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Executive Summary

Growing concerns about pesticide residues in fresh produce could result in increased demand for low-input agriculture with reduced pesticide residues, and decreased demand for conventional fresh produce. The objective of this study was to empirically evaluate consumer concern about pesticide residues and analyze the effect of socio-demographic factors on pesticide residue concern. Two separate surveys were used to provide data about consumer risk perceptions and demographic characteristics.

Statistical models using data from both surveys show that females are approximately 9 to 14 percent more likely to be risk averse toward pesticides than males. Furthermore, both surveys indicate that households with children are more likely to be risk averse than those without children. Specifically, the earlier survey (1990) indicates that households with at least one child were 11 percent more likely to be risk averse than households without children. The more recent survey (1997) shows households with two or more children to be 22 percent more likely to be risk averse. Those who frequently purchase organic produce and those who grew vegetables for consumption in their home were both found to be at least 18 percent more likely to be risk averse than those who did not. Individuals over 35 years of age are more likely to have high levels of risk aversion toward pesticide residues and suburban households were found to be 10 percent more likely than rural or urban households to be risk averse. The result also indicated that households with higher levels of income and education generally exhibit lower risk aversions.

With sustainable and environmentally safer forms of agriculture likely to comprise a more significant share of the nation's food production, marketing research must be implemented to ascertain public willingness-to-purchase of such produce. Predicting which consumers are likely to have high concerns about synthetic pesticide residues should be beneficial to identifying those who are more likely to purchase low-input agriculture such as IPM and organically grown produce.

Introduction

Pesticide residue has repeatedly been documented as the leading source of food safety concern among consumers (Byrne et al., 1991; Misra, Huang and Ott, 1991; Govindasamy, Italia and Liptak, 1997). Regardless of whether these fears are legitimate or exaggerated, public perceptions of the risk posed by pesticides can translate into very real effects in the marketplace (Dunlap and Beus, 1992). Widespread fears of pesticide residues in recent years have helped to renew interest in low-input agriculture. Accordingly, organic produce is now commonly found in most major supermarkets and integrated pest management methods of crop protection has received increasing public and research attention. Even so, the majority of growers still rely heavily on pesticides as their primary defense against insect, weed, and disease damage. The concern for grocery shoppers over pesticide usage has not been limited to their personal health. In an altruistic sense, significant concerns about the pesticide induced external damage to farm workers, groundwater, wildlife, and the environment have also been documented (Weaver, 1992).

Possible reasons for this behavior may be due in part to the uncertainty inherent to agrichemical use. For instance, it is impossible for any individual to quantify how much pesticide residue he or she is exposed to without explicit product labeling. Debates within the scientific community about the safety of insecticides and herbicides as well as specific events such as the Alar and Chilean grape incidents that have been widely publicized in the media have no doubt contributed to the concerns of consumers. The growing concern of residues in fresh produce could manifest itself as changes in consumer behavior in two ways: (1) an increased demand for low-input agriculture with reduced pesticide residues or (2) decreased demand for conventional fresh produce (Weaver, 1992). For low-input agriculture to be marketed successfully, it will be necessary to determine whether consumer concern for pesticide residues has resulted in fundamental changes in consumer attitudes and behavior. An important foundation of this process is to assess which segments of the population are highly risk averse to pesticide usage.

The objective of this study was to empirically evaluate consumer concern about pesticide residues and analyze the effect of socio-demographic factors on pesticide residue concern. Two surveys conducted by Rutgers Cooperative Extension were utilized as data sources. It was initially hypothesized that various socio-demographic variables influence consumer risk perceptions of pesticide residue. A logit framework was used to quantify the effect of various demographic factors on the risk aversions of consumers.

Review of Literature

While studies have found only modest variation in pesticide concern across different segments of the public, most have found that women are more likely than men to place pesticide residues as a top concern. Additionally, younger adults tend to show more concern over pesticide usage than older adults (Dunlap and Beus, 1992).

