

FACTORS INFLUENCING THE ADOPTION DECISION: AN ANALYSIS OF ADOPTERS AND NONADOPTERS

Robert N. King, Agriculture Team Leader
Monroe County, Cornell Cooperative Extension

Timothy Rollins, Associate Professor
The Pennsylvania State University

Abstract

This study identified incentives and barriers to the diffusion and adoption of an agricultural innovation, the pre-sidedress nitrogen test (PSNT), evaluated technology transfer processes (educational programs), identified strategies and tactics for technology transfer, and profiled adopters and non adopters. A random sample of 220 adopters and nonadopters indicated that economic and technical information as well as change agents' attitudes impacted the adoption decision. Farm management information and economic concepts required to facilitate adoption decisions were absent during the original educational program. Adopters indicated that economic variables, saving money and inexpensive to use, influenced their adoption decision. Both adopters and nonadopters either did not possess or adhere to the prerequisite knowledge and skills in soil sampling to correctly perform the PSNT. When promoting agricultural innovations, educational programs should include economic and technical information. Change agents attitudes, as reported by farmers, were significant in discriminating adopters from nonadopters. Educators must consider and motivate change agents to promote and follow up on an innovation's use. Change agents need to recall and discuss prerequisite information to help farmers relate to the innovation and use it correctly. Holistic and multi-disciplinary approaches are necessary to promote an agricultural innovation.

The Cooperative Extension Service has the reputation of being one of the world's most successful systems for the diffusion and adoption of agricultural innovations (Rogers, 1988) which consist of ideas, practices, or objects perceived as being new to individuals or industry (Rogers, 1983). The movement of this technology from laboratory to the field has been a significant challenge, and extension has had to recognize and address the psychosocial component of technology adoption as part of the educational process (Barao, 1992) as well as educate potential adopters about the economic aspects of innovations (Rosenberg, 1972).

A critical component of adopting innovations is the educational process used to equip individuals with the necessary knowledge and skills for using that innovation (Rosenberg, 1982). Recent practices and innovations that have been adopted by

America's farmers have been, to a large extent, promoted through educational programs conducted by extension practitioners in the Cooperative Extension Service (Bracewell, Persons, Lakjaa, & Chen, 1993).

Information sources also have a significant impact on adoption of agricultural innovations and should be considered in developing educational programs (Sulaiman, Baggett, & Yoder, 1993). Potential adopters may require an affiliation with at least three communication networks to gain information and learn how to use agricultural innovations: a social communication network; a clique; and, a personal communication network. Communication networks may also influence diffusion and adoption depending on the degree of connectedness, integration, diversity, openness, and linkages within these networks. Communication networks provide feedback that facilitates

understanding and encouragement of an innovation's diffusion and adoption (Rogers & Kincaid, 1981).

It is crucial that potential adopters be educated about economic aspects of an innovation. Supply and demand considerations play an integral role in determining the diffusion and adoption rate, which can be explained by the expected profits from an innovation (Mansfield, 1979; Rosenberg, 1972; Rogers, 1983). These factors may indicate an innovation's potential profitability, assess its risk and uncertainty, and indicate the likelihood of adoption. The less observable or less communicable an innovation may be, the more likely the innovation will be undervalued and hinder its adoption (Mansfield, 1979). In addition, economically useful and technically efficient innovations may never gain market acceptance because potential adopters are unaware of or do not know how to use the innovation. *Economic usefulness requires that benefits occur from using an innovation and that these benefits contribute to economic growth. Technical efficiency includes the appropriate and effective use of agricultural inputs to produce a given level of output.*

Bracewell et al. (1993) found that the most compelling reasons for not adopting a dairy innovation were economics and the time involved in the adoption decision. Economic research supports that economic costs and benefits are a major determinant in describing or predicting the adoption process (Mansfield, 1979). However, economic costs and benefits alone are not sufficient to describe, or predict, the entire adoption decision (Cohen, 1988).

The pre-sidedress nitrogen test (PSNT) is an agricultural innovation that exhibits many of the factors previously identified. The PSNT was designed for use in corn fields by scientists interested in manure management, nutrient management, and public concern about environmental pollution. The PSNT indicates the level of nitrate nitrogen present in soil and enables

farmers to determine, with some degree of certainty, the amount of nitrogen fertilizer required to produce a targeted yield of corn.

