FARMER ACCEPTABILITY AND ATTITUDES TOWARDS ZERO-TILLAGE

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FARMER ACCEPTABILITY AND ATTITUDES TOWARDS ZERO-TILLAGE

BY

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ABSTRACT

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Farmer acceptability and attitudes towards zero-tillage were studied using a combination of mail and telephone questionnaires. A mail questionnaire was used to determine the personal and demographic characteristics of a sample of 500 Manitoba farmers. These characteristics were in turn used to determine if prediction models, based on combinations of the personal and demographic characteristics, could be developed to predict successfully whether an individual was an adopter or a non-adopter of zero-tillage.

Seven prediction models were developed and tested. Three were capable of predicting with at least 80% accuracy whether an individual was an adopter or non-adopter of zero-tillage. The prediction accuracy of the remaining four models ranged from 49% to 78%.

A series of four marketing treatments, designed to persuade an individual to adopt zero-tillage were mailed to one-half of the original sample of 500 farmers. The marketing treatments did not persuade the recipients to adopt zero-tillage although they did have an effect on the way in which they perceived the attributes of zero-tillage.

A telephone survey was used to determine how each farmer perceived the attributes of zero-tillage. These perceived attributes were analysed to determine if a prediction model could be developed that could

successfully predict whether an individual was an adopter or non-adopter of zero-tillage. Two such models were developed and tested. One model achieved a prediction accuracy of 63%, while the other was 71% accurate. These classification levels were considered useful although they were not statistically acceptable..

The perceived attribute questionnaire was not so good a predictor as the personal and demographic survey. The former, however, utilized substantially fewer questions (19 vs. 97 questions) to develop the prediction model and as such was considered to be more efficient.

A personal and demographic profile was developed for the adopting farmers. Only one characteristic showed a significant relationship between adopters and non-adopters, i.e., farm location. A larger proportion of adopters than non-adopters were located in Northwestern and Northern Manitoba. There was also a larger percentage of non-adopters than adopters in North Central and Southeastern Manitoba.

Although the differences were not significant, adopters tended to be older, have more years of farming experience, less education, a higher gross farm income, and larger farms than non-adopters.

The marketing treatments affected the way in which farmers perceived some of the characteristics of zero-tillage. They were effective in altering how a farmer perceived the advantages of zero-tillage, the amount of risk involved in the adoption of zero-tillage and the observability of zero-tillage.

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INTRODUCTION

Zero-tillage crop production has been a widely accepted agricultural practice in the United Kingdom for decades, and more recently in the United States. In Canada, however, it has not gained popularity and can be considered one of the most recent agricultural innovations.

Zero-tillage crop production research in Manitoba began in 1969. Donaghy (1973) showed that the production of small grains and oilseed crops was feasible in Manitoba using zero-tillage. Chinsuwan (1976) designed an adaptation for a double disc press drill so that the drill could be used for zero-tillage. Nelson (1975) and Taylor (1977) investigated a number of herbicides that could be used for pre-seeding weed control. The consensus among these research scientists, and others, was that zero-tillage was at a technological stage whereby it could be successfully practiced in Manitoba, and for that matter in Western Canada.

The objectives of this study were to determine (1) if adopters of zero-tillage could be identified with 80% accuracy based on their personal and demographic characteristics; (2) if adopters of zero-tillage could be identified with 80% accuracy based on the way in which they perceived the attributes of zero-tillage; (3) if marketing treatments developed to persuade individuals to adopt zero-tillage were effective, and (4) if a profile of an adoption type could be developed using their psychographic and demographic characteristics.

their thoughts about the attributes of zero-tillage. The prediction accuracy of the two questionnaires was then compared. The final mail questionnaire was issued to determine which farmers had adopted zero-tillage.

Marketing treatments were developed to persuade one-half of the group to adopt zero-tillage. An evaluation of the persuasiveness of the marketing treatments was conducted. In addition, the effectiveness of the marketing treatments in altering how the farmers perceived zero-tillage was evaluated. Finally, the psychographic and demographic characteristics of the adopting farmers were compared with the non-adopters in an attempt to develop a profile of an adopter.

REVIEW OF LITERATURE

A. DIFFUSION RESEARCH

One of the most important causes of change in the farming community is technological innovation. New ideas are largely the result of the efforts of agricultural scientists, commercial companies and provincial and federal agricultural research stations. Change agents, such as the extension services, then communicate these innovations to rural audiences. The communication of these new ideas is called the diffusion process (Rogers and Shoemaker, 1971).

Diffusion is the way in which an innovation spreads among members of a social system and is a slow complicated process. Diffusion studies are primarily concerned with messages that embody new ideas. An innovation is an idea, practice, or object, perceived as new by an individual. An innovation may have initially been introduced several years earlier in a different social system. However, when brought to a new area it can be, and is, perceived as an innovation.

One of the early pioneers in diffusion research was Wilson (1927). He studied the ratio of innovations adopted relative to the cost of their diffusion. Sixteen years later, Ryan and Gross (1943) interviewed 259 farmers located in two small Iowa communities to determine their adoption of hybrid corn seed. The major findings of this study were:

(1) First use of hybrid seed followed a bell-shaped (but not exactly normal) distribution when plotted over time. Four adopter categories were classified on the basis of first use of hybrid seed. The social

characteristics, such as age, social status, and cosmopoliteness of both the earliest and the latest adopters were also determined.

(2) The innovation-decision period from first knowledge to the adoption decision average about nine years for all respondents. This finding lead to a clearer realization that the innovation-decision process involved considerable deliberation by most adopters, even in the case of an innovation with spectacular results.

(3) The typical farmer first heard of hybrid seed from a salesman but neighbours were the most frequent channel leading to persuasion. Salesmen were more important channels for earlier adopters, and neighbours were more important for later adopters.

The Ryan and Gross study provided the springboard for diffusion research. The field mushroomed during the 1950's and 60's to such an extent that Rogers and Shoemaker (1971), in attempting to collect all information regarding diffusion, found that there were 1,084 independent empirical publications available. The innovations studied ranged from the adoption of hybrid corn (Ryan and Gross, 1943) to the purchase of a rotary engine car (Feldman, et al, 1975).

Diffusion researchers have long recognized that an individual's decision about an innovation was not an instantaneous act. Rather it was a process that occurred over a period of time. The North Central Rural Sociology Subcommittee for the Study of Diffusion of Farm Practices (1955) (Rogers and Shoemaker, 1971) divided this process into five categories:

(1) Awareness stage - the individual learns of the existance of a new idea but lacks information about it.

(2) Interest stage - the individual develops interest in the innovation and seeks additional information about it.

(3) Evaluation stage - the individual makes mental application of the new idea to his present and anticipated future situation and decides whether or not to try it.

(4) Trial stage - the individual actually applies the new idea on a small scale in order to determine its utility in his own situation.

(5) Adoption/non-adoption stage - the individual uses the new idea continuously on a full scale or rejects the idea completely.

This adoption process will vary in length of time from the awareness to the adoption/non-adoption stage. While it may take an innovation such as fertilizer only 5 to 6 years to reach complete adoption in a community, another innovation such as artificial insemination of dairy cows may require decades to reach widespread use.

The innovation-decision process has been described as the mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject and to later confirmation of this decision. Rogers and Shoemaker (1971) site an example of this innovation-decision process for a Thai farmer who adopted a new rice variety and can be seen in Table 1.

This particular farmer adopted the new rice seed in 1969, but discontinued its use the following year. However, the average farmer in his community adopted it in 1966. We can therefore say that our farmer was less innovative than the average farmer in his community. Innovativeness is "the degree to which an individual is relatively earlier in adopting new ideas than the other members of his society."

TABLE 1. Adoption Process of Thai Farmer of New Rice Seed

Year	Stage	Process
1965	Awareness	Talked with extension worker.
1967	Interest	Interpersonal communication with neighbours.
1969	Trial and Evaluation	Planted total rice acreage in the new seed.
1970	Adoption/ Non-Adoption	Discontinued use of the seed.

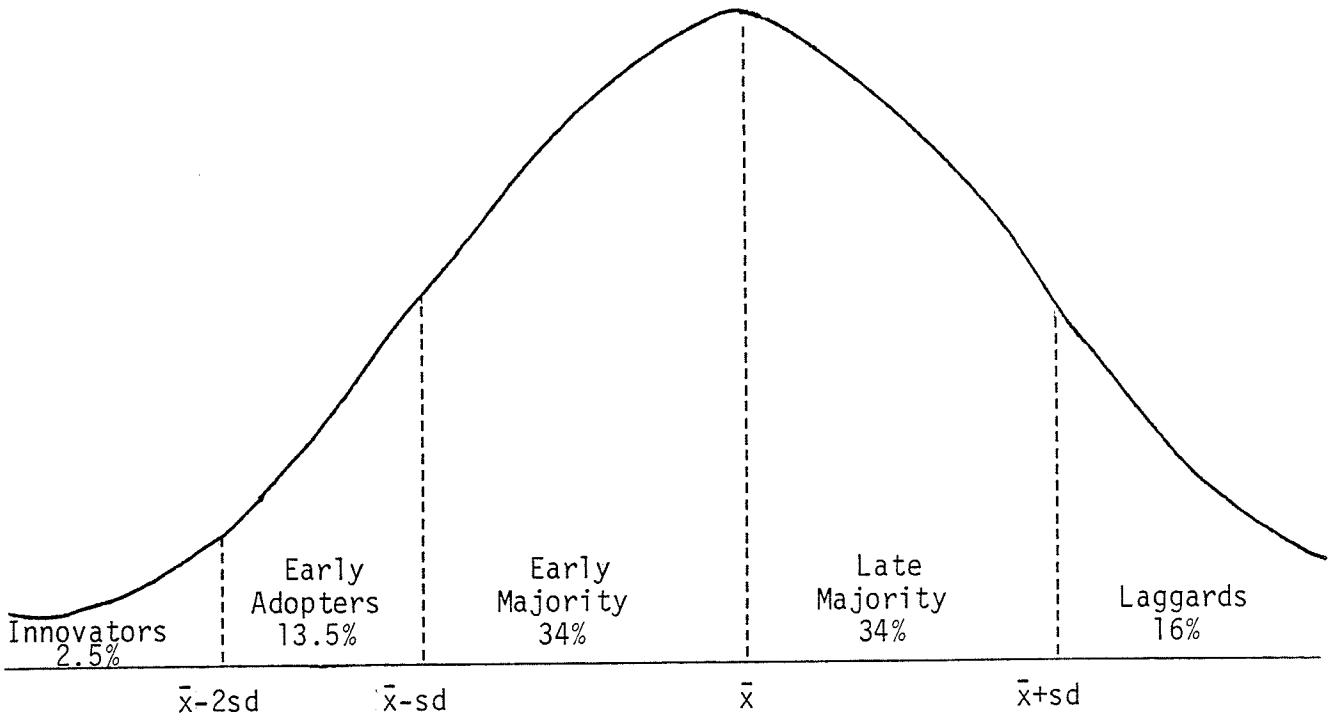
An individual's degree of innovativeness has become accepted as the criterion for adopter categorization. Jahoda, (1951) specified the characteristics which a set of categories should possess. Ideally, categories should (1) be exhaustive, or include all the respondents of the sample, (2) be naturally exclusive, or exclude from any other category a respondent who appears in one category, and (3) be derived from one classificatory principle.