A pioneering study by Bealer and Willitis in 1965 indicated a general acceptance of pesticide use existed at the time of their analysis. This initiative was among the first empirical studies to measure consumer perception of synthetic pesticides. When compared to Bealer and Willitis original findings, consumer perceptions have changed dramatically over the past thirty years. Only one half of the Pennsylvania residents surveyed at that time indicated that they believed chemical pesticides were harmful to wildlife and residues consumed by humans were found to have an even lower level of concern. Only 6% of respondents reported that they were very concerned about pesticide use and approximately one half responded they were not at all concerned (Kidwell, 1994; Bealer and Willitis, 1968). Socio-demographic characteristics did not appear to play a major role in affecting consumer beliefs about pesticides. The attributes tested included age, gender, education, income, place of residence, and religious preferences all of which suggested that there were no statistically significant differences between those who were risk averse to pesticide usage and those who were not. However, the study did find that those who were most concerned about pesticide residues had the least confidence in government inspection, farmer's care in selecting and applying pesticides, and the effectiveness of washing produce with water when compared to participants with little or no concern about pesticide use (Kidwell, 1994).

In 1984, a follow-up to the Bealer and Willitis study was completed by Sachs, Blair, and Richter. A survey was again administered in Pennsylvania which included many of the same questions as the 1965 survey. Many of the demographic characteristics of the two samples were also similar. The results indicated that consumer concerns over pesticide usage had risen and knowledge of pest control practices had greatly increased. Concern was also escalated for pesticide damage to wildlife and agricultural workers. Regression analysis indicated that none of the differences between 1965 and 1984 could be explained by socio-demographic factors. However, the extensive media coverage of environmental issues throughout the 1960's and 1970's may account for much of this shift in public opinion.

Respondents to a 1989 survey conducted by Cornell University felt that the lack of absolute evidence, the lack of simple precise documents addressing pesticide concerns, and conflicting information from experts all contributed to the complexity and level of public pesticide fears. Participants saw the pesticide dilemma as a long term problem due to the vested interests of chemical manufacturers and the necessity of pest control which conflicted with public health and environmental fears (Ostiguy et al., 1990).

An ongoing nationwide study by the Food Marketing Institute, which began in 1984, reported that consumers consistently rank pesticides as the most serious food hazard. With a low of 73 percent ranking pesticides as their top food safety fear in 1985, concern has generally increased each year since (Dunlap and Beus, 1992).

In a California study of consumer response to information about IPM, Bruhn et al. (1992) found that younger individuals and those with lower levels of education were both more likely to express uncertainty about the safety of food grown in the U.S.

Approximately 40% of the respondents noted that they had avoided some produce items due to safety concerns. Similarly, over 50% of Hispanic consumers indicated that they have stopped purchasing certain fruits and vegetables due to food safety concerns (Diaz-Knauf et al., 1995).

A telephone survey of Idaho residents by Dunlap and Beus (1992) examined public attitudes toward pesticides and investigated if these attitudes could be predicted by demographic characteristics. While men and women exhibited approximately the same amount of trust in the food system, women were significantly more concerned about the safety of pesticide usage. Younger adults and those with higher levels of education were found to be more concerned about pesticide usage than their counterparts. Individuals with higher levels of education were also more likely to see pesticide usage as necessary. Overall, the survey demonstrated that pesticide usage in agriculture is seen as a serious risk that elicits a high level of public concern. Yet, despite this perceived risk, the results indicate that many consumers still see a role for pesticides in modern agriculture. Similarly, other studies have indicated that the general public sees a positive relationship between the use of pesticides and both the size of the food supply and aesthetic appearance of produce (Dunlap and Beus, 1992; Govindasamy, Italia, and Liptak, 1997).

Both Byrne et al. (1991) and Dunlap and Beus (1992) documented that pesticide residue concern levels were found to be lower for high earning households. However, Byrne et al. found that those with higher levels of education exhibited lower pesticide residues concerns. Safety information from the academic community was found to have the greatest likelihood of acceptance by consumers when compared to other information sources such as the government and the media. Other polls have indicated that 70-85% of the national population exhibits a medium to high degree of concern toward pesticide residues and pesticide usage. A study of four U.S. cities reported that 83% of respondents were risk averse to pesticide usage (Zellner and Degner, 1989), and another survey had 86% of respondents expressing concern for pesticide usage (Zind, 1990). In a survey conducted by Cornell University, 46% of the respondents indicated they were very concerned about the use of chemical pesticides in growing food for consumption, while 50% were somewhat concerned and only 4% were unconcerned (Burgess et al., 1989).

Risk perceptions have a significant effect on consumers' attitudes toward pesticide use which can, in turn, influence willingness-to-pay for produce (Huang, 1993). Risk aversion toward pesticide residues was tested as a function of several independent variables which included gender, education level, age, population density of region, employment, and housing ownership/renting. The results of the study suggest that females are more likely to place pesticide residues as a top food concern.