In summary, both technical and economic factors are major determinants for describing the adoption of most innovations. Information sources and communication networks also describe the adoption of most innovations because they create awareness and educate potential adopters about an innovation. Consequently, these actions promote observability of the benefits and costs associated with the innovation and, thus, promote its adoption.

Purpose and Objectives

The purpose of this study was to measure and assess factors associated with the technical aspects and economic usefulness of the PSNT. The data provide a basis for designing and developing educational materials for potential adopters of the PSNT. The objectives were to: (1) identify disparities in technical efficiency and economic usefulness of the PSNT; (2) identify farmers' level of knowledge and skill required to use the PSNT; (3) profile farmers who used the PSNT; (4) describe communication networks of farmers; and, (5) identify factors discriminating adopters from nonadopters.

Procedures

Population and Sample

The frame for this study was Pennsylvania farmers (adopters and non-adopters) who had participated in an educational program about the PSNT offered by extension specialists in the Agronomy Department at Penn State University. All of these farmers had used the PSNT and were required to send their soil samples to the university's soils laboratory for analysis. The names and addresses of 515 farmers from 37 central and south-central Pennsylvania counties who had used manure on their corn fields were tabulated into a computer database. Using Cochran's (1977)

formula for sampling proportions, a sample size of 220 farmers was calculated with a correction factor for finite populations due to the small population. A simple random sample was generated by using a computerized random number generator.

Instrumentation

This study used descriptive survey methodology to measure factors associated with the adoption and diffusion of the PSNT. Using Likert scales and multiple response questions, the instrument solicited data about farmer's experience, skills, attitudes, and knowledge about the PSNT. The instrument was examined for content and face validity by eight faculty members in the departments of Agronomy, Agricultural Economics and Rural Sociology, and Agricultural and Extension Education at The Pennsylvania State University. A pilot test (N=14) of the instrument resulted in a Cronbach's alpha of .92 for the experience, skills, and attitudes section and .90 for the information and knowledge section.

Data Collection

Three mailings of the instrument were initiated in late August and ending in December, 1993. The first mailing resulted in a response rate of 28% (60 usable). Five weeks later, a second mailing resulted in an additional response rate of 29% (46 usable). A final mailing five weeks later resulted in an additional response rate of 23% (21 usable). The total response rate for the sample (220) was 127 (61%). Six questionnaires were either undeliverable or unusable for an adjusted usable response rate of 58%.

Responses from the three mailings were statistically compared on key variables relating to demographic and adopter characteristics. Chi-square and one-way ANOVA statistical analyses found no statistical differences ($p \leq .05$)

between the respondents to the three mailings. The Chi-square and t-test statistical analyses on key variables (demographic, economic, knowledge, and skills) revealed no significant differences ($p \leq .05$) between the first mailing with the combination of second and third mailings. According to Miller and Smith (1983), comparison of early and late respondents may be used as a proxy for the profile of non-respondents. No statistical differences were found between early and late respondents; therefore, it was concluded that non-respondents were similar to respondents.

Results

Objective 1: Economic Usefulness and Technical Efficiency

All 127 farmers in the sample had used the PSNT. Figure 1 shows results of a multiple response question (total responses= 352) which solicited farmers' preferences for using the PSNT. The five most frequently selected preferences for using the PSNT were: the ability to test and fine tune nitrogen applications (19%); to save money (18%); as a management tool to prevent nitrogen pollution in ground water (14%); the PSNT was inexpensive (14%); and/or, the PSNT reduced uncertainty about growing a corn crop (13%).

A multiple response question (total responses = 234) asked farmers why they did not like using the PSNT. Farmers reported: the reliability of the PSNT was questionable (23%); the timing of the PSNT conflicted with other production practices (22%); difficulty in taking soil samples (12.5%); drying soil samples (11%); and/or, the PSNT did not reduce uncertainty (8.5%) (Figure 2).