Utilizing these characteristics and studies that demonstrated that adopter distribution closely approach normality, five adopter categories have been developed (Rogers and Shoemaker, 1971). Figure 1 shows the normal frequency distribution divided into five adopter categories: (1) (1) Innovators, (2) Early Adopters, (3) Early Majority, (4) Late Majority, (5) Laggards. These categories were developed utilizing the mean time of adoption and the standard deviation or the amount of dispersion about the mean.

The area to the left of the mean time of adoption minus two standard deviations included the first 2.5% of the individuals to adopt an innovation -- the innovators. The next 13.5% to adopt the new idea were included

in the area between the mean minus one standard deviation and the mean minus two standard deviations; they were labelled "early adopters." The next 34% of the adopters, called "early majority," were included in the area between the mean date of adoption and minus one standard deviation. Between the mean and one standard deviation to the right of the mean were located the next 34% to adopt the new idea, the "late majority." The last 16% were called "laggards." This can be seen diagramatically in Figure 1.

FIGURE 1. Adoption categorization on the basis of innovativeness.



This method of adopter classification was probably the most widely used in current diffusion studies. An outline of each category follows:

(1) Innovators: Venturesomeness is almost an obsession with innovators. This interest leads them out of a local circle of peers into more cosmopolitan social relationships. These individuals make little use of extension workers, preferring to go directly to agricultural scientists. Innovators are research minded and often read research bulletins. To be an innovator an individual must be in control of substantial financial resources and be able to understand and apply complex technical knowledge. They are generally characterized by high levels of education, large farms, and have high incomes. Innovators are seldom asked for their advice by their neighbours and are seldom regarded by their peers as opinion leaders. As one innovator said in a research interview, "Fifty percent of the farmers think I am crazy, and the other fifty percent are sure that I am." Approximately 2.5% of the population can be classified as innovators.

(2) Early Adopters: Early adopters are well integrated members of the local system. Early adopters are localites and are sought by their neighbours for information and advice. The early adopters are not too far ahead of the average individual in innovativeness, so they serve as role models. Early adopters are the embodiment of successful and discreet use of new ideas. Approximately 13.5% of the population will fall within the early adopter category.

(3) Early Majority: This adopter category adopts new ideas just before the average members of the system. The main social value of early majority farmers seems to be their deliberateness. They follow with deliberate willingness in adopting innovations but seldom lead. Their education, readership of farm magazines, participation in formal organizations,

and contacts with change agents are slightly higher than for the average farmer. The early majority is composed of 35% of the population.

(4) Late Majority: For this category, adoption occurs just after the average member of a social system. Adoption may be both an economic necessity and the answer to increasing social pressures. Innovations are approached with a skeptical and cautious air and these farmers are convinced only when the weight of community opinion definitely favours the new idea. This group comprises 34% of the population.

(5) Laggards: This category is the last to adopt an innovation. Its members possess almost no opinion leadership and their point of reference is the past. A laggard interacts primarily with others who also hold traditional values and tend to be openly suspicious of innovations, innovators, and change agents. Typically they have smaller farms, low incomes, and little formal education. This group contains the remaining 16% of the population.

Van der Ban (1960) also found that a system's norm affects one individual member's innovation-adoption behaviour. Norms are the established behaviour patterns for the members of a given social system. They define the range of tolerable behaviour and serve as a guide or a standard for the members of a social system.

Very often the most innovative member of a social system is perceived as a devient and accordingly has very low credibility. His role in diffusion will be minimal. On the other hand, there are those who function as opinion leaders. These are thought to be early adopters.

Opinion leadership is the ability to influence informally an individual's attitudes or behaviour in a desired way with relative frequency. It is

earned and maintained by technical competence, social accessibility, and conformity to the system's norms. It is generally agreed that compared with their followers, opinion leaders were more exposed to all forms of communication about new ideas, were more socially accessible to their followers, were cosmopolite, had higher social status, and were more innovative (Rogers and Shoemaker, 1971).

Researchers have developed two methods which they feel can be used to predict the type of individual most likely to adopt an innovation. The first method is based on the belief that an individual's personal characteristics determine whether he is likely to adopt an innovation. The other field of research involves a prediction based on how the individual perceives the attributes of the proposed innovation (Ostlund, 1974).

a. Personal characteristics as a predictor of adoption

Many studies have been conducted to differentiate between adopters and non-adopters of new innovations. These studies have attempted to utilize the demographic and psychographic characteristics of an individual to predict whether he is an adopter or non-adopter.

Donnelly and Ivancevich (1974) demonstrated that the social character of an individual acted as a good predictor of adopters of an innovation. Several researchers (Coleman, et al, 1966), (Rogers, 1960) have shown that earlier adopters generally have been found to be cosmopolite, younger, more gregarious and, with the exception of the first few percentage to adopt, are well adapted into peer social groups. Czepiel (1974) proved that early adopters exhibited greater opinion leadership with respect

to the innovation than did later adopters. The demographic and psychographic characteristics of adopters have been studied using the following parameters:

(1) Socioeconomic status

(2) Personality variables

(3) Communication behaviour

(1) Socioeconomic status

The socioeconomic characteristics that have been studied include:

Age: Rogers and Shoemaker (1971) reviewed many research studies and hypothesized that early adopters were no different than later adopters in terms of age. About one-half of the studies show no relationship, 19% show that earlier adopters are younger, and 33% indicate that earlier adopters are older.

Education: Earlier adopters have more years of education than do later adopters. Rogers (1957), in analysing the innovative characteristics of 96 agricultural innovators found that compared to the average farmer, the innovators were more highly educated, especially in agriculture. Gross (1949) studied the differential adoption by 259 farmers of a new system to erradicate worms and neuro bacillus in hogs. He found that acceptors of this innovation were better educated than non-acceptors.

Size of Farm: A large percentage of those studies in which the size of units (farms) have been studied as a predictive variable have shown that earlier adopters have larger sized units than do later adopters. Gross (1949) examined the relationship between the size of farm and the adoption of two recommended agricultural practices - hybrid

corn and a hog sanitation system. The study revealed a significant correlation between the farm size (measured in acres) and the adoption of both these innovations. Havens (1965), examining the adoption of the bulk milk handling system, also found a significant correlation between size of enterprise and innovativeness. Havens, however, measured size by using the Productive Man Work Units method (PMWU). A PMWU is the amount of work performed in a 10-hour day by an average farm worker with typical methods and equipment. The PMWU has been considered a more accurate measure of farm size than are acres because it reflects the scope of both crop and livestock enterprises.

Credit: Earlier adopters have a more favourable attitude toward credit (borrowing money) than late adopters. Using a four-item scale as a measure of the individual's willingness to use credit, Havens (1965) found a significant relationship between the attitude toward the use of credit and the time of adoption of bulk milk tanks. An example of how this scale is handled is as follows: Farmers are given statements which they are asked to react to by indicating whether they strongly agree, agree, disagree, or strongly disagree. On the basis of their responses, they can be classified with regard to their attitude toward credit. Typical statements might include:

(1) Most farmers who enlarge their operations by borrowing profit more than farmers who have small operations free of debt.

(2) Farmers should wait until they can accumulate their own capital rather than to borrow for farm production purposes.

(3) Communication behaviour

Communication is the process by which messages are transferred from a source to a receiver. Communication behaviour involves the levels of the communication network to which an individual is attuned.

Factors that have been examined and found to be associated with innovative individuals are:

Cosmopoliteness: A cosmopolite person is one who is free from local, provincial, or national prejudices. Earlier adopters are more cosmopolitan than later adopters. An innovator's reference groups are more likely to be outside rather than within the social system. They travel widely and are involved in matters beyond the boundries of their local system. Ryan and Gross (1943) found the Iowa hybrid corn innovators travelled more often to urban centres like Des Moines than did the average farmer. Medical doctors, who innovated a drug, were observed by Coleman et al (1966) to attend more out-of-town professional meetings than non-innovators. Chaparro (1955) concluded that Costa Rican innovators were amazingly cosmopolite. Over 84% had visited the U.S.A., 62% had travelled to Europe, and 65% had visited Mexico.

b. Perceived attributes as a predictor of adoption

Although a great number of studies have been conducted over the past years on the value of an individual's characteristics as a predictor of innovativeness, other researchers feel there is another avenue worth exploring.

Rogers and Shoemaker (1971) showed that in some studies the rates of adoption of innovations depended on the individual's perception of the characteristics of an innovation. In other words, there was a difference

in the way in which an adopter perceived an innovation versus the way in which a non-adopter perceived the same innovation. Ostlund (1974) indicated that only a few studies, regardless of research context, have focused on the attributes of innovations, as perceived by the potential adopters. The relevant studies that do exist have been successful in explaining from 49 to 87% of the variance in the rate of adoption.