Personal experience with pesticide usage appears to lower risk aversions toward them. Home gardeners, especially those who use chemical pesticides, were found to be less likely to be concerned about foods grown using pesticides and were less willing to support a ban of them (Ott, Huang, and Misra, 1991). While most consumers have reported being risk averse to pesticide residues found in commercial produce, they are themselves quite liberal with pesticide application at home. In a survey of homeowners and gardeners (Grieshop et al., 1992) which examined the basis for choosing between chemical pesticides and non-chemical alternatives, gender, age, and the number of years the individual had been using pesticides were found to be significantly correlated with pesticide use. Over one half of an urban California sample chose not to use protective clothing while applying pesticides and two-fifths did not read the labels before administration (Grieshop and Stiles, 1989). Men were also found to choose chemical pesticides more often than females over non-chemical alternatives.

Methodology

The logit model was selected as the regression method in this analysis because its asymptotic characteristic constrains the predicted probabilities to a range of zero to one. The logit technique is a better procedure for capturing the magnitude of the independent variable effects for qualitative variables than probit models (Amemiya, 1983). The logit model is also favored for its mathematical simplicity and is commonly used in a settings where the dependent variable is binary. Because the data source provided individual rather than aggregate observations, the common estimation method of choice was the maximum likelihood method (Gujarati, 1992). Among the beneficial characteristics of MLE are that the parameter estimates are consistent and asymptotically efficient (Pindyck and Rubinfeld, 1991).

The empirical model assumes that the probability of being highly risk averse toward pesticide residues, P_i, is dependent on a vector of independent variables (X_{ij}) associated with consumer i and variable j, and a vector of unknown parameters β. The likelihood of observing the dependent variable was tested as a function of variables which included socio-demographic and consumption characteristics.

$$\mathbf{P_i = F(Z_i) = F(\alpha + \beta X_i) = 1 / [1 + exp(-Z_i)]}$$

Where:

$F(Z_i)$	=	represents the value of the standard normal density function associated with each possible value of the underlying index Z_i.
P_i	=	the probability observing a specific outcome of the dependant variable (i.e. the individual would be highly risk averse) given the independent variables X_is
e	=	the base of natural logarithms approximately equal to 2.7182
Z_i	=	the underlying index number or βX_i
α	=	the intercept

And βX_i is a linear combination of independent variables so that:

$$\mathbf{Z_i = log [P_i /(1- P_i)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + . . . + \beta_n X_n + \varepsilon}$$

Where:

i	=	1,2,. . . ,n are observations
X_n	=	the n^{th} explanatory variable for the i^{th} observation
β	=	the parameters to be estimated
ε	=	the error or disturbance term

The parameter estimates do not directly represent the effect of the independent variables. To obtain the estimators for continuous explanatory variables in the logit model, the changes in probability that $Y_i = 1(P_i)$ brought about by a change in the independent variable, X_{ij} is given by

$$(\partial \mathbf{P_i} / \partial \mathbf{X_{ij}}) = [\beta_j \exp(-\beta X_{ij})] / [1+\exp(-\beta X_{ij})]^2$$

For qualitative discrete variables such as the explanatory variables used in this study, $\partial \mathbf{P_i}/\partial \mathbf{X_{ij}}$ does not exist. Probability changes are then determined by:

$$(\partial P_i / \partial X_{ij}) = P_i(Y_i : X_{ij} = 1) - P_i(Y_i : X_{ij} = 0)$$

The following models were developed to predict the likelihood of being highly risk averse toward pesticide residues:

Specification of Model One - (1990 Data)

Risk = β_0 + β_1 Female + β_2 Age + β_3 Education + β_4 Income + β_5 Children + β_6 Single + β_7 Married + β_8 Separated&Divorced + β_9 Suburb + β_{10} Supermarket + β_{11} Hsize

Where:

Risk	=	1 if the individual was highly averse toward pesticide usage and 0 otherwise.
Female	=	1 if the individual is female and 0 otherwise.
Age	=	1 if the individual is 35 or younger and 0 otherwise.
Education	=	1 if the individual indicated that the highest level of education they had completed was high school and 0 otherwise.
Income	=	1 if the household income was under $40,000 and 0 otherwise.
Children	=	1 if the household has children and 0 otherwise.
Single	=	1 if the individual was single and 0 otherwise.
Married	=	1 if the individual was married and 0 otherwise.
SepDiv	=	1 if the individual was either presently separated or divorced and 0 otherwise.
Supermarket	=	1 if the individual visits a supermarket more than 3 time a week and 0 otherwise.
Suburban	=	1 if the individual resides in a suburban neighborhood and 0 otherwise.
Hsize	=	1 if the number of individuals living in the household were 3 or more and 0 otherwise.

