the respondents fell within the age range of 20-39 years, while 33.9 percent had completed a college-level education. Their average years of farming experience was 17.5 years. The size of their farm operations ranged from six acres to 3,000 acres with a mean farm size of 545.5 acres.

Perceptions of Sustainable Agriculture

In regard to the respondents' perceptions of the profitability and compatibility of the selected practices, the data in Tables 1 and 2 indicated that the majority of the respondents had positive perceptions. For instance, 81.6 percent, 80.7 percent, and 70.2 percent of the respondents, respectively, rated soil nitrogen testing, use of green manure, and spring/summer application of nitrogen fertilizer as profitable practices. Most of the other practices, with the exception of the use of nitrification inhibitor, were each rated by over 40 percent of the respondents as profitable. In the same vein, the practices were generally rated

positively, in terms of their compatibility with farmers' farming systems. The data in Table 2 indicate that banded application of herbicide, crop rotation, and nitrification inhibitor were rated as incompatible by 41.2 percent and 34.2 percent of the respondents, respectively, and were the only practices that seemed to have poor compatibility ratings.

Adoption of Sustainable Agricultural Practices

The data in Table 3 indicate the percentage distribution of the respondents according to their stages of adoption of the selected sustainable agricultural practices. An analysis of the use of nitrification inhibitors, and banded application of herbicide, indicated that 38.3 percent and 41.7 percent of the respondents, respectively, were not using these practices. However, a majority of the respondents had either adopted the other practices or were in the process of doing so. For instance, 68.7 percent and 62.6 percent of the respondents, respectively, had already adopted spring/summer

Table 1. Percentage Distribution of Respondents According to Their Perceptions of the Profitability of Selected Sustainable Agricultural Practices (n=115)

Practices	Unprofitable %	Neutral %	Profitable %
Nitrification Inhibitor	33.9	47.8	18.3
Crop Rotation	30.4	21.7	47.8
Soil Nitrogen Testing	3.5	14.9	81.6
Spring/Summer N ₂ Application	7.0	22.8	70.2
Use of Green Manure	3.5	15.8	80.7
Mechanical Weeding	12.2	38.3	49.6
Reduced Rates of Herbicide	15.7	34.8	49.6
Banded Herbicide Application	20.9	35.7	43.4
Reduced Nitrogen Fertilizer Rates	15.7	40.0	44.3

Table 2. Percentage Distribution of Respondents According to Their Perceptions of the Compatibility of Selected Sustainable Agricultural Practices (n=115)

Practices	Incompatible %	Neutral %	Profitable %
Nitrification Inhibitor	26.3	37.3	36.0

Crop Rotation	34.2	16.7	49.1
Soil Nitrogen Testing	6.2	19.5	74.3
Spring/Summer N ₂ Application	7.0	13.2	79.8
Use of Green Manure	10.6	12.4	77.0
Mechanical Weeding	17.5	29.8	52.6
Reduced Rates of Herbicide	19.3	27.2	53.5
Banded Herbicide Application	41.2	28.1	30.7
Reduced Nitrogen Fertilizer Rates	11.4	21.9	66.7

application of nitrogen fertilizer, and the taking of credit for manure in the determination of fertilizer rates. The percentage of respondents who had adopted other practices ranged from 45.2 percent for soil nitrogen testing, 40 percent for mechanical weeding, 33 percent for crop rotation, and 32.2 percent for reduced herbicide rates.

Respondents were asked to indicate if they had reduced their input of nitrogen fertilizer and herbicide during the last three years. The percent of respondents who had reduced their herbicide and nitrogen fertilizer rates is shown in Figure 1. An analysis of the chart shows that close to 60 percent and 67 percent of the respondents, respectively, had reduced their rates of nitrogen fertilizer and herbicide inputs over the last three years. While 33 percent and 40.9 percent of respondents indicated no reduction in their rate of nitrogen and herbicide application, the remaining respondents had done so, some by as much as 50 percent.