When research is conducted in this area, the innovation selected to be studied must be one that has not gained acceptance, since an individual's perception of an innovation will change after adoption. Most people who have adopted an innovation will rationalize their decision by having positive perceptions. If the innovation has performed satisfactorily, his perceptions will be favourable. It is therefore essential that the innovation to be chosen for study be one that is technologically ready for adoption, but one that has not already gained acceptance.

Feldman and Armstrong (1975) attempted to identify the buyers of a major automobile innovation (the rotary engine). The results indicated that when compared to the non-innovators, the innovators perceived their purchase to have a greater relative advantage, was easier to understand (lacked complexity), involved lower risk of purchase, and was more consistent with present ways of doing things (compatible).

Fliegel and Kivlin (1966) investigated the perceived attributes of 33 agricultural innovations as expressed by 195 dairy farmers in northern Pennsylvania. These researchers found that the rate of adoption was reduced the more complex (and thus less easily understood by decision makers) the innovation was. Relative advantage, as defined by the saving of hard, dirty or sweaty work and low initial cost, showed a modest but positive relationship with adoption.

(2) Personality variables

Personality variables that have been demonstrated to have good value for predicting innovative individuals include:

Risk: Earlier adopters have a more favourable attitude toward risk. Pessimier et al (1967) examined the correlation between innovators and their attitude toward risk. The study consisted of eliciting the characteristics of 259 members of a household panel group. These housewives were then categorized as early or late buyers of a new laundry detergent and their characteristics examined. It was found that the early buyers (innovators) expressed more willingness to try new detergents and were thereby identified as having more favourable attitude toward risk.

Ramsey et al (1959) determined the adoptive behaviour of 188 dairy farmers towards four new dairy practices and the use of lime. They found that the more security oriented the farmers were, the less likely they were to adopt.

Dogmatism: Dogmatism is unfounded positiveness in matter of opinion. One-half of the research dealing with dogmatism supports the theory that earlier adopters are less dogmatic than non-adopters, while the other half does not. Jacoby (1971) presented 60 unmarried 18-20 year old female university students 5 pictures of similar products and asked them to identify the one they would purchase if given the chance. One item was defined as innovative within each of the three product groups. Dogmatism for all respondents was identified using the Rokeach Dogmatism Test and as predicted, low dogmatics were found to be more innovative than high dogmatics. Coney (1972) repeated Jacoby's test,

although he utilized a sample of 60 unmarried university males. His study concurred with Jacoby's in finding that low dogmatics were more innovative.

Rogers (1957) interviewed 23 farm operators in Iowa. The farmers were classified as adopters or non-adopters based on whether or not they had adopted 24 practices recommended by the Iowa Extension services. A correlation between dogmatism and adoption was determined to be in the expected direction, but was not significant.

Attitude toward Change: Earlier adopters have a more favourable attitude toward change than later adopters. Rogers (1966) collected data from a statewide sample of innovators in Ohio and found that innovators had more favourable attitudes towards innovations and because of this, less "behavioural inertia" must be overcome by the communication stimuli. Coughenour et al (1960) analysed the personal and social characteristics of 285 farm operators in Kentucky. They found that the earlier adopters had a more positive attitude toward change. The attitudes of 331 homemakers toward new foods were evaluated by Byland (1964). He found that the earlier adopters also had a more positive attitude toward change.

Abstractions: Early adopters have a greater ability to deal with abstractions than do later adopters. Rogers (1961.b) in a survey of 99 agricultural innovators in Ohio noted that innovators possessed a type of mental ability that enabled them to deal with abstractions. He observed that an innovator must be able to conceptualize relatively abstract information and apply this information on his own farm. Later adopters can observe the results of innovations on other farms and do not require this ability.

They also showed that new practices that are relatively divisible, and thus permit trial on a small scale prior to full adoption, are adopted at a more rapid rate than those that require full adoption at the outset.

Singh (1966) conducted an investigation on 133 Canadian farmers. He found that the relative advantage, as defined by rate of cost recovery, financial return and low initial cost, was significantly related to the rate of adoption. He also noted that complexity, trialability, and observability were significantly related to the rate of adoption.

Cox (1964) examined perceived risk of ordering by telephone and found that perceived risk was a major behavioural determinant. Where perceived risk was too high, this method of shopping was avoided. Conversely, for those who felt the perceived risk was minimal, this shopping method was utilized heavily.

These studies indicate that an innovation can contain five attributes that can be perceived by a potential adopter. These perceived attributes have been identified by Rogers and Shoemaker (1971) and include: relative advantage, compatibility, complexity, trialability, and observability.

(1) Relative advantage - the degree to which an innovation is perceived as better than the idea it supersedes. This advantage can be measured in economic terms, convenience, prestige factors, and satisfaction.

(2) Compatibility - the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of the receivers. Obviously an idea that is compatible will be adopted much quicker than one that is not compatible.

(3) Complexity - the degree to which an innovation is perceived as difficult to understand. Some innovations are readily understood by

most members of the social system while others are more complex and will be adopted more slowly.

(4) Trialability - the degree to which an innovation may be experimented with on a limited basis. An innovation that can be used on a small scale trial basis will have a much shorter adoption period than one that cannot be tried on a limited basis. Essentially an innovation that is trialable reduces the risk factor for the individual who is evaluating it.

(5) Observability - the degree to which the results of an innovation are visible to the receiver and to others. The easier it is for an individual to observe the results of an innovation, the more likely he is to adopt it. An illustration of this is the case of pre-emergent weed killers that are sprayed on a field before the weeds emerge from the soil. The rate of adoption of this idea by Midwest farmers was very slow in spite of its relative advantage, because there were no dead weeds that the farmers could show their neighbours.

To determine the effectiveness of this new approach, Ostlund (1974), utilizing two independent studies, contrasted the predictive efficacy of the perceived innovation attributes dimensions with the predictive efficacy of the commonly used respondent characteristic dimensions. As his research sample, a group of housewives were chosen. Two new products, a self-layering dessert mix in the first study, and a brand of oven roasting bag were utilized. In both studies Ostlund utilized the perceived attributes labels as identified by Rogers and Shoemaker (1971). In addition to these, he added the variable, perceived risk. Perceived risk, as conceptualized by Bauer (1960) is the degree to which risks are perceived as associated with the innovation.

In the first study, the personal characteristics included venturesomemess, cosmopolitanism, social integration, social mobility, privilegedness (perceived financial well-being relative to peers), interest polymorphism (variety and extent of one's personal interests), general self-confidence (self-esteem) in problem solving and psychosocial matters (perceived ability to cope with day-to-day problems and with others' opinions of one's decisions), family income, respondent education, social status of the husband's occupation, and respondent's age. In the second study, this list was reduced to include socioeconomic status; an index of family income and the social status of the husband's occupation, social mobility, venturesomeness, general self-confidence in problem solving and the respondent's age.

The results from both studies suggests that "the perceptions of innovations by potential adopters can be very effective predictions of innovativeness, more so than personal characteristic variables." Ostlund (1974) indicated that more work must be devoted to the replication among differing types of potential adopters and products.

Ostlund (1974) also pointed out that methodological difficulties can be encountered utilizing this type of research. Perceptions gathered after adoption were likely to be contaminated by experiences with the innovation. The ideal situation was to gather perceptions prior to adoption. Should this be possible, his fear was that prior questioning could stimulate adoption of the innovation. This stimulation would be unlikely however, if the innovation was costly or otherwise difficult to adopt.

To utilize the perceived attribute prediction technique, the innovation must be technologically sound yet one that has not gained acceptance. One such innovation is zero-tillage. "Zero-tillage is a farming practice in which no tillage is carried on between the time one crop is harvested and the next one is seeded. In other words, the field receives no tillage for seedbed preparation, no fall cultivation, and no cultivtion during a summerfallow season. The only soil disturbance is the cutting action of the drill at seeding, and even then, the idea is to use a machine that causes minimum damage to the trash cover." (Stobbe, 1978).

B. AGRONOMIC ASPECTS OF ZERO-TILLAGE

For several years, zero-tillage has been proposed as an extremely practical method of farming (Ford, 1969). To this point in time, however, zero-tillage has met with a considerable amount of skepticism within the farming community. In 1976 it was estimated that fewer than twenty-five farmers in the entire province of Manitoba utilize this farming technique. This concept was introduced to the United States several years ago and its advantages over conventional farming techniques have been accepted and proven fact (Philips and Young, 1973).

Farmers in the United States believe zero-tillage has a place in their farming practices. This can be seen in Table 2, which shows that zero-tillage is being practiced in 44 of 50 states. By the year 2010, the United States Department of Agriculture predicts that only 5% of the cropland will be farmed via conventional tillage. By that date, United States Department of Agriculture researchers expect to see 54% of the

TABLE 2. 1976-77 NO-TILL FARMER ACREAGE SURVEY[a]

State	No-Tillage Acreage	
	1976	1977
Alabama	64,000	75,000
Arizona	11,200	11,500
Arkansas	350	700
Colorado	3,490	3,490
Connecticut	1,000	1,000
Delaware	95,544	97,844
Florida	5,286	8,986
Georgia	121,940	146,335
Idaho	100	2,435
Illinois	390,000	397,000
Indiana	2,153,970	2,311,700
Iowa	400,000	350,000
Kansas	135,000	157,000
Kentucky	1,039,500	1,104,000
Louisiana	2,000	2,500
Maine	5,200	6,500
Maryland	221,085	220,865
Massachusetts*	3,000	3,000
Michigan	70,000	79,000
Minnesota	17,340	17,600
Mississippi	89,500	102,000
Missouri	430,030	479,950
Montana*	5,120	10,200
Nebraska	155,000	155,000
New Hampshire	500	500
New Jersey	18,000	21,000
New Mexico	2,700	4,800
New York	26,000	31,500
North Carolina	330,500	335,000
North Dakota	950	1,160
Ohio	190,000	200,000
Oklahoma	5,780	7,800
Oregon	119,291	119,301
Pennsylvania	419,000	435,000
Rhode Island	50	150
South Carolina	23,704	29,650
South Dakota	185,500	189,250
Tennessee	103,800	128,600
Texas	209,798	212,986
Vermont	5,600	6,100
Virginia	342,550	360,600
Washington	4,530	8,047
West Virginia	27,500	31,000
Wisconsin	93,950	103,515
TOTALS	7,529,358	7,969,564

[a]Source: State agronomists of Soil Conservation Service

*Estimates provided by Co-operative Extension Service agronomists.

farmland farmed with no-tillage and 41% worked with minimum tillage (No-Till Farmer, March 1977). This prediction appears to be reliable when one observes the two-fold increase in zero-tillage acreage that has occurred from 1972 to 1976 (No-Till Farmer, March 1977).

