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Beliefs of Farmers and Adoption of Integrated Pest Management

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Abstract

Georgia peanut farmers have adopted integrated pest management (IPM) on only a limited basis, although objective data indicate that IPM technology may be more efficient than conventional pest control strategies. Users and nonusers of IPM hold different views pertaining to the consequences of employing IPM. These beliefs influence its use. Educational programs on these beliefs should influence adoption and continued use of IPM. This article analyzes belief data pertaining to IPM among 192 Georgia peanut farmers and explores the relationship between beliefs about IPM and its adoption.

Keywords

Integrated pest management, risk, beliefs

Introduction

Integrated pest management (IPM) programs have recently expanded to encompass a multitude of crops. IPM programs are generally designed to optimally manage pest populations so that producers' profits are maintained or enhanced with minimal environmental degradation. Recent economic analysis indicates that peanut producers who employ a mean level of IPM have 34-percent higher profits and significantly lower insecticide expenditures compared with conventional pest control (14).¹ Despite this economic advantage, farmers have been relatively slow to adopt IPM, less than 40 percent of Georgia peanut acreage is currently under some

type of IPM program (9). One popular explanation of this slow adoption rate is that response to risk impedes adoption of new practices (5, 7, 27). A previous study of IPM adoption in California investigated risk preferences and subjective probability distributions of IPM users and nonusers (13). The two groups indicated no differences in risk preferences, but each group perceived that its practice was the least risky.

This prominence of risk aversion in economic adoption literature reflects an attempt to explain behavior inconsistent with neoclassical microeconomics under certainty with an alternative economic theory. A potential weakness of this approach is that not all departures from neoclassical profit or utility maximization can be attributed to risk aversion (25, 28).

Risk aversion can be confused with behavior under certainty because of dynamic considerations (3), incomplete specification of resource constraints (4), dispersion of price expectations (24), and transactions costs for commodities which are periodically both inputs and outputs (26). Carlson recently concluded that risk aversion may not affect pest control decisions even though pest control does affect risk

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¹Italicized numbers in parentheses refer to items in the References at the end of this article.

(6) In a broader view, neither profit maximization nor risk aversion may be the most important goals in pest control. Economists often tend to use their theory to explain behavior motivated by goals and constraints outside the realm of economics. Dillon, a pioneer in risk analysis in agricultural economics, endorses this view in reference to the relationship between risk and economic development.

Most people would agree that uncertainty prevails in underdeveloped agriculture and that development would be facilitated by an appreciation, understanding and recognition of this uncertainty. While not disagreeing with this assessment, my view, however, is that uncertainty is not a major detriment to agricultural development. It is far overshadowed by the influence of political goals, resource ownership, human capital stock, social power, tradition, and ignorance. Compared to these, uncertainty is just a marginal element in most less developed countries. We do best to recognize uncertainty, of course, but we delude ourselves if we think of it as a key factor to development except in countries where occasional crop failures on a grand national scale are not expected (8, p. 37).

Literature on goals of U.S. farmers also supports the existence of noneconomic goals (23). Thus, a study of the importance of economic goals in the adoption of IPM should also include other broader goals for comparison.

The purpose of this article is to present an interdisciplinary study of the relationship between risk and other perceptions of farmers and their adoption of IPM. Working with entomologists and psychologists, we identified potentially important economic and other consequences of decisions on pest control related to IPM. We represented these aspects as "belief measures," a psychological concept. We collected belief data on IPM, including a risk measure, for Georgia peanut producers in a 1982 telephone survey.