When respondents were asked why other farmers did not use the PSNT, they responded (n=127) that the non-users did not know about the

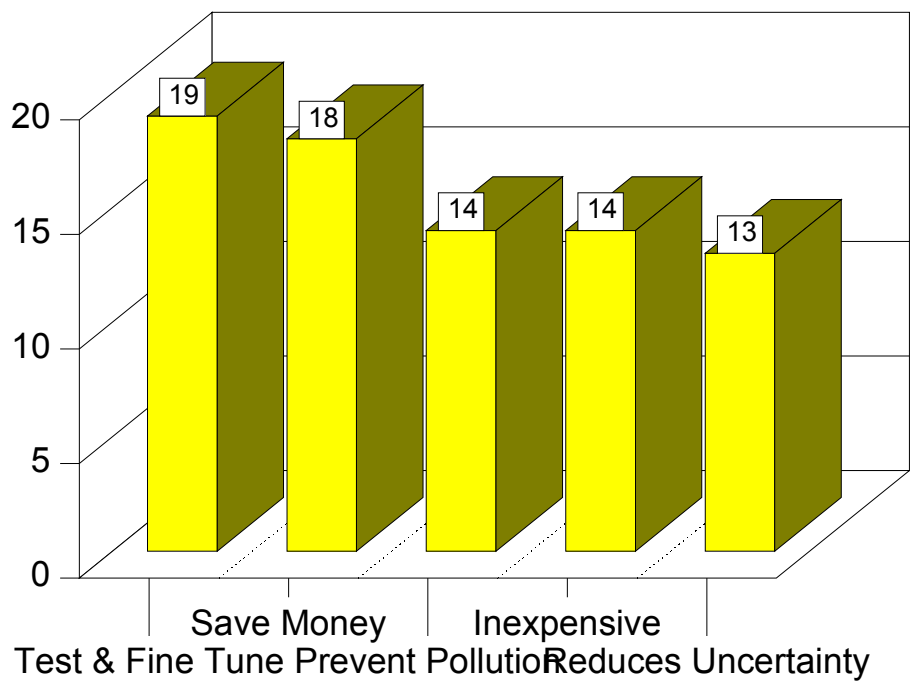


Figure 1. Preferences for Using the PSNT

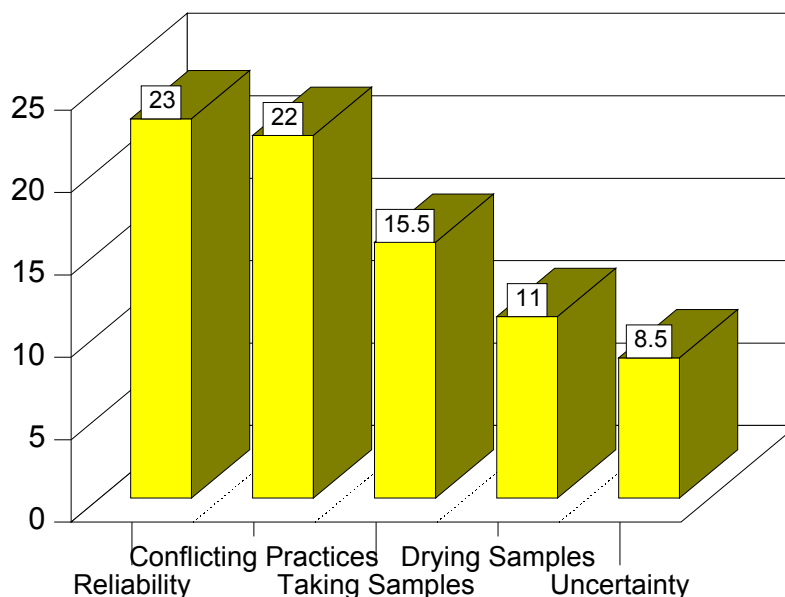


Figure 2. Drawbacks of Using PSNT

Forty-three percent of the respondents indicated that they probably would use the PSNT again; 27% reported they would definitely use the PSNT again, and 30% indicated they would not use it again (15%), or only use the PSNT with major changes (15%).

Objective 2: Farmers' Level of Knowledge and Skill

Several questions assessed farmers' knowledge and skill about the technical guidelines required for using the PSNT. More than 75% of the respondents had violated the guidelines: soil samples were taken at improper depths (68%) or from poorly drained fields (66%); farmers had soil samples dried too late (53%); the PSNT was performed on corn taller than 12 inches (43%); and farmers used the PSNT in fields injected with manure (13%).

Objective 3: Profile of Farmers Using the PSNT

The ages of farmers ranged from 24-75 years with a mean of 45 years. Ninety-nine percent of the farmers were male and almost half (45%) had completed high school; ten percent had less than a high school education while the remainder had some postsecondary education. Farming experience ranged from 5-60 years with a mean of 23 years. Almost two-thirds (62%) of the farmers had herds averaging 58 milking head with an average of 47 heifers.