The major crops under zero-tillage crop production in the United States in 1977 were corn and soybeans (Table 3). In Canada, however, these two crops comprise less than 4% of the total farm acres (Canada Yearbook, 1976). It was obvious, therefore, that if zero-tillage was to become a reality in Western Canada, it must be suitable for small grain production.

Zero-tillage research was initially conducted in Western Canada by Chipman Chemicals Limited. In a three year trial established in 1966, Ford (1969) outlined the possibilities of zero-tillage. Ford investigated five factors that were associated with zero-tillage:

(1) Weeds and herbicides: One of the major factors to be contended with in zero-tillage are weeds. Ford postulated that with no-tillage, weed germination would be reduced by not stimulating their growth. A herbicide treatment was proposed that would eliminate the weeds that germinate prior to planting, and direct seeding could then be practiced.

(2) Soil factor: Studies demonstrated that tillage was not required to condition soils for plant and root growth. Observations of land under zero-tillage also revealed that soil structure actually improved under zero-tillage and the top 2-4" remained quite friable due to frost action.

(3) Trash cover and its effects: Research from Western Canada and the United States indicated that wind and water erosion is substantially reduced under no-tillage. Soil moisture conservation is also increased by zero-tillage practices.

TABLE 3. A Six-Year Tillage Comparison

Category	1977 (estimated)	1976 (actual)	1975 (actual)	1974 (actual)	1973 (actual)	1972 (actual)
Total no-till acres	7,969,564	7,529,358	6,545,229	5,442,507	4,875,799	3,355,467
Total minimum-till acres	58,858,440	52,137,280	49,690,662	41,294,505	39,062,755	26,355,613
No-till corn acres	4,727,545	4,615,765	4,105,843	3,305,480	3,043,157	2,069,340
No-till soybean acres	1,937,918	1,724,117	1,632,611	1,523,869	1,168,732	867,481
No-till grain sorghum acres	328,094	292,854	367,442	226,320	165,073	141,545
No-till cotton acres	7,801	6,654	6,627	6,159	3,200	1,710
No-till vegetable acres	3,000	825	12,345	10,395	7,683	6,370
No-till small grain acres	614,255	584,821	286,472	222,316	222,833	
No-till pasture renovation acres	291,926	246,487	126,000	140,300	204,830	
No-till of other crops*	59,025	57,835				

*Does not include 982,000 acres of no-till citrus for 1976 or 1,008,000 acres of no-till citurs for 1977.

(4) Drills: Ford indicated that a triple disc drill design allowed for easy cutting of the heavy trash and could be used on all soil types.

(5) Yields: In trials conducted in Western Canada from 1966-68, increases in yield of the zero-tillage plots as compared to normal tillage practices were observed in all eleven sites. Six of these increases showed significant differences.

Donaghy (1973) examined the influence of zero-tillage on weed populations and crop response at three locations in Southern Manitoba. Utilizing a triple disc drill system and pre-planting treatments to control weed growth Donaghy found:

(1) Annual weed populations were lower under zero-tillage than under conventional tillage: e.g., green foxtail, wild oats, green smartweed, and wild buckwheat. The perennial weeds, quackgrass and Canada thistle, however, presented problems under zero-tillage.

(2) Good pre-plant weed control was exhibited by:

(a) paraquat at 4 oz.

(b) dinoseb at 4 and 8 lbs.

(c) glyphosate at 8 oz.

(3) More crop plants emerged under zero-tillage. These plants grew more rapidly to produce a more vigorous stand than under conventional tillage.

(4) Root development was not restricted under zero-tillage. When differences were observed in root development, the zero-tillage crop was superior to conventional tillage.

(5) Grain yields were not different except where a nitrogen deficiency was evident. Seed yield in flax and rape was higher under zero-tillage in 4 of 15 instances.

(6) Under zero-tillage, less soil nitrogen was available but additional nitrogen fertilizer was used more efficiently under zero-tillage. At high rates of nitrogen (101-269 kg/ha), zero-tillage crops outyielded conventional tillage.

(7) Wheat, barley, flax, and rape could be grown under zero-tillage on three soil types (very fine sandy loam, clay loam, and Red River clay) with a potential for yields greater than those produced under conventional tillage.

Following Donaghy's conclusions, researchers continued to look at zero-tillage (Chinsuwan, 1976). Chinsuwan (1976) reported successful zero-tillage seeding with a double disc press drill equipped with additional cutting coulters to cut trash and aid penetration into compacted soil. Taylor (1977) evaluated broad spectrum annual weed control and the effect of seeding date under zero-tillage. He found that excellent results were obtained using a variety of broadleaf herbicides in combination with paraquat and glyphosate. He also found that in general the yield of spring wheat (cv. Napayo) decreased as the seeding date was delayed.

It appears now that zero-tillage is ready to be adopted by innovative farmers. Researchers are convinced that a pre-seeding weed control treatment is commercially available. Weed control, one of the major stumbling blocks, has been solved and it is felt that this farming practice is ready for introduction to the farming community.

The Manitoba Department of Agriculture developed a project whereby ten Manitoba farmers tried zero-tillage on a small portion of their farm. This program has proven successful in 1977, and is to be expanded in 1978.

Zero-tillage field days have been held throughout the province. It is estimated that in 1977, 3,000 acres of zero-tillage were seeded. In 1978, Donaghy (1977) predicts there will be 15,000 acres seeded.

MATERIALS AND METHOD

A four-stage marketing research study was conducted in Manitoba to determine farmer acceptability and attitudes towards a new farming practice called zero-tillage.

The purposes of this study were:

1. To ascertain whether a statistical prediction regarding intended adoption of zero-tillage can be made using demographic and psychographic characteristics.

2. To determine if the way a person perceives the attributes of an innovation can be used for predicting adoption.

3. To determine if marketing treatments developed to persuade an individual to adopt zero-tillage were effective.

4. To determine if a marketing treatment, developed to persuade an individual to adopt zero-tillage, had an effect on the way in which an individual perceives zero-tillage.

5. To develop a psychographic and demographic profile of an adopting farmer.

To accomplish these objectives, it was first necessary to obtain psychographic and demographic information using a mail survey of a sample of Manitoba farmers. Secondly, as part of an experimental design, several packages of information concerning zero-tillage were developed and distributed to one-half of these farmers. Third, a telephone questionnaire was used to determine how each farmer perceived the attributes of zero-tillage.

These data were gathered prior to spring seeding before the farmer had to make his planting decision. In the fall each farmer was contacted and asked if he had adopted zero-tillage.

Four distinct stages of research were conducted. These stages were:

(1) Stage I - To obtain a psychographic and demographic profile for each farmer, a mail questionnaire (Appendix 1B) was sent to a sample of 2,000 farmers.

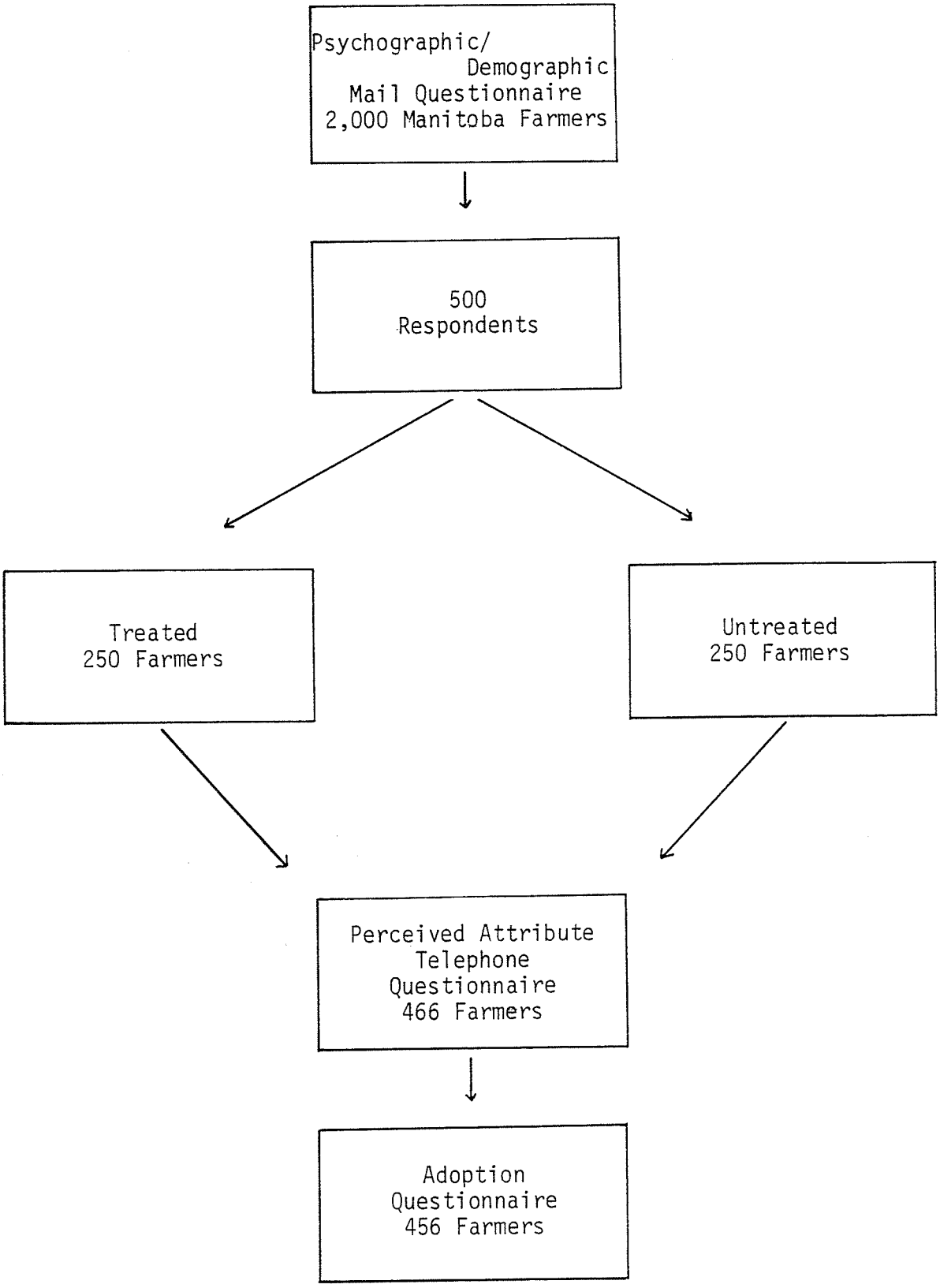
(2) Stage II - To determine whether an individual could be persuaded to adopt zero-tillage, a series of four marketing packages outlining the advantages of zero-tillage (Appendix 2) were developed. The 500 farmers who responded to the mail questionnaire of Stage I were divided equally into two groups. The first group, called the "treated" sample, received the information. The second group, called the "untreated" sample, received no information.