The Concept of Beliefs

Beliefs are defined as information one holds about a particular object and are different from a related term, attitudes. Attitudes are affective or emotional responses one has toward an object. For example,

the statement "I do not like IPM" is an attitude, "IPM increases returns" is a belief. Although theoretical constructs are often difficult to reconcile among different disciplines, attitudes are similar to the economic concept of preferences, and beliefs are similar to the concept of expectations including subjective probability distributions (20). Belief measures have at least two advantages for this study. First, the concept is flexible enough to encompass both economic and other perceptions about IPM. Measurement of beliefs has extensive psychometric foundations and is not subject to the empirical problems of the conventional economic measures of risk preferences and subjective probability distributions.²

The psychological literature has two alternative theories concerning the relationship between beliefs and behavior. *Learning theory* espouses the view that beliefs underlie attitudes which, in turn, motivate a response or behavior (12). For example, the belief that IPM increases returns leads to a positive attitude towards IPM and eventual adoption. *Cognitive dissonance* is the second theory about the relationship between beliefs and behavior. A central proposition of this theory is that holding attitudes and beliefs inconsistent with current behavior is discomforting. These attitudes and beliefs are modified to become consistent with current behavior (11). Cognitive dissonance theory implies that beliefs may not explain use of IPM, but may instead reflect a rationalization of current behavior. Under this theory, differences in beliefs would not explain adoption.

Assuming that IPM is more profitable than are conventional control methods, users may have adopted IPM, under learning theory, because they gained in-

²Musser and Musser recently reviewed the literature on problems in eliciting risk preferences and probability distributions in relationship to psychological theories on risk decisions (20). The main empirical problems are instability of the measures at different times and lack of evidence on the relationship between these measures and behavior. Problems with these procedures are not surprising considering the current psychological evidence that individuals are poor intuitive statisticians. For example, individuals tend to overweight current or otherwise very salient outcomes over more distant outcomes, and they do not consider prior information such as suggested by Bayes Law. Furthermore, they overweight unlikely events and underweight more likely events. Agricultural economists have been aware of this literature for some time (2). However, they have not fully appreciated the implications of the literature on economic methodology. Kahneman and Tversky provide a recent introductory survey of some of this literature (16).

formation from educational materials or observations of other farmers, causing them to develop positive beliefs about IPM. However, farmers who have not adopted IPM have not developed these same positive beliefs because they lack access to or trust in the information about IPM. In contrast, cognitive dissonance would imply that these respective beliefs did not motivate adoption behavior, but arose *ex post facto* to rationalize behavior in a consistent manner.

The learning approach is more consistent with the perspective of economic theory and the whole rationale of the agricultural land-grant system. Under this view, an investigation of beliefs among IPM users and farmers who practice conventional control methods may reveal differences in beliefs that could be used to design an educational program to modify beliefs and, therefore, to change behavior. In contrast, the cognitive dissonance approach suggests limited usefulness of an educational program to change behavior. Beliefs about and support for IPM would change after IPM was adopted. Adoption may require coercion through the political-legal system or some stronger economic incentives such as subsidies.

As with all theories, both theories are abstractions of human behavior, and both may operate at different times. For example, a positive belief may motivate behavior which in turn motivates a more positive belief towards the behavior. Alternatively, some beliefs about an object may motivate behavior towards that object, whereas other distinct beliefs may adjust rationalization to behavior. Given the considerable differential relevance of the two theories for public programs on IPM adoption, it is important to distinguish the process involved in the belief formation. Testing the alternative theories of IPM is unfortunately difficult in a cross-sectional study such as this article. Under the learning approach, IPM users should have more positive beliefs about the benefits of IPM than do nonusers, who practice conventional methods, because beliefs influence behavior. However, user and nonuser beliefs would adjust to the same pattern for rationalizing behavior under cognitive dissonance. Hanemann and Farnsworth recognize these alternative explanations of their cross-sectional study of IPM adoption (13). Standard methodology to measure beliefs does provide measures of support for various beliefs, which may provide some support for alter-

native theories. For example, positive beliefs about IPM among nonusers is inconsistent with cognitive dissonance.