Specification of Model Two - (1997 Data)

$$\begin{aligned}Risk = \beta_0 &+ \beta_1 Male + \beta_2 Age1 + \beta_3 Age2 + \beta_4 Age3 + \beta_5 Income2 + \beta_6 Income3 \\ &+ \beta_7 Income4 + \beta_8 Education1 + \beta_9 Education2 + \beta_{10} Suburb \\ &+ \beta_{11} Rural + \beta_{12} Organic + \beta_{13} Visit + \beta_{14} Garden + \beta_{15} Negative \\ &+ \beta_{16} No\text{-}Diff + \beta_{17} Hsize + \beta_{18} 2Kids + \beta_{19} Media1 + \beta_{20} Media2.\end{aligned}$$

Where:

Risk = 1 if the individual believed that the use of pesticide posed a very serious health risk and 0 otherwise.
Male = 1 if the individual is male and 0 otherwise.
Age1 = 1 if the individual at least 65 years of age and 0 otherwise.
Age2 = 1 if the individual is between 51 to 64 years of age and 0 otherwise.
Age3 = 1 if the individual is between 36 and 50 years of age and 0 otherwise.
Income2 = 1 if the household income was between $30,000 and $49,999 and 0 otherwise.
Income3 = 1 if the household income was between $50,000 and $69,999 and 0 otherwise.
Income4 = 1 if the household income was over $70,000 and 0 otherwise.
Education1 = 1 if highest level of education attained by the participant was a high school degree and 0 otherwise.
Education2 = 1 if highest level of education attained by the participant was higher than a high school degree but less than a Masters Degree and 0 otherwise.
Suburban = 1 if the individual resides in an Suburban neighborhood and 0 otherwise.
Rural = 1 if the individual resides in a rural area and 0 otherwise.
Organic = 1 if the individual frequently purchases organic produce and 0 otherwise.
Visit = 1 if the individual indicated they had visited a farmers' market within the past five years and 0 otherwise.
Garden = 1 if fruits and vegetables were grow for consumption at the household and 0 otherwise.
Negative = 1 if the individual believed that the use of pesticides had a negative effect on the environment and 0 otherwise.
No-Diff = 1 if the individual felt there was no difference in the safety of low-input and conventional produce.
Hsize = 1 if 4 or more individuals presently reside in the household and 0 otherwise.
2Kids = 1 if two or more children under the age of 17 reside in the household and 0 otherwise.
Media1 = 1 if the participant indicated that they regularly made use of food advertisements and 0 otherwise.
Media2 = 1 if the participant indicated that they regularly made use of media reports on food safety and 0 otherwise.

Data Description

The data for this study was collected from two separate mail surveys conducted by Rutgers Cooperative Extension. The use of two data sources allowed for the comparison of results between two periods in time. Additionally, the more recent survey incorporated more explanatory variables than were available with the earlier data set.

The first survey, administered in 1990, contained data about characteristics important to food purchasing behavior as well as health and environmental risk perceptions. A small incentive of one dollar enclosed with each survey was sent to 1,195 households randomly contacted by mail yielding a total of 656 responses and a response rate of 55 percent.

Table 1 provides a descriptive tabulation of the variables used in model one. The dependent variable was based upon a survey question which asked the respondents to indicate how risky they felt the use of pesticides were to human health. Overall, 39 percent of the respondents indicated that they believed the use of pesticides was very risky.

Approximately 68 percent of respondents were female and 73 percent had at least some college. About 33 percent of the participants were 35 years of age or below, while approximately 37 percent of the respondents had annual household incomes of less than $39,999. About half the respondents (48%), purchased groceries for children who lived in their household. About 11 percent of respondents were single, 73 percent were married, 8 percent were separated or divorced and 8 percent were widowed. About 21 percent lived in rural or urban areas while 79 percent lived in suburban areas. Of those responding, 92 percent visited a supermarket three times or less per week, and 53 percent of the households surveyed were comprised of three or more individuals. The average household size was 2.9 individuals.