(3) Stage III - To obtain information on how both the "treated" and "untreated" samples viewed the advantages of zero-tillage, a telephone questionnaire (Appendix 3) was administered to both groups.

(4) Stage IV - Finally, to determine which farmers had adopted zero-tillage and who had not, a mail questionnaire (Appendix 4B) was sent to both the "treated" and "untreated" samples.

Figure 2 represents the method by which the data were collected.

FIGURE 2. A schematic diagram of the research methodology



A. STAGE I

a. The sample

Two thousand Manitoba farmers were selected to receive the initial mail questionnaire (Stage I). The sample was selected by the Agricultural Division of Statistics Canada from their most up-to-date file of Canadian farmers.

A stratified random sampling technique, in which all Manitoba farmers were categorized according to total farm size, was used to select the sample. All members of the population were stratified into one of five categories or cells according to the number of acres owned and/or rented. An equal number of farmers, 400, were selected from each category. The total sample, therefore, consisted of 2,000 farmers, drawn from a total population of 34,981 in the province of Manitoba (Table 4).

TABLE 4. Sample Farms Classified By Size of Farm

Size of Farm in Acres	Number of Farms	% of Total Sample
0 - 480	400	20
481 - 800	400	20
801 - 1,120	400	20
1,121 - 1,440	400	20
greater than 1,440	400	20
	2,000	100%

A comparison can be made of the sample and the total population. Table 5 shows the Manitoba farming population as determined by Statistics Canada in the 1971 Census.

TABLE 5. Manitoba Farms Classified by Size of Farm (Canada Yearbook, 1975)

Size of Farm in Acres	Number of Farms	% of Total Sample
0 - 480	18,047	51.59
481 - 800	10,006	28.60
801 - 1,120	3,897	11.14
1,121 - 1,440	1,272	3.64
greater than 1,440	1,758	5.03

By comparing the percentage of total farmers in each category in Tables 4 and 5, it can be seen that the distribution of farmers in the sample is not the same as the distribution of farmers in the total population. The sample has a disproportionate number of farmers in the larger farm sizes.

This sampling technique was used to ensure adequate representation from each stratum. Furthermore, a greater proportion of large farms should increase the probability of obtaining an adequate number of early adopters in the sample. Adoption research shows that earlier adopters have larger size units than later adopters (Rogers and Havens, 1962). More than 50% of Manitoba farmers have fewer than 481 acres (Table 5). If the sample distribution had been identical to the population distribution, with more than 50% in the smallest farm size category, the potential number of adopters in the sample would have been relatively low.

A 16 page mail questionnaire (Appendix 1b) was designed and sent to the sample of 2,000 Manitoba farmers. The survey was designed to

determine psychographic and demographic characteristics of the farmers. It was a self-administered questionnaire which included detailed instructions on how it was to be completed.

b. Questionnaire pre-test

Before the questionnaire was distributed to the 2,000 farmers, a pre-test was conducted to detect any biased or ambiguous questions that may have made the classification and the interpretation of the data difficult. The tentative questionnaire was distributed to three farmers and four non-farmers who were asked to answer all the questions. Their reactions to the questionnaire and suggestions for improvements were discussed the following day.

Two of the farmers completed the questionnaire in one hour - the third required two hours. It appeared that the third respondent took longer because he attempted to analyse each question and "second-guess" its intent. As they looked at it, the first two farmers initially felt that the questionnaire was too long, but this feeling disappeared as they worked through the questionnaire, found it rather interesting, and realized that it was not so overpowering as initially thought.

The non-farmers took between one-half hour and one and one-half hours to complete the questionnaire. Their first impressions regarding the length of the questionnaire were similar to those of the farmers, but they too quickly realized that its length was deceptive once they started to work the questionnaire.

All members of the pre-test sample found the directions to be very clear and concise and thought the extensive use of examples was very helpful. When asked if they would complete the questionnaire if received

in the mail, two of the farmers said yes - as long as there was a very convincing letter appealing for help. The third farmer said he did not normally reply to mailed surveys and he would not have answered this one.

The pre-test raised several suggestions regarding the wording and intent of some questions. These suggestions were noted and minor revisions were made to eliminate any apparent problems.

c. The questionnaire

The final questionnaire was divided into three sections - A, B, and C.

Section A. Section A was designed to determine a number of different attitudes of the respondents and was based on the Likert attitude measurement technique (Luck et al, 1974). The questions were adapted from previously proven scales. The attitudes measured were: cosmopoliteness (Robinson and Shaver, 1973), dogmatism (Rekeach, 1960), abstraction (Cattel and Eber, 1957), attitude towards credit (Havens, 1965), attitude towards education (Glassey, 1967) and attitude towards scientific farming (Coughenour, 1960).

In Section A, a series of 33 statements were listed, which represented viewpoints of opinions on a wide range of topics. The respondents were asked to rate each statement according to whether they strongly disagreed, moderately disagreed, were neutral (or the statement did not apply), moderately agreed, or strongly agreed.

Section B. Section B questions were designed to determine additional attributes and characteristics of the farmer and were divided into four subsections.

Section B1 was intended to determine the farmer's opinion leadership, rationality, and interpersonal channels of communication. The questions were adapted from work done by Rogers (1962), Dean et al (1958), and Wilkening (1956). This section consisted of 20 questions, each with between 3 and 8 responses from which the farmer was to select the one response that best answered the question. Four of the questions were open-ended in that the responses included an "other - please specify" response.

Section B2 was designed to determine the respondent's value orientation, belief in science, achievement, security and traditionalism. The questions were adapted from scales developed by Ramsay et al (1959). As in Section B1, this section consisted of questions and responses from which the respondent was to choose the best answer.

Section B3, in which the Likert technique was again used, was designed to measure the farmer's achievement motivation, innovativeness, attitude towards education, attitude towards change, and his communication behaviour. These questions were developed by Strauss (1959). This section consisted of 18 statements or opinions, and the farmer was to decide, using a five-point scale, if the statement was most like him, least like him, or somewhere in between.

Section B4 was designed to determine what publications the farmer read, what farming practices he had adopted, his opinions on the effectiveness of the mass media, and his rationality according to the index developed by Dean et al (1958). It consisted of six questions with accompanying responses from which the farmer was to select one or more responses which correctly answered the question. All questions were open-ended in that they included an "other - please specify" answer.

Section C. Section C determined the demographic characteristics of the respondent including age, sex, education, income, number of years of farming experience, size of farm, location of farm, type of farm, and the number of farm workers.

In total, 100 questions were asked of each respondent. The questionnaire was printed in booklet form, 8 1/2 inches by 11 inches in size, and was 16 pages long.

d. First mailing and reminder

The questionnaire, along with a letter, an offer of a free booklet and a self-addressed, stamped envelope, was mailed to the 2,000 farmers in the sample on March 14, 1976. The timing of the mailing was important as it was necessary to complete Stages I and II of the study before the respondents became involved in their spring farming operations.

The letter (Appendix 1a) outlined the purpose and importance of the study, appealed for the farmer's help, and assured him of the confidentiality of his responses. It identified the sender as a graduate student in the Plant Science Department of the University of Manitoba - Barrie C. Forbes.

The offer of the free booklet "Pesticides and Their Safe Use," published by the Canadian Agricultural Chemical Association was made to increase the rate of return of the questionnaire. Gilb (1972) showed that the questionnaire return rate could be increased with such an incentive. To obtain a copy of the booklet, the farmer was required to complete a return card (Appendix 1c) and enclose it with the completed survey

in the return envelope. If the farmer did not complete the return card, he was not sent the booklet.

On March 25, one week after the initial mailing, a reminder notice (Appendix 1d) was mailed to each farmer in the sample who had not yet returned a completed questionnaire to try and increase the rate of return.

A return rate of 25%, or 500 of the initial 2,000, was required before Stage II of the study could be done. This return figure was reached on April 1, 1976 - less than two weeks after the initial mailing. (Surveys continued to be returned until April 20, 1976, at which time the total response rate was 33%, or 675 of the initial 2,000.)

B. STAGE II

Stage II was administered to determine whether an individual could be persuaded to adopt zero-tillage. A series of four marketing packages containing information about zero-tillage was developed and sent to 250 of the 500 farmers who responded to Stage I. These 250 respondents made up the "treated sample." The other 250 respondents, the "untreated sample," received no information during Stage II.

To divide the initial sample into the treated and untreated categories, the questionnaires were arranged in ascending order according to the total workable acres owned and rented. Every second questionnaire was then removed and assigned to the treated sample. This paired sampling technique was utilized to ensure that the "treated" and "untreated" populations would be comparable in terms of size of farm.