Further dividing farmers into present users who are currently using IPM, past users who have discontinued use of IPM, and nonusers who have never used IPM may provide additional evidence for these alternative theories. The behavior of past users is an interesting issue. If IPM is in fact, more profitable, then past users were not able to recognize this fact, ignored the information, or had inadequate management to implement IPM. Under learning theory, this process led to more negative beliefs and the reemergence of conventional methods, of course, these beliefs would adjust after the behavioral change under cognitive dissonance. However, cognitive dissonance implies that beliefs of past users would be in the interval between beliefs of present users and nonusers. Beliefs of past users would be more negative than beliefs of present users to rationalize their current behavior, but would still be more positive than beliefs of nonusers because of their need to rationalize past behavior. Under learning theory, a less clear prediction is possible. Past users discontinued IPM because the beliefs that motivated adoption became less positive, thus, their beliefs should be more negative than present users. Although the beliefs of past users may be as negative as those of nonusers, some may have more positive beliefs than nonusers, which could result in a similar pattern for these groups as does cognitive dissonance. However, a different pattern of beliefs could also hold under learning theory. The experience with IPM provided past users with more information about both alternatives, which causes their beliefs to become even more negative than nonusers. Thus, an intermediate positive for past users provides no evidence on the two theories, but the more negative beliefs of past users supports learning theory.

A complete testing of the alternative theories would require time series data on beliefs of each group. Under learning theory, beliefs of present users would be higher than those of nonusers before adoption, and beliefs of past users would be lower than those of present users before discontinuation. Under cognitive dissonance, these differences would not exist before behavior changes but would arise only after behavior change. Although such time series

data were unavailable for this study, the number of years present users have used IPM was available and could provide some evidence on this relationship. As more time elapses, present users should develop a more positive attitude towards IPM under cognitive dissonance to rationalize continued use. A similar relationship could exist under the learning theory if IPM fulfilled expectations. However, the opposite pattern is also consistent with learning theory. Unfulfilled expectations would lower the initial level associated with adoption, if these beliefs decline to a certain point, present users would become past users. Thus, changes in belief among present users through time can reject the cognitive dissonance explanation if beliefs are inversely related to tenure, but these changes cannot definitively reject the learning explanation.

Even if the relationship between beliefs and adoption cannot be established, analyzing differences in beliefs among users and nonusers provides evidence on the importance of different dimensions of IPM programs for the different groups. Beliefs that are more strongly held, as measured by differences between the two groups, are relevant for farmers either in explaining or rationalizing behavior. For example, the differences in risk perceptions found in Hanemann and Farnsworth indicate that their sample is motivated by risk aversion (13). If no differences were found or if the reverse pattern held, the study would have supported the view that risk aversion is not important.

Data

This study on beliefs was part of a larger study which evaluated the IPM program sponsored by the Department of Extension Entomology of the Georgia Cooperative Extension Service. The most important component of the program involved periodic insect counts by scouts and treatment recommendations based on damage thresholds. Present, past, and non-participants in extension IPM were considered present users, past users, and nonusers, respectively, for our study, even though some farmers in Georgia practice IPM outside this program (9).

We obtained belief data on IPM for a stratified random sample of peanut producers in six Georgia counties selected from a list of Georgia peanut producers provided by the Georgia State Office of the

U S Agricultural Stabilization and Conservation Service. From a sample of 240 producers, 192 (80 percent) cooperated in completing a telephone survey. The survey, developed by a team of entomologists, cooperative extension county agents, agricultural economists, and industrial psychologists, was conducted in late spring early summer of 1982.

The survey required several months to devise. Each question was evaluated in terms of its contribution to obtaining the desired information on pest management practices. The questionnaire was pretested at several stages of development, with confusing or misleading questions being clarified or deleted. A copy of the final questionnaire is available in Edwards, Musser, and Wetzstein (10).

Nine students enrolled at the University of Georgia conducted the interviews. Prior to the interviews, the students were provided with an explanation of the questionnaire and its purpose, given appropriate standard answers to probable questions, practice, and feedback. Calls were occasionally monitored and appropriate feedback given. The students placed the telephone calls in the early evening from Sunday through Thursday. The questionnaire contained 46 questions and required slightly less than 30 minutes to complete.