Two of every three (65%) farmers did not have off-farm jobs. Almost 85% of the farmers were responsible for making major management decisions concerning the land they owned and operated. About 80% of the farmers planted corn

Table 1. Information Sources Used by Farmers

Descriptor	Information Source
Trustworthy:	University Specialist (28%); Crop Management Consultant (21%); Local Dealer (12%); Private Consultant (12%)
Knowledgeable:	University Specialist; County Extension Agent (15%); Crop Management Consultant (15%)
Available/ Convenient:	Local Dealer (36%); Crop Management Consultant (28%); Ag Chemical Representative (12%)
Up-to-Date:	University Specialist (25%); Local Dealer (19%); Crop Management Consultant (19%)
Locally Relevant:	Local Dealer (31%); County Extension Agent (21%); Crop Management Consultant (17%)
Preferred:	Crop Management Consultant (23%); Own Experience/Knowledge (18%); Local Dealer (15%)

for grain on an average of 81 acres. About half of the farmers applied their own nitrogen while almost one-third indicated that most of their nitrogen applications were made while sidedressing. Generally, the PSNT was used by male, middle-aged farmers with a high school education who had dairy operations of fewer than 125 head or other animal operations with a great diversity in farm income.

Objective 4: Communication Networks of Farmers

Table 1 reveals farmers' responses to six questions which asked them to attribute six descriptors to the sources of information they used for fertilizer application decisions, techniques, and products. The most trustworthy source of information was university specialists, followed closely by crop management consultants, private consultants and local dealers.

The most knowledgeable source of information was university specialists, with crop management consultants and county extension agents rating

equally as the next most knowledgeable source. The two sources rated most available and convenient were the local dealer and crop management consultants. University specialists, local dealers, and consultants were rated as the three top up-to-date sources of information. Local dealers, county extension agents, and crop management consultants were the most locally relevant sources of information. Crop management consultants were the most preferred source of information. The second most preferred source of information was a farmer's own experience and knowledge, followed by local dealers, county extension agents, and university specialists.

Objective 5: Factors Discriminating Adopters and Nonadopters

Participants were asked if they would use the PSNT in the future and, based on their responses, were categorized into two groups. Those who answered Definitely (n = 30) were categorized as adopters, and those who answered Only with major changes/No (n = 19) were categorized as

nonadopters. Independent t-tests revealed that adopters and nonadopters differed significantly on eight factors (Table 2) measuring attitudes of change agents and farmers. The t-tests revealed that nonadopters possessed negative to mixed attitudes (2.6) concerning their impression of the

PSNT and their willingness to recommend it (2.4). Adopters reported positive attitudes concerning their impression of the PSNT (4.3) and their willingness to recommend it (4.0). In addition, nonadopters reported that attitudes of farmers and change agents (1.7-2.1) were negative.

Table 2. Factors that Discriminated Adopters from Nonadopters

Discriminating Factors	Adopters (n=30)		Nonadopters (n=19)		t-value
	Mean	SD	Mean	SD	
Farmers attitudes	3.7	2.3	1.7	3.5	2.9**
Extension agent attitudes	4.1	2.0	2.1	2.7	4.1**
Government agent attitudes	3.9	3.0	1.7	2.7	2.7**
Consultant attitudes	3.7	1.6	1.7	2.1	3.4**
Impression	4.3	0.9	2.6	1.4	4.7**
Recommend	4.0	1.0	2.4	1.5	4.0**
Confidence	5.9	1.0	4.1	2.0	3.7**

** Significant at $p \leq .01$; Attitudes scale: 0 (Don't know), 1 (Very Negative), 2 (Negative), 3 (Mixed), 4 (Positive), 5 (Very positive); Confidence scale: 1 (Not at all confident) to 7 (Very confident).

Nonadopters were skeptical (4.1) of the PSNT while adopters were not as skeptical (5.9). However, adopters reported that attitudes of other farmers and change agents were mixed (2.8).

Economic, demographic, knowledge, and skill variables measured categorically were used in a logistic regression model to develop categories for the dependent variable (two levels: adopter or nonadopter). The dependent variables found statistically significant as a result of the independent t-tests (Table 2) were included as independent variables in several regression models. Table 3 shows the significant model that correctly classified 92.3% of the respondents. This model has two variables: (1) inexpensive to use; and, (2) saves money. Other logistic regression models were tested; t-test variables were not significant in classifying adopters and nonadopters. All of these independent variables resulted in no statistical significance even though adding an independent variable with other independent variables in a regression equation can influence the relationship of any or all independent variables with the

dependent variable (Gujarati, 1992).