The four marketing packages were designed to provide the farmers with the most up-to-date information that was available on zero-tillage. The first three packages were mailed to the treated sample on consecutive Fridays commencing April 2, 1976, and ending April 16, 1976. The fourth treatment was mailed on Tuesday, April 20, 1976.

The four marketing packages were prepared as follows:

a. Marketing treatment A

Marketing treatment A contained a letter, a promotional pamphlet and reprints of two articles which had been published in Canadian magazines (Appendix 2a, b, c, d). The letter informed the farmer that during the next few weeks he would receive information about zero-tillage, a new farming practice. It identified the sender as a student in the Plant Science Department of the University of Manitoba - B. Campbell. This name was different from the one used in the Psychographic Demographic Mail Questionnaire. This was done to disassociate the two stages of research. This would eliminate any bias that might have occurred if the farmers knew that the same individual was conducting both studies. The promotional pamphlet (Appendix 2b) was prepared by the researcher. It gave a brief description of the practice of zero-tillage and outlined the advantages of using the practice. To stimulate communication between the researcher and the farmers, the pamphlet also included the telephone numbers where B. Campbell could be reached (collect) should the farmers have any questions about zero-tillage. The reprints of the magazine articles were entitled "Zero-tillage - One Way to Cut Cropping Costs," Country Guide, March 1975, and "Scientists Take a Close Look

at Zero-Tillage," Spotlight, September 1975. The basic information for these articles was gleaned from a Ph.D. thesis (Donaghy, 1973).

b. Marketing treatment B

Marketing treatment B contained three simulated press releases, a zero-tillage herbicide recommendation chart (Appendix 2e, f, g, h), and publication 483 of the Manitoba Department of Agriculture, the 1976 Guide to Chemical Weed Control. The press releases were written to highlight the fact that zero-tillage was a reality in Manitoba, and were based on factual information. Their titles were (1) "Manitoba Farmer Proves that Zero-Tillage Works," (2) "Stobbe Advocates Zero-Tillage," and (3) "Roundup Corrals Zero-Tillage Weed Problems." The herbicide recommendation chart was a compilation of chemical weed control recommendations for wheat, barley, oats, and flax taken from Publication 483. For each crop and herbicide the chart outlined the weeds controlled, recommended rates, stage of application, and the cost per acre.

c. Marketing treatment C

Marketing treatment C contained one simulated press release, engineering plans for a zero-tillage drill, and a brochure on field sprayers (Appendix 2i). The press release described the design of a set of cutting coulters that researchers at the University of Manitoba successfully adapted for an International Harvester 620 press drill. The engineering plans consisted of detailed drawings of the drill and adaption and a list of required parts. The brochure "Field Sprayers" (Manitoba Department of Agriculture, 1976) contained guidelines for selecting field sprayers that operate efficiently and apply chemicals accurately.

d. Marketing treatment D

Marketing treatment D contained the May 1976 issue of the No Till Farmer magazine (Appendix 2j) to let the farmers know that such a publication was available and to expose them to the zero-tillage movement in the United States.

C. STAGE III

A telephone questionnaire (Appendix 3) was developed and administered to both the "treated" and the "untreated" samples - i.e., the initial 500 respondents from Stage I. This survey was designed to determine how each farmer perceived the attributes of zero-tillage.

A pre-test telephone questionnaire was drafted and administered to four Manitoba farmers selected at random from the rural telephone directory. Problems were noted and the questionnaire was revised accordingly.

Six interviewers were hired to conduct the telephone interviews. On April 24, 1976, a training session was held with the interviewers. They were informed as to the nature of the study and were given a copy of the preliminary questionnaire. The entire survey was discussed and it was pointed out that while all questions had definite answers that were to be read to the respondents, some questions allowed for additional comments. The interviewers were instructed to probe the farmer if they felt a comment was forthcoming.

To familiarize themselves with the questionnaire, the interviewers were paired and a role-playing session was conducted. One interviewer

acted as the surveyor and the other the respondent. The roles were reversed and the procedure was repeated until everyone felt at ease with the questionnaire. Several suggestions that came from this session were incorporated into the questionnaire to make the questions clearer and facilitate the interview.

The telephone questionnaire included an introduction that was to be read to the farmer by each interviewer. It identified the caller, told where the call was coming from, and the purpose of the study. A definition of zero-tillage was included that was to be read to each farmer to ensure that all of the parties concerned understood the term.

The introduction was followed by 16 questions designed to determine how each farmer felt about zero-tillage according to the following definitions as proposed by Rogers and Shoemaker (1971):

1. relative advantage - the degree to which the innovation was perceived to be better than the one it replaced (which in this case was conventional tillage) (questions 6, 7, and 8)
2. observability - the degree to which the innovation was visible to others (questions 1 and 2)
3. compatibility - the degree to which the innovation was perceived as being consistent with the existing values, past experiences, and needs of the receiver (questions 3, 4, 9, 10, 13, and 15)
4. risk - the degree to which the innovation was perceived as having a risk attached to its adoption (question 5)

In addition to the perceived attribute questions, adoption questions were asked. These questions related to whether the farmer had a field that was untilled, whether he would adopt zero-tillage in 1976 or in the

future, and whether he thought farmers in his area would adopt zero-tillage within the next two years (questions 11, 12, 14, and 16).

The telephone questionnaire was administered the week of April 26, 1976. The callers were given a list of farmers names and telephone numbers. The numbers had been obtained from the Manitoba Rural Telephone Directory. In 31 instances there was some difficulty ensuring that the telephone number was in fact for the same person who had completed the initial questionnaire in Stage I. These farmers were asked how many acres of land they owned or rented. If the acreage corresponded to the information obtained in Stage I, the interview was conducted as planned - if not, it was terminated.

The interviewers were instructed not to divulge the identity of the researcher. They were to identify the Plant Science Department but were to deny any knowledge of the previous two stages. These precautions were taken to reduce any upward bias that might occur if the farmers knew this was associated with the other parts of the study. Most calls were made between 5:00 p.m. and 10:00 p.m. April 26 to April 30, 1976, as it was felt this was the time in which most farmers were likely to be available. Some calls were also made between 12:00 noon and 1:00 p.m.

Throughout this phase of the study, the interviewers were periodically monitored to ensure uniformity of administration. If any inconsistencies were detected, the interviewer was reminded that she was to adhere to the format of the questionnaire.

During the week of April 26; 103, 120, 110, and 75 interviews were completed on four consecutive evenings and 30 interviews were completed during three noon hours. The following week, one interviewer completed

twenty-eight more questionnaires for a total of 466 out of the initial 500. Thirty-four farmers were either unavailable or would not consent to the interview and these had to be eliminated, leaving a total of 466.

D. STAGE IV

This stage was designed to determine those farmers who had adopted zero-tillage. A five-question mail questionnaire with an accompanying letter was mailed on August 7, 1976, to the 466 respondents from Stage III (Appendix 4a, b).

The questionnaire was designed to determine if the farmer had adopted zero-tillage in 1976 or if he planned to adopt it in 1977. His opinions were also requested on how many acres in Manitoba he felt were seeded to zero-tillage in 1976, where in the Province he felt zero-tillage could be practiced, and what was the biggest single disadvantage of zero-tillage. Four of the five questions were closed - the fifth was open-ended.

The questions were printed on a 5" x7" self-addressed, postage-prepaid card. Each farmer was asked to answer the questions and return the card. Each questionnaire was identified using a four digit number identical to the number used on the previous two surveys.

On September 1, 1976, a reminder notice (Appendix 4c) was sent to those farmers who had not yet responded. On September 27, the survey, along with a letter (Appendix 4d) was sent to those farmers who had not yet returned the survey. By October 4, 94% of the questionnaires had been returned. The final 6% were telephoned and the questions were administered over the telephone. Ten surveys were returned which could

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not be used. This gave a total sample size of 456 to be analysed.

E. DATA HANDLING

Once the first stage was completed, coding of the data from the psychographic demographic mail questionnaire commenced. The questionnaire was designed to allow the coding to be done directly on the form. For open-ended questions, new codes were developed to suit the appropriate answers. The coding was checked and the data prepared for transfer to computer cards. The data were then keypunched and verified.

The perceived attribute telephone questionnaire (Stage III) was, for the most part, a self-coding form. The interviewers were instructed to write the coded answers in the appropriate box on the sheet. The questions for which comments were recorded were coded and verified at a later date. The information was then punched onto computer cards and verified.

The adoption questionnaire (Stage IV) was designed to allow coding on the form. The information was coded, keypunched onto data cards, and verified.

a. Data analysis

Once the data were collected, coded, keypunched onto computer cards, and verified, various statistical techniques were applied using the Statistical Package for the Social Sciences (1975) program. A sub-program called Two-Way Multiple Discriminant Analysis was used to develop a prediction model that would discriminate between "adopters" and "non-adopters" of zero-tillage. This model was then applied to the data to determine its prediction accuracy.

In addition to discriminant analysis, the chi-square test of statistical significance was applied to the data to determine whether the marketing treatments were effective. This test was also used to determine whether differences in demographic characteristics and communication patterns existed between adopters and non-adopters.

Discriminant analysis begins with the desire to distinguish statistically between two or more groups of cases. These groups are defined by the particular research situation (Nie. 1975). An example of groups of cases would be persons who have voted for the Conservative candidate in a recent election, versus those who voted for the Liberal candidate.

To distinguish between the groups, the researcher selects a collection of discriminating variables that measure characteristics on which the groups are expected to differ. For example, the voters may have been asked several questions about their political opinions.

The mathematical objective of discriminant analysis is to weigh and lineally combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible. In other words, the purpose was to discriminate between the groups in the sense of being able to tell them apart. No single factor will be able to differentiate the two political groups in the example, but by taking several issues and mathematically combining these, a single dimension may be found on which Conservatives were clustered at one end and Liberals at the other. Once the discriminant functions have been derived, classification into the two groups was attempted.