Multiple Regression Analysis of the Adoption of Sustainable Agriculture

In order to determine the factors that best predicted a farmer's adoption of the selected sustainable agricultural practices, a multiple regression analysis was carried out. The regression model incorporated farmers' human capital variables such as education, age, years of farming experience, farm size, their access to information, and perceptions of the selected practices. The dependent variable was the respondents' sustainable agriculture adoption

index, which was defined as the proportion of the nine selected sustainable practices already adopted.

The result of the regression analysis as shown in Table 4, shows that variables characteristic of the classical diffusion model such as farmers' age, level of education, and farm size were poor predictors of the adoption of the selected sustainable agricultural practices. Farmers' perceptions regarding the compatibility of the practices with their farming systems, which accounted for 21.75 percent of the variance in innovation adoption emerged as the best predictor. The only other variable that was significant at the .05 level of confidence was the level of farmers' access to sustainable agriculture information.

Conclusions and Recommendations

1. On the basis of the findings of the study, it was concluded that the majority of the respondents had very positive perceptions

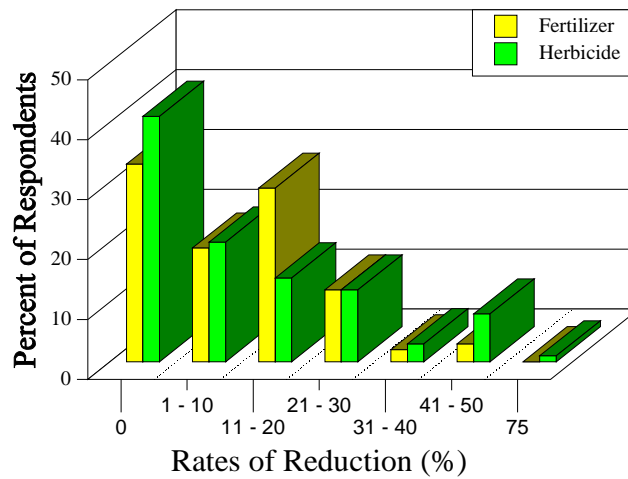


Figure1. Percent Distribution of Respondents According to the Reduction in Nitrogen Fertilizer and Herbicide Rates

Table 3. Percentage Distribution of Respondents According to Their Stages of Adoption of Selected Sustainable Agricultural Practices (n=115)

Practices	Rejected %	Awareness %	Interest %	Trial %	Adopt %
Nitrification Inhibitor	38.3	9.6	25.2	15.7	11.3
Crop Rotation	20.9	2.6	17.4	26.1	33.0
Soil Nitrogen Testing	7.0	6.1	24.3	17.4	45.2
Spring/Summer N ₂ Application	8.7	2.6	7.0	13.0	68.7
Use of Green Manure	7.8	0.9	7.8	20.9	62.6
Mechanical Weeding	13.9	0.0	14.9	31.6	39.5
Reduced Rates of Herbicide	11.3	0.9	21.7	33.9	32.2
Banded Herbicide	42.1	1.8	24.6	13.2	18.4
Reduced N ₂ Rates	4.3	4.3	28.7	38.3	24.3

Table 4. Distribution of Respondents According to Their Stages of Adoption of Selected Sustainable Agricultural Practices

Predictor Variables	Multiple R	R ²	Percent Variance	F-Value Prob.
Perceptions of Compatibility	.466	.2175	21.75	25.00*
Level of Innovation Information	.511	.2615	05.02	15.75*