Table 1 lists both the eight belief questions included on the questionnaire and variable names for reference. The belief questions focused on aspects of insect control as important in managerial decisions on IPM use. These questions must be interpreted within the context of the whole questionnaire where users of IPM were considered as participants in the extension scouting program and nonusers apply pesticides on a fixed schedule. "Damage" and "yield" are concerned with monetary costs of insect control, and "profit" is associated with overall profit from use of IPM. "Risk" reflects a safety-first concept of risk which is generally more intuitive than are more general measures like variance associated with expected utility theory (21). "Personnel" and "environmental" were aspects of the use of IPM programs not directly reflected in profit calculations, but they may be important in the managerial process. "Method" was included largely as a methodological check on communication with the producer because the belief corresponds with the actual use of IPM for peanuts in Georgia.

Table 1—Belief measures

Belief variable	Questions ¹
General statement	I'd like to ask for your opinions on pest control strategies. These questions will ask you whether you strongly agree, agree, disagree, or strongly disagree with them. There are no right or wrong answers, these are only your opinions.
Damage	The likelihood of insect damage is lessened with the use of scouts. Do you SA A D SD
Expense	It is less expensive to pay scouts to monitor my fields than spraying on a predetermined schedule. Do you SA A D SD
Personnel	Hiring my scouts on a personal basis rather than going through my county extension program best serves my needs. Do you SA A D SD
Yield	Farmers can expect higher average yields by spraying on a predetermined schedule rather than using scouts. Do you SA A D SD
Environmental	The use of insecticides poses a harmful environmental threat. Do you SA A D SD
Method	In my county the most widely used method of pest control is spraying on a predetermined schedule. Do you SA A D SD
Profit	Some people argue that IPM produces higher profits. Others strongly disagree. Do you SA A D SD with the following statement? Conventional pest management strategies give farmers higher profits.
Risk	People disagree about the differences in yield produced by integrated pest management (IPM) vs. conventional pest management strategies. Some argue that IPM produces better average yield over a period of years. Others say the same for conventional methods. Do you SA A D SD with the following statement? IPM reduces the chances of having extremely low-yielding years.

¹In the questions, strongly agree, agree, disagree, and strongly disagree are coded as SA, A, D, and SD.

To facilitate telephone responses, interviewers gave respondents one of four choices when they answered the questions: (1) strongly agree, (2) agree, (3) disagree, and (4) strongly disagree. These responses were coded 4, 3, 2, and 1, respectively, for statistical analysis, and they were assumed to reflect measurements of continuous theoretical variables.

The assumption in the coding that these responses reflect equal intervals along an underlying scale is

standard methodology in psychometrics. (1) The questions were counterbalanced to preclude a response bias because "strongly agree" is the most positive response to IPM on all beliefs. "Strongly agree" is the most positive for the categories of damage, expense, environmental, and risk, whereas "strongly disagree" is the most positive for personnel, yield, and profits. Questions included in the survey concerned use of IPM in the current year and in past years. These questions were used to

separate respondents into present user, past user, and nonuser groups. Data on tenure of the farmers in IPM were available for only four of the six counties, so analysis of possible changes in IPM beliefs through time were confined to a subset of the sample.

Results

We first applied a multivariable analysis of variance (MANOVA) to the eight belief variables. MANOVA tests the hypothesis of a common set of means for the eight variables in the three producer IPM groups (19). The MANOVA F test was significant at the 1-percent level, thus, the hypothesis of common means can be rejected. We then used analysis of variance (ANOVA) of each belief variable by IPM use group to determine which variables contributed to the MANOVA result. Table 2 summarizes the ANOVA results along with mean responses for each producer group.

The damage, expense, personnel, and yield variables were directly concerned with the use of insect scouts, which is the most important component of IPM programs in Georgia. The expense question had different responses among the groups significant at the 10-percent level, and the other three variables had differences significant at the 1-percent level.