In addition to the 1990 questionnaire, a short consumer survey was administered in the Spring 1997 at several food retail locations in central New Jersey. To minimize bias, the study was presented to participants as a “survey of consumers of fresh vegetables” with no mention of pesticides made prior to handing out the questionnaire. In total, 408 surveys were physically distributed to respondents generating a sample of 291 responses and a response rate of 71 percent. Topics in the survey questionnaire were based on an amalgamation of several surveys developed for assessing the demand for organic produce. In addition to attitudes and preferences, the questionnaire included items relating to demographic information such as age, gender, income, education, and household size. Questions related to consumer risk perceptions and the premium price that consumers would be willing to pay for organic produce were a primary focus of the survey. Table 2 provides a descriptive tabulation of the variables used in model two. In administering the questionnaire, the major food purchaser for the household was encouraged to be the study participant. Before distribution, the survey was pre-tested by a group of randomly selected individuals. The pre-tested surveys were not included in the final data set. The survey data was input into a flat text file which was subsequently read by SAS running on a UNIX platform for descriptive and econometric analysis.

Specific questions were included to ascertain perceptions of pesticide use and pesticide concern levels. Of the 291 participants that responded, 60 percent felt that pesticides posed a very serious risk to human health, 37 percent felt pesticides were somewhat hazardous while only 3 percent felt they were not hazardous. Approximately 55 percent believed that conventional produce was generally safe to consume, while 44 percent were unsure or disagreed. Similarly, 58 percent of the respondents believed that there was a difference in the safety of consuming conventional and low-input agriculture. Only 10 percent believed that there was no difference in the safety of conventional and low-input agriculture while 32 percent were unsure. The majority of respondents (66 percent) indicated that they believed the use of synthetic pesticides had a negative effect on the environment while 26 percent were unsure and only 9 percent disagreed.

All the explanatory variables included in the regression models were binary dummy variables generated from categorical questions in the two surveys. Dummy variables were chosen because of the qualitative nature of the responses (Pindyck and Rubinfeld, 1991). In many cases, similar categories were combined (such as divorced and separated) when there were too few responses in a given category. When dropping categories to prevent perfect collinearity, an effort was also made to omit either the highest or lowest category in situations such as age or income to make the interpretation of results easier.

Table 1: Explanatory Variables for Model 1

Variable	***Mean***	***Std. Deviation***
Gender		
Female	0.68	0.4768
Male*	0.32	0.4668
Age		
Less than 35 years of age	0.33	0.4718
More than 35 years of age*	0.67	0.4718
Education		
High School Degree	0.27	0.4458
College or Graduate studies*	0.73	0.4458
Annual Household Income		
$39,999 or less	0.37	0.4837
$40,000 or more*	0.63	0.4837
Children in the Household		
Yes	0.48	0.5000
No*	0.52	0.5000
Marital Status		
Single	0.11	0.3093
Married	0.73	0.4473
Separated/Divorced	0.08	0.2724
Widowed*	0.08	0.2652
Regional Location		
Suburban	0.79	0.4071
Rural and Urban*	0.21	0.3881
Frequency of Supermarket Visits		
More than three times per week	0.08	0.2652
Three or less per week*	0.92	0.2652
Household Size		
Three or more individuals	0.53	0.4997
Less than three individuals*	0.47	0.4997

* Refers to omitted category in the logit analysis

Table 2: Dependent and Explanatory Variables for Model 2

Variable		*Freq.*	*Mean*	*Std. Dev.*
Dependent Variable:				
Do you believe residues from pesticide pose a very serious hazard?				
(Risk)	Yes	175	0.601	0.4905
	No*	116	0.399	0.4905
Explanatory Variables:				
Gender				
(Male)	Male	100	0.344	0.4757
	Female*	191	0.656	0.4757
Age				
(Age4)	Less than 36 years of age*	68	0.234	0.4239
(Age3)	36 - 50 years of age	103	0.354	0.4790
(Age2)	51 - 65 years of age	69	0.237	0.4260
(Age1)	Over 65 years of age	51	0.175	0.3808
Annual Household Income				
(Income1)	$29,999 or less	48	0.165	0.3718
(Income2)	$30,000 to $49,999	58	0.199	0.4001
(Income3)	$50,000 to $69,999	58	0.199	0.4001
(Income4)	$70,000 or more*	127	0.436	0.4968
Education				
(Education1)	High School Degree	43	0.148	0.3555
(Education2)	Some College - Some Graduate School	169	0.581	0.4942
(Education3)	Masters or Doctoral Degree*	79	0.271	0.4455
Regional Location				
(Suburb)	Suburban	229	0.787	0.4102
(Rural)	Rural	39	0.134	0.3413
(Urban)	Urban	23	0.079	0.2703
Do you usually purchase organic produce?				
(Organic)	Yes	99	0.340	0.4746
	No*	192	0.660	0.4746
Have You Visited a Farmer's Market in the past five years?				
(Visit)	Yes	257	0.883	0.3218
	No*	34	0.117	0.3218
Do you grow fruits or vegetables at home?				
(Garden)	Yes	97	0.333	0.4722
	No*	194	0.667	0.4722