*p = .001

about sustainable agriculture in terms of their profitability and compatibility. It is, however, instructive to note that many of the respondents still expressed neutral or negative perceptions about some of the selected practices. The study also showed farmers' perceptions of the research and educational efforts be directed towards making sustainable agriculture as profitable and compatible as possible in order to facilitate farmers' transition from conventional to sustainable practices. This finding is also consistent with those of past studies by Miranowski (1982), Smathers (1982), and Carlson, Dillman, and Lassey (1981). For instance, Miranowski (1982), Smathers (1982), and Carlson, (1981) found that Idaho farmers who did not adopt erosion control were more likely to adopt a practice that was perceived to be compatible with their rotation pattern than they were if they had to change their rotation pattern to accommodate the erosion control practice. The findings of these studies have several implications for educational programming. It underscores the need to consider the influence of farmers' perceptions of the characteristics of practices if they are to be motivated to adopt sustainable agricultural practices. For, according to Miranowski (1982) and Smathers (1982), it is likely that the successful adoption of conservation practices will be influenced more by a farmer's attitude and perceptions than any other factor.

2. Contrary to conventional wisdom regarding farmers' resistance to the adoption of sustainable agricultural practices, the findings of this study show that many farmers were either trying out some of the selected sustainable agricultural practices or had in fact already incorporated them into their production practices. For instance, over 60 percent of respondents claimed to have reduced nitrogen fertilizer rates. Similar

findings concerning the adoption of sustainable agricultural practices by Iowa farmers have been reported by Korsching and Malia (1991). While some of the farmers might have incorporated elements of sustainable agriculture into their farming systems, it is, however, instructive to note that a large number of the respondents indicated that they were at the information gathering stage with regard to the adoption of the practices. This has several implications for agricultural extension education. If these farmers at the persuasion stage in the innovation-decision process are to decide in favor of sustainable agricultural practices, they would need to be provided with adequate agronomic and economic information about the practices.

3. The multiple regression analysis of the variables predictive of the farmers' adoption of the selected sustainable agricultural practices showed that the human capital indicators of education, farm size, and tenure arrangement, usually included in the classical diffusion model, were poor predictors of farmers' adoption rates. While the homogeneity of the sample used in this study might well have accounted for the failure of classical diffusion variables, similar findings have been reported by other studies, van Es (1983), Buttel, Gillespie, Larson, and Harris (1981), and Napier, Thraen, Gore, and Goe, (1984); all of whom observed that variables characteristic of the classical diffusion model were not good predictors of the adoption of conservation technologies.

References

- Batie, S. S, & Taylor, D. B. (1989). Widespread adoption of non-conventional agriculture: Profitability and impacts. *American Journal of Alternative Agriculture*, 4(3&4), 129-134.

Berry, W. (1977). The unsettling of America: Culture and agriculture. San Francisco: Sierra Club Books.

Beus, C. E., & Dunlap, R. E. (1990). Conventional versus alternative agriculture: The paradigmatic roots of the debate. Rural Sociology, 55,(4), 590-616.

Buttel, F., Gillespie, G., Larson, O., & Harris, C. (1981). The social bases of agrarian environmentalism: A comparative study of Michigan and New York farm operators. Rural Sociology, 46(3), 391-410.

Carlson, J., Dillman, D., & Lassey, W. (1981). The farmer and erosion: Factors influencing the use of control practices. Idaho Agricultural Experiment Station Bulletin No. 610.

Daubom, D. B. (1986). Publicly sponsored Agricultural Research. In A. K. Dahlberg (Ed.), New direction for agriculture and agricultural research: Neglected dimensions and emerging alternatives. Totawa: Rowman and Allenheld.

Ervin, D. E. (1982). Perceptions, attitudes and risk: Overlooked variables in formulating public policy on soil conservation and water quality -- A discussion. In L. A. Christensen & J. Miranowski (Eds.), Perceptions, attitudes, and risks: Overlooked variables in formulating public policy on soil water conservation and water quality. ERS staff report No. AGES 820129. Washington, D.C. Economic Research Service, United States Department of Agriculture.

Green, P., & Heffernan, W. D. (1987). Soil erosion and perception of the problem. Journal of Rural Studies, 3, 151-157.

Heffernan, W., & Green, G. (1981). Applicability of the adoption-diffusion model to resource conservation: The pro-position. Paper presented at the annual meetings of the Rural Sociological Society, San Francisco.