Present users believed that scouting reduced insect damage, was less expensive, and resulted in higher yields. Although the beliefs of present users differ significantly from the other two groups, the mean response for all producers indicated that they either agreed or strongly agreed that scouting reduced damage and was less expensive. For the yield questions, present users disagreed that higher yields resulted from spraying on a predetermined schedule rather than from using scouts; mean values of the other two groups lay between disagree and agree.

Table 2—IPM belief results, by user group

Belief	Mean value			ANOVA F statistic	Significance level ¹
	Present user	Past user	Nonuser		
Damage ²	3.23	3.08	2.93	6.98	0.0012***
Expense ²	3.39	3.23	3.06	2.66	0.0727*
Personnel ³	2.42	2.73	3.30	5.14	0.0067***
Yield ³	1.95	2.65	2.43	5.85	0.0035***
Environmental ²	2.31	2.50	2.72	1.85	0.1607
Method ⁴	2.60	2.73	2.72	23	0.7936
Profit ³	2.22	2.62	2.72	6.16	0.0026***
Risk ²	3.07	3.77	3.54	3.27	0.0404**
Number of producers	106	26	54	NA	NA

NA = Not applicable

¹ * = Significant at the 10 percent level,

** = Significant at the 5-percent level, and

*** = Significant at the 1 percent level

²Large number indicates positive belief about IPM

³Small number indicates positive belief about IPM

⁴This variable is a methodological check on communication with the producer. The magnitude of the number indicates no level of belief about IPM.

Thus, the effect of insect control on yields seemed to indicate more important differences than did the components measured by these other three variables

The profit question also produced differences among the groups significant at the 1-percent level with group patterns similar to the yield question. Users disagreed that conventional pest management strategies give farmers higher profits, whereas past and nonusers generally tended to agree more with this statement. The mean responses to expense, yield, and profit questions indicate that the differences in beliefs on profits associated with IPM use arose from differences in yields and revenues rather than costs. These beliefs only partially correspond with economic analysis of IPM use by Georgia peanut farmers. In their study of IPM use in Georgia peanut production, Hatcher, Wetzstein, and Douce found a significant reduction in insecticide cost, which corresponded to beliefs of all groups, and a significant increase in yields, which is consistent only with the beliefs of users (14).

For the risk question, all groups tend to agree that IPM reduces the chances of having extremely low-yielding years. In fact, past users and nonusers generally believe more strongly that IPM reduces variability. Differences between these groups were significant at the 5-percent level. These results sharply contrast with the previous findings of Hanemann and Farnsworth (13). Because belief measurement has fewer methodological problems than does elicitation of subjective probabilities, the findings of this article are credible. If the risk responses are interpreted jointly with the profit responses for each group in isolation, they seem plausible with expected utility theory. Users adopt IPM because they believe it raises average profits and lowers risk, whereas the other group does not adopt IPM because the sacrifices in expected profits does not compensate for the decreased risk. However, the pattern of risk responses among the groups is difficult to rationalize. Assuming producers are risk averse, the risk responses are definitely inconsistent with cognitive dissonance; users have a less positive view than do the other two groups. Although these beliefs might be consistent with learning, they do not explain the behavior. Profits alone explain behavior as well as profit and risk, suggesting that risk is not important in explaining the use of IPM.

If one relaxes the assumption of risk aversion, responses to the risk question are consistent with farmers' being risk seekers. Under this assumption, the low value for present users' risk response would be a positive belief in IPM, the higher value for nonusers' risk response would be a negative belief, and the even higher value for past users' risk response would be a negative belief arising from learning behavior. As Young notes, past studies measuring risk preferences found some farmers' being risk seekers (28). However, the complete sample would probably not be dominated by risk-preferring behavior. Furthermore, the interest in risk in the adoption literature is motivated by an assumption of risk aversion, that is, risk seekers would readily adopt new technology perceived as being risky. This assumption does not seem a plausible method of interpreting risk. The results support the general view emerging in the literature reviewed in the introduction to this article—namely, risk is not important in the IPM adoption decision.