In this study, the groups of cases which were to be statistically distinguished were farmers who were "adopters" of zero-tillage, versus

those who were "non-adopters." "Adopters" were those farmers who answered "yes" to either or both of the first two questions of the adoption questionnaire (Stage IV). These questions were:

1. Did you plant any crops using zero-tillage in 1976?

   Yes No Don't know

2. Do you plan to use zero-tillage in your farming operation in 1977?

   Yes No Don't know

"Non-adopters" were farmers who answered "no" to question one and "no" or "don't know" to question two.

b. Psychographic demographic mail questions

With these definitions of the two groups, discriminant analysis was conducted on the psychographic demographic mail questionnaire (Stage I) to determine whether a prediction regarding intended adoption of zero-tillage could be made using psychographic and demographic questions. Using the same definition of adopters and non-adopters, the perceived attributes telephone questionnaire (Stage IV) was analysed to determine if the way in which an individual perceives the attributes of an innovation could be used for predicting adoption.

The stepwise method of discriminant analysis was utilized in this study. The stepwise method was chosen because it was felt that the full set of variables contained excess information about the group of differences and that some of the variables were not very useful in discriminating among the groups. The program sequentially selected the "next best" discriminator at each step and a reduced set of variables was found.

The discriminant program chose the single variable that had the highest value on the selection criteria. This initial variable was then paired with each of the other available variables, one at a time, and the selection criterion was computed. The new variable which, in conjunction with the initial variable produced the best criterion value, was selected as the second variable to enter the equation. These two were then combined with each of the remaining variables, one at a time, to form triplets which were evaluated on the criterion. The triplet with the best criterion value determined the third variable to be selected. This procedure of locating the next variable that would yield the best criterion score, given the variables already selected, continued until all variables were selected or until no additional variables provided a minimum level of improvement.

As variables were selected for inclusion, some variables previously selected could lose their discriminating power. The loss of discriminating power can occur because the information that they contain about group differences was available in some combination of the other included variables. Thus, at the beginning of each step, each of the previously selected variables was tested to determine if it still made a significant contribution to discrimination. If any were eligible for removal, the least useful was eliminated. A variable that was removed at one step may re-enter at a later step if it satisfied the selection criteria at that time.

A variable was considered for selection only if its partial multivariate F ratio (herafter called the F ratio) was larger than a specified value. (The multivariate F ratio measures the discrimination introduced

by the variable after taking into account the discrimination achieved by the other selected variables). This F test was performed before the variable was evaluated on the stepwise criterion. If F was too small, the variable was not considered for inclusion, regardless of its value on its entry criterion. In addition, variables were tested for removal only on the basis of their F ratio, which must be smaller than a given value for removal to occur. The use of the stepwise procedure resulted in an optimal set of variables being selected.

Before the discriminant program could be run, the questions of the psychographic demographic mail questionnaire (Appendix 1b) were divided into three groups. The assignment of the questions to the groups was based on the response options. The three groups were:

(1) Psychographic questions

The responses utilized the Likert scale. A five-point Likert scale ranging from strongly agree to strongly disagree was developed. The respondent was asked to rate the sentence according to whether he strongly agreed, moderately agreed, was neutral (or the statement did not apply), moderately disagreed, or strongly disagreed. There was a definite progression from one end of the scale to the other to facilitate comparison between individuals. An Example of this type of question can be found in Section A, Question 1:

1. The most rewarding organizations a person can belong to are local clubs and associations rather than nationwide organizations.

Strongly Disagree	Moderately Disagree	Neutral	Moderately Agree	Strongly Agree
1	2	3	4	5

The psychographic questions that either were related to a specific topic or were part of a measurement scale were combined. For example, all ten questions relating to Dogmatism were numbered Dogmatism 1 to 10 and analysed together.

(2) Farming Behavior and Demographic Questions

These questions were divided into two categories:

(a) Category 1 questions:

The best answer was to be selected from a number of possible responses. Every attempt was made to ensure the responses were exhaustive. In some questions where this was not possible, an "other - please specify" option was included. The replies to these questions could not be placed in a linear progression since one answer was not considered to be better or worse than the other.

In the analysis therefore, it was necessary to avoid a situation where the answers would be ranked. To facilitate this question for which a farmer was to select the best of four possible answers became four identical questions, with one possible response to which the answer was yes or no. One such question can be found in Section B1, Question 9 (a):

From whom do you now buy most of your farm supplies?

1. Independent dealers
2. Co-op dealers
3. Grain elevator managers
4. Others - please specify

In the analysis this question was reworked to become:

9 (a) From whom do you now buy most of your farm supplies?

Independent dealers Yes ____ No ____

From whom do you now buy most of your farm supplies?

Co-op dealers Yes ___ No ___

From whom do you now buy most of your farm supplies?

Grain elevator managers Yes ___ No ___

From whom do you now buy most of your farm supplies?

Other - please specify Yes ___ No ___

(b) Category 2 questions:

The farmers were allowed to respond with more than one reply, although a single reply was adequate. The question was asked and several optional responses were given. The farmer was to indicate the answer or answers that best suited the question. Every attempt was made to make the responses exhaustive, however, an "other - please specify" option was included. As in the Category 1 questions, it was not desirable to place the replies in a linear progression and the questions had to be altered for analysis purposes.

One such question was found in Section B4, Question 2:

2. How did you decide how many acres of cereal grains to plant in 1975?

1. According to market conditions _____
2. Taking into account recommended crop rotation practices _____
3. According to the feed requirements of the farm _____
4. By planting the same each year _____
5. Don't know _____
6. Other - please specify _____

In the analysis, a question that had six possible answers became six questions, each with one response to which the answer was yes or no. In other words, the questions were broken down as follows:

2(a) How did you decide how many acres of cereal grains to plant in 1975?
According to market conditions Yes ___ No ___

2(b) How did you decide how many acres of cereal grains to plant in 1975?
Taking into account recommended crop rotation practices Yes ___ No ___

2(c) How did you decide how many acres of cereal grains to plant in 1975?
According to the feed requirements of the farm Yes ___ No ___

2(d) How did you decide how many acres of cereal grains to plant in 1975?
By planting the same each year Yes ___ No ___

2(e) How did you decide how many acres of cereal grains to plant in 1975?
Don't know Yes ___ No ___

2(f) How did you decide how many acres of cereal grains to plant in 1975?
Other - please specify Yes ___ No ___

By changing the question structure in this way, there was no linear ranking of the answers and the analysis could be conducted without fear of any forced rankings.

The data were analysed using the stepwise method of multiple discriminant analysis and each variable with an F value sufficient for computation was assigned an unstandardized discriminant function coefficient.

This coefficient was multiplied by the respective variable value and all of the variables relating to a specific topic were summed. In this manner, an equation was developed that corresponded to each question that significantly affected the prediction results.

The equations for each of the three types of questions were summed to form a classification equation. This equation was then applied to the data through the stepwise method of multiple discriminant analysis and a discriminant score was produced. This score placed each farmer on a continuum representing the function and that value determined whether he was placed in the adopt or non-adopt category. Prediction results were produced to indicate the accuracy with which the discriminant score split the population into the two groups. For the hypothesis to be supported, the prediction must be 80% accurate.

c. Perceived attributes telephone questionnaire

The questions from the perceived attributes telephone questionnaire (Appendix 3) were reworked to facilitate a multiple discriminant analysis program. The questions were similar to those asked in the Category 1 questions of the psychographic demographic mail questionnaire (Appendix 1b).

In the perceived attributes telephone questionnaire, the respondent was requested to select the answer that best suited the question. Every attempt was made to ensure the responses were exhaustive. The replies to these questions could not be placed in linear progression, since one answer was not considered to be better or worse than the other. In the analysis, therefore, it was necessary to avoid a situation where the answers would be ranked. To facilitate this, a question for which a farmer was to select the best of three possible answers became three

identical questions with one possible response, of which the answer was yes or no. One such question is Question 3 in the questionnaire:

3. What would you think of a farmer if you saw him seeding directly into stubble? Would you think he was a

   1. good farmer
   2. poor farmer
   3. no opinion

   In the analysis this question was reworked to become:

3a. What would you think of a farmer if you saw him seeding directly into stubble? Would you think he is a good farmer?

   1. yes
   2. no

3b. What would you think of a farmer if you saw him seeding directly into stubble? Would you think he was a poor farmer?

   1. yes
   2. no

3c. What would you think of a farmer if you saw him seeding directly into stubble? No opinion.

   1. yes
   2. no

All of the questions that were asked in the perceived attributes telephone questionnaire were similar to the one described above. The questions either related to the way the farmers perceived the attributes

of zero-tillage (called the perceived attribute questions) or related to whether the farmer was prepared to adopt zero-tillage (called the adoption questions).

The perceived attribute questions were analysed separately, utilizing the stepwise method of multiple discriminant analysis. They were also combined with the adoption questions and analysed utilizing the stepwise method of multiple discriminant analysis. The analysis resulted in unstandardized discriminant function coefficients being developed for all variables with an F value sufficient for inclusion.

The multiple discriminant analysis program produced prediction equations for the perceived attribute questions and the combination of the perceived attribute questions and the adoption questions. These equations were the sum of the products of the unstandardized discriminant function coefficient times the value of the corresponding question. This equation was then applied to the data and a discriminant score was produced. This score placed each farmer on a continuum representing the group of questions. That value determined whether the farmer was placed in the adopter or non-adopter category. Prediction results were produced to determine the accuracy with which the discriminant score split the population into the two groups. For the hypothesis to be supported, the prediction must be 80% accurate.

d. Effectiveness of the marketing treatment

In addition to determining if a prediction could be made using discriminant analysis, the chi-square test of statistical significance was used to determine if the marketing treatment, developed to persuade an individual to adopt zero-tillage, was effective.

e. Effect of the marketing treatment on how a farmer perceived the attributes of zero-tillage

Statistical tests were conducted to determine if the marketing treatment had an effect on how a farmer perceived the attributes of zero-tillage. The Mann-Whitney-Wilkoxon Rank Sum Test (Huntsberger and Billingsley, 1974) and the Binomial Test (Huntsberger and Billingsley, 1974) were utilized to determine whether two populations had the same means. The Mann-Whitney-Wilkoxon Rank Sum Test was utilized when the data could be ranked, while the Binomial Test was administered when ranking was not possible.

f. Development of demographic characteristics and communication pattern profile

The chi-square test of statistical significance was utilized to determine whether a difference could be observed in the demographic characteristics and communication pattern of the adopters and non-adopters.