Do you think the use of synthetic pesticide has a negative effect on the environment?				
(Negative)	Yes	193	0.663	0.4734
	No*	98	0.337	0.4734
Do you believe that there is a significant difference in the safety of IPM, organic and conventionally grown produce?				
(No-Diff)	Yes	255	0.876	0.3298
	No*	36	0.124	0.3298
Household Size				
(Hsize)	Four or more individuals	67	0.770	0.4217
	Less than four individuals*	224	0.230	0.4217
Are there two or more children residing in the household?				
(2Kids)	Yes	53	0.182	0.3866
	No*	238	0.818	0.3866
Do you usually make use of food advertisements?				
(Media1)	Yes	64	0.220	0.4149
	No*	227	0.780	0.4149
Do you usually make use of media reports on food safety?				
(Media2)	Yes	119	0.409	0.4925
	No*	172	0.591	0.4925

* Refers to category that was generally omitted in the logit analysis. Please refer to the actual specification of each model.

Because R^2 values are not typically high for cross sectional data, (Kennedy, 1992; Nayga and Capps, 1992; Kmenta, 1971), more weight was given to the number of significant variables as a means of selecting the final model specifications. In this study, variables were considered significant at the 0.10 level, however those significant at the 0.05 and 0.01 level are also labeled as such in the regression tables. Another statistic that was used in selecting models was a joint p-value which was calculated to test the null hypothesis that the coefficients of all explanatory variables are zero. The lower the joint p-value, the greater the likelihood of having significant coefficients among the set of explanatory variables. The joint p-values for the final accepted models were both 0.0001.

Results: Model One (1990 Data)

Regression models one and two in this bulletin are measures of risk aversion toward pesticide usage. Model one uses data from the 1990 survey while model two uses data from the 1997 survey. In the case of the dependent variable of model one, 248 respondents believed the use of pesticides was "very risky" while 393 respondents believed the use of pesticides was "less than very risky."

The maximum likelihood estimates for the risk aversion logit analysis are displayed in tables three and four. The dependent variable equaled 1 for participants who believed pesticide residues posed a very serious risk and 0 otherwise. The results indicate that females are more likely to have high levels of risk aversion than males, a finding that has been substantiated by other studies (Byrne et al., 1991; Huang, 1993; Penner, Kramer, and Frantz, 1985). While the stereotypical family is more complex and difficult to define than it once was, and while women have more fully entered the work force, they are nevertheless still more active in deciding and preparing what American families eat. In the majority of U.S. households, women are the primary grocery shopper and women do approximately 90% of the cooking. These factors may help to explain why females were 9.5 percent more likely to be "very concerned" with pesticide resides than males.

Households with children were more likely to be concerned with pesticide usage than were households without children. Of the significant variables, having children resulted in the largest change in probability (11%) of being risk averse. While not significant, a dummy variable to capture the effect of household size was found to have a sign consistent with the results of households having children (i.e. larger households are highly correlated with families having children). Households of three or more individuals were more likely than smaller households to be concerned with pesticides. Furthermore, single individuals, who accounted for many of the smallest households, were found to be the least concerned with pesticide residues (.11 significance level). A possible interpretation is that individuals having less responsibility for selecting and providing food for others are, on average, less concerned about pesticide residues. Conversely, individuals more intimately involved in selecting food for others (i.e. households with children, larger households, and females) may be more cautious or display higher risk aversions.

Suburban households were found to be 10 percent more likely to have higher pesticide risk aversions when compared to the combined rural and urban household group. Individuals below the age of 35 were found to be less concerned with pesticide residues when compared to older respondents. Those who were under the age of 35 were 8 percent less likely to be very concerned with pesticide residues than individuals 35 or older. While marital status was not significant, it was consistent with the marginal age estimates. The base group, individuals who were widowed, were both the oldest as a marital status group and also more concerned with pesticide residues than the single, married and separated/divorced groups. Similarly, single respondents were both the youngest and least concerned with pesticide residues.