The method and environmental questions did not significantly differ among the groups. The mean responses to the method question were similar and indicated a tendency to agree. These responses indicated that producers had some knowledge of current pest control methods and that respondents were serious in their responses to at least this survey question. All groups had mean responses to the environmental question that were neutral; the mean responses had as much difference as some of the other variables, but had high variances as reflected in the F statistic.

Mean responses for past users were within the interval between present users and nonusers for most variables. Exceptions were the yield and risk questions. Past users tended to agree that higher yields resulted from spraying on a predetermined schedule rather than from using scouts, with a mean response of 2.65 compared with 2.43 for nonusers and 1.95 for present users. Past users strongly agreed with a mean response of 3.77, compared with 3.07 for present users and 3.54 for nonusers, that IPM reduces the chances of having extremely low-yielding years. Thus, past users believe that not practicing IPM will boost average yields and promote greater yield variability than do the other groups. The response on risk is again not consistent with their status as past users under either learning or cognitive dissonance. The yield response contradicts cognitive dissonance and suggests that

experience with low yields contributed to past users' abandonment of IPM. Their management ability may have precluded implementing IPM practices, and their belief may have reflected this experience. This belief may have resulted from spurious correlation, the series of recent droughts in Georgia was probably the main reason for lower yields. Good extension information may have precluded formation of and action on this belief.

Besides responses from past users on yield and risk, overall responses to some variables also support learning theory. The nonusers' mean response of 3.54 on risk does not suggest reduction of cognitive dissonance. Similarly, nonusers' mean response of 2.93 on the damage question and 3.06 on the expense question indicates that they agreed with positive statements about IPM which is inconsistent with their behavior. The mean response of 2.42 on the personnel question for present users is also not consistent with current behavior. Finally, the largely neutral mean responses with large variances to the environmental question are inconsistent with cognitive dissonance, more consistent tendencies on this belief could have been a rationalization for behavior unrelated to profits of the business. No evidence on profit, which does have large differences among groups, is available, unfortunately.

We used linear regression analysis of beliefs of the present user groups to provide further evidence on the relationship between beliefs and behavior. We regressed the eight belief measures separately on the number of years a present user had participated in IPM. Data were available for 52 IPM users in four counties in 1979-82. We included county dummy variables in the regression analysis to account for possible differences in climatic and soil conditions. Table 3 gives the regression results. As previously discussed, a negative coefficient on years of IPM use is inconsistent with cognitive dissonance where "strongly agree" indicates a positive belief about IPM, and vice versa.

The regression analysis was not highly satisfactory. The R^2 s were extremely low, even for cross sectional regressions. None of the county dummy variables differed significantly from zero, indicating no geographical differences in beliefs between these three counties and the county with no dummy variable. Years of IPM use was significant at the

5-percent level in the damage equation. This negative coefficient indicated that the belief that the likelihood of insect damage is lessened with the use of scouts declined through time for users, which was inconsistent with cognitive dissonance. The coefficient on years of IPM use did not differ significantly from zero in the other equations. Furthermore, the signs of these coefficients do not prove the alternative theories in most cases.

Conclusions

Results support the view from earlier research that IPM users and nonusers hold different views about the consequences of IPM use. As expected, users of IPM hold more positive beliefs about IPM than nonusers, except one. The single exception concerned risk which, contrary to earlier research, had a reverse pattern. Because no theoretical explanation exists for the response pattern obtained on the risk question, these results suggest that beliefs about risk are not related to adoption of IPM. However, beliefs on average yields probably influence adoption and continued use of IPM. Although no direct evidence existed that beliefs on average profits influenced adoption of IPM, the predominance of evidence against cognitive dissonance processes for the other beliefs supports the view that the differences in beliefs on average profits also affect adoption. Thus, the results support the emerging trend in agricultural economics literature that profit maximization may explain much economic behavior formerly attributed to risk aversion. More research on this issue in reference to IPM seems warranted.