Hightower, J. (1973). Hard tomatoes, hard times. Cambridge: Schenckman.

Klepper, R., Lockeretz, W., Commoner, B., Gertler, M., Fast, S., O'Leary, D., & Blobaum, R. (1977). Economic performance and energy intensiveness on organic and conventional farms in the Corn Belt: A preliminary comparison. American Journal of Agricultural Economics, 59, 1-12.

Lacy, W. B., & Busch, L. (1984). The role of agricultural research for U.S. food security. pp. 298-320. In W. B. Lacy & L. Busch (Eds), Food security in the United States, Boulder, CO: Westview Press.

Lockeretz, W., Shearer, G., & Kohl, D. H. (1981). Organic farmers in the Corn Belt. Science, 211, 540-547.

Korsching, P.F., & Malia, J.E. (1991). Institutional support for practicing sustainable agriculture. American Journal of Alternative Agriculture, 6,(1), 17-22.

Lovejoy, S., & Napier, T. (1986). Conserving soil: Sociology insight. Journal of Soil and Water Conservation, 41, 304-310.

Lovejoy, S., & Parent, D. (1982). Conservation behavior: A look at the explanatory power of the traditional adoption-diffusion model. Paper presented at the annual meeting of the Rural Sociological Society, San Francisco.

Miranowski, J. A. (1982). Overlooked variables in Best Management Practices (BMP): Risks, attitudes and perceptions and human capital characteristics. In Christensen, L. and J.A. Miranowski (Eds.), Perceptions, attitudes and risks: Overlooked variable in formulating public policy on soil conservation and water quality. Staff Report (AGES 820129). United States Department Agriculture, Athens, Georgia.

Napier, T. L., Thraen, C. S., Gore, A., & Goe, W. R. (1984). Factors affecting adoption of conventional and conservation tillage practices in Ohio. Journal of Soil and Water Conservation, *39*, 205-209.

Nowak, P., & Korsching, P. (1983). Social and institutional factors affecting the adoption and maintenance of agricultural BMPs. In F. Schaller and G. Bailey (Eds.), Agricultural Management and Water Quality. Iowa State University Press, Ames, Iowa.

Olson, R., Frank, K., Graboki, P. H., & Rehm, G. W. (1982). Economic and agronomic impacts of varied philosophies of soil testing. Agronomy Journal, *74*, 492-499.

Pampel, F., & van Es, J. C. (1977). Environmental quality and issues of adoption research. Rural Sociology, *42*, 57-71.

Rogers, E. (1983). Diffusion of innovations. New York: The Free Press.

Smathers, W. M., Jr. (1982). Farmers attitudes: Omitted factors in non-point pollution policy. In L.A. Christensen & J. Miranowski (Eds). Perceptions, attitudes and risks: Overlooked variables in formulating public policy on soil and water conservation and water quality. Staff Report

(AGES 820129). United States Department Agriculture, Athens, Georgia.

Swanson, L., Camboni, S., & Napier, T. (1986). Barriers to adoption of soil conservation practices on farms. In S. Lovejoy and T. Napier (Eds.). Conserving soils: Insights from socioeconomic research. Ankeny, Iowa: Soil Conservation Society of America.

Tweeten, L. and Helmers, G. (1990). Comment on alternative agriculture systems. In Alternative Agriculture: Scientists Review. Special Publication No. 16. Council for Agricultural Science and Technology, Ames, Iowa, pp. 134-138.

van Es, J. (1983). The diffusion/adoption tradition applied to resource conservation: Inappropriate use of existing knowledge. The Rural Sociologist, *3*, 26-32.

Westra, P. (1990). LISA: Where do weed scientists fit in? In Alternative Agriculture: Scientist's Review. Special Publication No. 16. Council for Agricultural Science and Technology, Ames, Iowa, pp. 177-182.

Young, D.L. (1989). Policy barriers to sustainable agriculture. American Journal of Alternative Agriculture, *4* (3&4), 135-141.