Intuitively, we would expect that households with higher levels of income and education would exhibit higher risk aversions toward pesticide residues. However, as with other similar studies (Byrne et al. for example), the opposite was found to be true. While households with higher incomes had a greater ability to purchase low-input agriculture, they were in fact less concerned about pesticide residues. Individuals with annual household incomes of under $40,000 were found to be 8.7 percent more likely to be concerned with pesticides than those with higher incomes. Similarly, those who attained only a high school degree were 10 percent more likely to believe pesticides were riskier than individuals who had higher levels of education. This may be partially explained by the levels of trust individuals place in government and scientific safety standards. Higher levels of education were found to increase the level of acceptance of university scientists and federal agencies (Byrne et al.). Further, higher annual incomes are normally correlated with higher levels of education. If collectively, the higher educated and higher earning group of respondents are more trusting of government and scientific statements regarding the safety of chemical pesticides, this may account for some of the differences between lower levels of income and education.

The tabulation of prediction success is shown in table four. With a 50-50 classification scheme, approximately 62 percent of the individuals in the sample were correctly classified as either having a very high risk aversion to pesticides or not having a high risk aversion using the logit specification.

Results: Model Two (1997 Data)

The dependent variable in model two (RISK), which was also used as an explanatory variable in many of the other models, was coded as one if the respondents believed there was a “very serious” risk from the use of pesticides and 0 if they indicated a moderate level or no risk existed. Overall, 60.1 percent of respondents were categorized under serious risk aversion while the remaining 39.9 percent were categorized under less than serious risk aversion. The regression results for model two are given in tables five and six. Model two exhibited a McFadden’s R^2 statistic of 0.22 and a joint p-value for all explanatory variables of 0.0001.

As expected, males were 14 percent less likely to be risk averse toward pesticide usage than were females, a finding that was significant at the 0.05 level. While none of the age variables were significant in model two, all three of the estimated coefficients

Table 3: Regression Results, 1990 Data

Variable	***Estimate***	***Standard Error***	***Change in Probability***
Intercept***	-1.2621	0.3944	-0.2962
Female**	0.4026	0.1840	0.0946
Age < 35*	-0.3324	0.1901	-0.0780
High School**	0.4465	0.2018	0.1048
Income < $40,000*	0.3709	0.1986	0.0871
Children**	0.4674	0.2319	0.1097
Single	-0.6353	0.4025	-0.1491
Married	-0.2540	0.3168	-0.0596
Separated/Divorced	-0.3415	0.4085	-0.0801
Suburban**	0.4180	0.2173	0.0981
Supermarket	-0.2554	0.3227	-0.5994
Household Size	0.1498	0.2337	0.0352

Joint p value for all explanatory variables = 0001.
McFadden's R^2 = 0.04.
Ratio of nonzero observations to the total number of observations: 0.384.
* = significant at the .10 level.
** = significant at the .05 level.
*** = significant at the .01 level.

Table 4: Predictive Accuracy of Model 1

		Predicted	
		0	1
Actual	0	353	200
	1	44	48

Number of correct predictions = 401.
Percentage of correct predictions = 62.2.

suggested that the youngest age group (AGE4) was the least risk averse. Both the gender and age estimates of risk aversion in model two were consistent with those in model one.

Only one of the three income variables was significant, however, all three suggested that the lowest earning group (INCOME1) was the least risk averse. The significant variable (INCOME2) indicated that those who earned $30,000 to $49,999 annually were 20 percent less likely to be risk averse than those earning less than $30,000. Both education variables suggested that those at higher levels of education were less risk averse than those at lower levels. The education estimates were also consistent with those in model one.

Of the two media variables included in model two, MEDIA2 was significant indicating that those who made frequent use of food safety reports were 32 percent more likely to be risk averse than those who did not. Other highly significant variables indicated that those who frequently purchased organic produce (ORGANIC), those who maintained a garden (GARDEN) and those who believed pesticides had a negative effect on the environment (NEGATIVE) were all more likely to be risk averse than those who did not. As anticipated, organic purchasers were 25 percent more likely to be risk averse than non-organic purchasers. Those who grew fruits and vegetables for consumption at home were 18 percent more likely to be risk averse than those who did not. Those who believed there were negative environmental effects of pesticide usage were 15 percent more likely to be classified as risk averse than those who were not. While not significant, participants who felt there was no difference in the safety of conventional and low-input agriculture were less likely to be risk averse than those who believed there was a difference in safety.