Results in tables 2 and 3 also support the view that beliefs about IPM influence adoption rather than reflect a cognitive dissonance response. Under this view, processing information correctly may influence beliefs and, therefore, adoption. These results directly affect the Cooperative Extension Service's National IPM Impact Study, which was designed to evaluate IPM programs in various States. This impact study outlines in detail the possible advantages of IPM over conventional practices. Our study indicates that the National IPM Impact Study can positively influence producers' adoption of IPM.

The psychological literature also suggests some methods to influence incorrect beliefs. Hovland,

Table 3—Regression results for belief and years of use for present users¹

Belief measure	Intercept	Years of IPM use	County dummies			R ²
			1	2	3	
Damage ²	4 00** (14 16)	-0 19* (-2 44)	0 23 (1 16)	0 06 (27)	0 11 (50)	0 16
Expense ²	3 25** (11 42)	06 (70)	15 (72)	18 (- 79)	40 (1 74)	12
Personnel ³	2 29** (3 98)	- 04 (- 26)	- 29 (- 71)	- 13 (- 30)	52 (1 12)	08
Yield ³	1 81** (3 28)	(- 05) (- 31)	58 (1 47)	54 (1 23)	02 (04)	07
Environmental ²	2 26** (5 73)	- 05 (- 42)	- 50 (-1 50)	17 (46)	52 (-1 38)	11
Method ⁴	3 45* (4 94)	- 23 (-1 20)	5 97 (00)	04 (06)	- 82 (-1 46)	08
Profit ³	2 69* (7 16)	- 06 (- 61)	19 (- 70)	- 004 (- 01)	- 42 (-1 38)	05
Risk ²	1 96** (2 84)	23 (1 21)	15 (30)	28 (50)	1 10 (1 98)	11

NA = Not applicable

** = Significant at the 1 percent level

* = Significant at the 5 percent level

¹t-values appear in parentheses

²Large number indicates positive belief about IPM

³Small number indicates positive belief about IPM

⁴This variable is a methodological check on communication with the producer. The magnitude of the number indicates no level of belief about IPM

Janis, and Kelley suggest that correct information that is different from original beliefs must be provided in a way that incentives for change are provided (15). Such incentives might be a change in either the content of a message about the belief object or a perception about the expertise or prestige of the communicator. The recent emphasis on IPM evaluation by agricultural economists could provide these new incentives. Profit is probably a stronger motivator for farmers than are insect damage or environmental concerns about insecticide use. Furthermore, the perceived expertise of agricultural economists is important in reinforcing the expertise of entomologists involved in IPM programs.

Assessing IPM beliefs would be helpful in identifying incorrect beliefs of nonusers so as to develop

educational programs which could change behavior. Furthermore, such an assessment might document the importance of both entomologists and agricultural economists in the evaluation and education program. Data in table 2 demonstrate these propositions. Beliefs of nonusers can be modified by evidence that field scouting tends to decrease crop damage and pesticide expenditures and to increase yield and net returns, both areas of entomological and economic expertise. Changing these beliefs may help encourage adoption. Information about the effect of IPM on average yields may renew the interest of past users in IPM. Finally, reinforcing beliefs of present users with information about the consequences of IPM is important to maintaining IPM use. We should place particular effort on developing and disseminating information about differences in yield and profits, the two beliefs about which

significant disagreement existed between users and other groups

Use of psychometric methodology to understand farm management decisions has potential in other areas beyond IPM programs. Psychological methodology has had limited use in agricultural economic research on farm firm decisions. Krause and Williams (18), and recent work by Klieberstein and others (17) and by Patrick, Blake, and Whitaker (22), on modeling multiple goals are exceptions. However, many adoption problems in agricultural production are similar to the IPM issue we discuss here. Adopting new technologies to facilitate agricultural development, which was the concern of much of the risk literature we reviewed in the introduction, is an obvious extension. Several issues of public concern in farm management may also be amenable to similar research, soil conservation, water conservation, and marketing strategies are several examples. Assessment of beliefs about adoption establishes the relevance of different forms of economic information in planning research and extension programs.

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