Conclusions

Farmers were high school educated males with a wide range of farm incomes. They assessed the PSNT by the economic variables "saving money" and/or "inexpensive to use." These variables were statistically significant in discriminating between adopters and nonadopters and economic usefulness did impact farmers' adoption decision. Interestingly, this technology is not meant to increase profits or save money, but to promote the efficient use of nitrogen which may or may not increase profits.

Technical efficiency impacted farmers' adoption decisions. Several technical factors (reliability, conflicting practices, and taking and drying soil samples) were barriers to adoption. This impacted the reliability of the test, and consequently, the willingness to use the test again. The PSNT is a relatively uncomplicated innovation, yet the knowledge and skills that are crucial for its

technical efficiency are not within the repertoire of farmers.

Farmers indicated that university specialists were the most trustworthy, knowledgeable, and up-to-date sources of information. Both adopters and nonadopters reported that information sources (change agents) had mixed and negative attitudes toward the innovation. In this study, change agent attitudes were a barrier to the adoption of the PSNT.

The findings indicate that an instructional solution exists. Some of the technical and economic discrepancies can be corrected by a follow-up educational program that includes information about soil sampling.

Economic and technical factors largely described adoption of this innovation. Information sources and communication networks created

Table 3. Economic Variables Classifying Adopters and Nonadopters (N=39)

Variable	Beta	SE	df	Sig	R	Exp(B)
Inexpensive to use	-1.7	.76	1	.025	-.24	.181
Saves money	-2.32	.72	1	.001	-.40	.097
Constant	-1.40	.77	1	.069		

awareness and provided the education for using the innovation. However, a lack of skills and knowledge for using the innovation still existed after the educational program was concluded. In addition, the perceived attitudes among change agents were found to be statistically significant in discriminating adopters from nonadopters. Therefore, the evidence suggests that the benefits and costs of using the PSNT have been obscured due to inadequate education and less-than-positive attitudes among change agents.

Recommendations

It is vital that educators *pay attention to prerequisites* for using an innovation. University specialists and change agents should not assume that farmers know what they are doing. Many times, educators assume that learners know what they do yet many times learners do not.

If farmers intentionally violated PSNT guidelines, they need to be aware that proper soil sampling is critical for reliable test results. Attention must be given to the prerequisite

knowledge and skills to use an innovation. More than 20 years ago, Walsh and Beaton (1973) found that poor soil sampling techniques adversely impacted laboratory soil testing. Not surprisingly, the PSNT was also adversely impacted due to poor soil sampling techniques.

Educators should *include information about economic usefulness*. Farmers have been conditioned by Cooperative Extension and other agencies to think of maximizing yields rather than maximizing profits or promoting efficient use of inputs. Profits are a major reason to adopt any innovation, especially the PSNT. Risk, opportunity costs, production possibilities, and competing production practices can dramatically impact a farmer's adoption decision.

Educators should *consider potential information sources* when promoting adoption. Information sources varied in their effectiveness for promoting the adoption of the PSNT.

Educators must *motivate change agents to promote adoption*. Change agents' attitudes impact

the adoption of an innovation. Change agents should also be encouraged to follow up on the innovation's use to ensure that it is being used appropriately.

Educators must use *a holistic and multidisciplinary approach* to promote the adoption of an innovation. This requires more than providing information about engineering and science; this also includes information about farm management and economic concepts.

Implications

Little documentation exists concerning what constitutes effective and efficient instruction for technology transfer to occur. Farmers did not possess the prerequisite knowledge and skills to use the PSNT and thus they based their evaluations of the PSNT contrary to its intended purpose. This suggests that previous and current instruction about soil sampling and the PSNT are not effective.

New technologies and innovations have been characterized as management intensive which will require farmers to achieve performance standards and possess skills and knowledge, and a strong farm management background. Historically, Cooperative Extension has engaged in nonformal "adult" education. A paradigm shift to a more formal process maybe difficult to achieve and may cause dramatic changes in the mission of Cooperative Extension.

Due to new technologies, innovations, and regulations, basic education concerning production and farm management practices is more critical than ever. Change agents need to recall and discuss basic information that helps farmers relate to the innovation and reinforces previous knowledge and skills required for its use. The trick is to package old information in a manner that captures a farmer's attention.

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