Table 5: Regression Results, 1997 Data

Variable	Estimate	Standard Error	Change in Probability
Intercept	-0.6420	0.8475	-0.1474
Male**	-0.5977	0.3058	-0.1373
Age1	0.0963	0.4832	0.0221
Age2	0.2686	0.4240	0.0617
Age3	0.4762	0.3920	0.1093
Income2*	0.8914	0.5167	0.2047
Income3	0.1504	0.5203	0.0345
Income4	0.1608	0.4758	0.0369
Education1	0.5864	0.5182	0.1346
Education2	0.2219	0.3318	0.0510
Suburb	-0.7082	0.5666	-0.1626
Rural	-0.9009	0.6670	-0.2069
Organic***	1.1051	0.3345	0.2537
Visit	-0.2645	0.4441	-0.0607
Garden***	0.7855	0.3166	0.1804
Negative**	0.6544	0.3078	0.1503
No-Diff	-0.2046	0.4269	-0.0470
Hsize*	-0.8319	0.5011	-0.1910
Kids*	0.9499	0.5468	0.2181
Media1	-0.0076	0.3700	-0.0017
Media2***	1.4129	0.3210	0.3244

Joint p value for all explanatory variables = 0.0001.
McFadden's R^2 = 0.22.
Ratio of nonzero observations to the total number of observations: 0.601.
* = significant at the .10 level.
** = significant at the .05 level.
*** = significant at the .01 level.

Table 6: Predictive Accuracy of Model 2

		Predicted	
		0	1
Actual	0	61	44
	1	55	131

Number of correct predictions = 192.
Percentage of correct predictions = 66.0.

Conclusion

Males were significantly less concerned about pesticide residues than females. These findings were consistent with previous studies, most of which have found that women are more likely than men to place pesticide residue as a top concern (Dunlap and Beus, 1992). Huang (1993) also found that females are more likely to place pesticide residues as a top food concern and also that females were more likely than males to pay a premium for certified residue free produce.

Both models suggested that younger individuals were less concerned about pesticide residues than older individuals. This was consistent with the findings of Ott (1990) who reported that consumers over 40 years of age seemed to be more concerned about pesticide usage that those younger than 40. However, Dunlap and Beus found that younger adults tended to show more concern over pesticide usage than older adults. Similarly Bruhn et al. reported that younger people were more likely to express uncertainty about the safety of domestically grown food.

Inconsistent results were found when using income as a predictor of risk aversion to pesticide residues. Model two suggested that risk aversion increased with income while model one which used the 1990 data suggested that risk aversion decreased with income. The findings in model two were more statistically significant than model one and also more consistent with the findings of previous research. Most of the previous studies have found a decrease in food safety concern as household income rises (Buzby et al., Byrne et al., Dunlap and Beus, Jussaume and Judson).

Using the 1990 data, those with only high school diplomas were found to be more likely to have risk aversions toward pesticide usage; however, education variables were insignificant in the risk aversion model constructed from 1997 data. It is difficult to compare these results to previous studies. Inconclusive findings have been reported regarding the effect of education and pesticide residue concern. For instance, Dunlap and Beus (1992) found that higher educated individuals were more averse to pesticide usage. Conversely, Byrne et al. (1991) reported that pesticide concern levels were lower for more highly educated households.

The effect of having children under the age of 17 was found to significantly increase the risk aversion to pesticide residues in both models. Other nationwide studies have documented similar linkages between households with children and food safety concerns (Diaz-Knauf et al. 1995; Bruhn et al., 1992). As expected those who frequently purchased organic produce were more likely to be risk averse toward pesticide usage. Suburban households were more likely to be risk averse than urban or rural households.

Table 7 - Summarized Effects of Key Explanatory Variables

Explanatory Variable	***Model One (1990)***	***Model Two (1997)***	***Composite Findings***
Male	-	-	-
Education	+		+
Income	-		-
Age	+		+
Organic		+	+
Media2		+	+
Children	+	+	+
Suburban	+		+
Home Garden		+	+

Table 7 above summarizes the directional effect of many of the statistically significant findings. Innovative farms are trying to capture the demand for quality agricultural produce by producing Integrated Pest Management produce and organic produce. Predicting consumer risk perceptions may help farmers meet the consumer demand for quality agricultural produce.

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