RESULTS AND DISCUSSION

Of the 456 farmers who completed all aspects of the study, 35 were classified as adopters, 418 were non-adopters, and 3 were unclassified (as defined in the methodology).

In this study, the number of adopters was very low (7.7% of the population). For this reason the sub-sampling technique as described by Morrison (1969) was impractical. If one-half of the population were selected, the number of adopting farmers would be very small, (17.5 farmers) and a prediction equation would be meaningless. Press (1972), in discussing such a situation stated, "If the sample is small, this approach (the sub-sampling technique) is not recommended since then inefficient estimators of the parameters would result at the expense of obtaining a good power testing procuedure." In this case then, a greater degree of accuracy in developing a prediction model for the adopters and non-adopters of zero-tillage could be attained by using the total population rather than a sub-sample.

In this analysis two approaches were used. The first approach utilized the characteristics of the farmers as collected in the psychographic-demographic mail questionnaire (Appendix 1B). The second approach utilized data concerning how the farmer perceived the attributes of zero-tillage as collected in the perceived attributes telephone questionnaire (Appendix 3).

A. PREDICTION BASED ON PSYCHOGRAPHIC-DEMOGRAPHIC QUESTIONNAIRE

The questionnaire contained three types of questions: psychographic questions, category 1 questions, and category 2 questions (as described

in the methodology). These three question types were analysed together and in all possible combinations utilizing the stepwise method of multiple discriminant analysis.

a. Psychographic variables as predictors of adoption/non-adoption

Eleven psychographic variable sets (Table 6) were tested in the psychographic-demographic questionnaire. Each set was comprised of several questions relating to a specific psychographic variable. For example: ten questions were asked in the questionnaire to determine the farmer's attitude towards education. These ten questions comprised the Education set of psychographic variables. Each question of the set was identified through the use of a label (eg., Education 1, Education 2, ... Education 10). Table 7 contains the questions with their corresponding labels.

All of the component questions of the psychographic variable sets were analysed, utilizing the stepwise method of multiple discriminant analysis. The stepwise method selected the question in the set that made the greatest contribution to the prediction of adopters and non-adopters. In the presence of this best question, the next best question that made a significant contribution to the prediction was selected. This continued until the F level was insufficient for inclusion. In this manner the number of questions was reduced to include only those that made a significant contribution.

The summary table for Attitude Towards Education can be seen in Table 6. These data indicate that of the 10 questions analysed, five had an F level sufficient for inclusion. In the table, the questions are arranged in descending order of importance; the order in which they

were included in the stepwise method of multiple discriminant analysis. The question Education 10 made the greatest contribution to the prediction of adopters and non-adopters. In relation to Education 10, Education 3 was the next best question that made a significant contribution to the prediction. Education 2 was next, followed by Education 9, with Education 7 being the fifth best. The remaining 5 questions in the set of 10 had F levels insufficient for inclusion.

b. Discriminant equations for the psychographic variable sets

Once the unstandardized discriminant function coefficients were determined for the remaining psychographic variable sets, discriminant equations were determined, as described in the methodology, for 8 of the 11 sets. Table 8 lists the discriminant equations of the psychographic variable sets. The equations are the sum of the unstandardized discriminant function coefficient multiplied by the response to the appropriate questions. Equations were developed for dogmatism, cosmopoliteness, ability to deal with abstractions, attitude towards education, innovativeness, attitude towards credit, attitude towards change, and attitude towards science.

TABLE 6. Summary Table of Unstandardized Discriminant Function Coefficient for Psychographic Variable Set Attitude Towards Education

Question Entered[a]	Unstandardized Discriminant Function Coefficient
Education 10	0.4756
Education 3	0.40703
Education 2	-0.48715
Education 9	-0.49302
Education 7	0.29502

[a]Refer to Table 8 for contents of these variables.

TABLE 7. Significant Psychographic Variables with their Corresponding Questions and Location in the Questionnaire

Psychographic Variable	Corresponding Question	Location in Questionnaire
Education 10	I think high school is enough education for a practical man like a farmer.	B III 14
Education 3	Too much money is spent on education.	A20
Education 2	I feel that education is important.	A10
Education 9	I get enjoyment out of learning new ways of doing things.	B III 11
Education 7	I see little value in a farmer studying agriculture in school.	B III 1
Abstraction 5	I avoid games that involve intellectual problems.	A31
Abstraction 1	I would rather have someone tell me the solution to a difficult problem than to have to work it out for myself.	A3
Abstraction 3	I am challenged by situations I cannot immediately understand.	A17
Dogmatism 10	The main thing in life is for a person to do something important.	A30
Dogmatism 1	In this complicated world of ours, the only way we can know what is going on is to rely on leaders or experts who can be trusted.	A5
Dogmatism 7	Of all the different philosophies in this world, there is probably only one which is correct.	A25
Dogmatism 5	There are two kinds of people in this world; those who are for the truth and those who are against the truth.	A19
Innovativeness 2	I have tried out several new farm practices in the last few years.	B III 10
Cosmopoliteness 3	No doubt many newcomers to the community are capable people but when it comes to choosing a person for a responsible position in the community, I prefer a man whose family is well established in the community.	A15
Cosmopoliteness 4	I have greater respect for a man who is well established in his local community than a man who is widely known in his field but who has no local roots.	A24
Credit 2	Farmers should wait until they can accumulate their own capital rather than borrow for farm production purposes.	A9
Change 2	I believe traditional ways are the best ways of doing things.	B III 13
Science 3	Farmers in this neighbourhood feel that most new things in farming cost too much to try them.	A18
Science 4	Farmers in this neighbourhood really try hard to keep up with new developments in farming.	A23

The three variables with an F value insufficient for computation were: attitude towards risk, channels of communication, and achievement motivation. Table 7 contains the questions that correspond to each significant variable and its location in the questionnaire.

TABLE 8. Discriminant Equations for Psychographic Variable Sets

Total Number of Questions	Psychographic Variable Set	Equation
10	Attitude towards education	(0.47561 X Education 10) + (0.40703 X Education 3) + (-0.78715 X Education 2) + (-0.49302 X Education 9) + (0.29502 X Education 7)
5	Ability to deal with abstractions	(0.69500 X Abstraction 5) + (-0.46524 X Abstraction 1) + (-0.39129 X Abstraction 3)
10	Dogmatism	(0.42941 X Dogmatism 10) + (0.31092 X Dogmatism 1) + (-0.46697 X Dogmatism 7) + (0.38793 X Dogmatism 5)
2	Innovativeness	0.89197 X Innovativeness 2
5	Cosmopoliteness	(-0.74697 X Cosmopoliteness 3) + (0.65221 X Cosmopoliteness 4)
4	Attitude towards credit	0.83908 X Credit 2
3	Attitude towards change	0.85582 X Change 2
4	Attitude towards science	(0.70036 X Science 3) + (-0.63971 X Science 4)
4	Channels of	F level insufficient for inclusion
3	Achievement	F level insufficient for inclusion
1	Attitude towards risk	F level insufficient for inclusion

[a]Refer to Table 7 for contents of these variables.

The preceding steps facilitated the reduction from 11 to 8 in the number of variable sets to be analysed further. The stepwise method of discriminant analysis was then applied to the eight psychographic variable sets for which discriminant equations were developed (Table 8). Seven of the eight equations were found to have an F level sufficient for inclusion. Table 9 contains the variable sets which were analysed, the unstandardized discriminant function coefficient and the rank of each set as a discriminator. The psychographic variable set that was the best discriminator was attitude towards education. The next best discriminator was ability to deal with abstractions. These were followed (in descending order of importance) by dogmatism, innovativeness, cosmopoliteness, attitude towards credit, and attitude towards change.

TABLE 9. Unstandardized Discriminant Function Coefficients of Ranked Psychographic Variable Sets

Rank as a Discriminator	Psychographic Variable Set	Unstandardized Discriminant Function Coefficient
1	Attitude towards education	0.46359
2	Ability to deal with abstractions	-0.47079
3	Dogmatism	-0.37471
4	Innovativeness	-0.35086
5	Cosmopoliteness	0.31354
6	Attitude towards credit	0.27255
7	Attitude towards change	0.16680

c. Prediction results of the psychographic variable prediction equation

These unstandardized discriminant coefficients were then used to develop a final prediction equation for the psychographic variable sets. The equation was the sum of the seven unstandardized discriminant coefficients multiplied by their appropriate variable sets. The resultant equation was called the Psychographic Variable Prediction Equation (PVPE):

PVPE = (0.46359 X Attitude towards education) + (-0.47079 X Ability to deal with abstractions) + (-0.37471 X Dogmatism) + (-0.35086 X Innovativeness) + (0.31354 X Cosmopoliteness) + (0.27255 X Attitude towards credit) + (0.16680 X Attitude towards change)

The PVPE was applied to the data to test the hypothesis -- that an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage. When the equation was applied to the answers to the psychographic questions a prediction score was produced for each farmer. Table 10 demonstrates the efficiency of the prediction of adopters and non-adopters at various scores.

TABLE 10. Prediction Results of All Psychographic Variable Sets at Several Prediction Scores

Prediction Scores	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
-1.122	30/35 = 86%	282/418 = 67%	312/453 = 69%
-1.198	29/25 = 83%	294/418 = 70%	323/453 = 71%
-1.203	23/35 = 80%	294/418 = 70%	322/453 = 71%
-1.210	27/35 = 77%	294/418 = 70%	321/453 = 71%
-1.241	26/35 = 74%	300/418 = 72%	326/453 = 72%
-1.649	18/35 = 51%	345/418 = 83%	363/453 = 80%

The data indicate that a score of -1.203 was required to give the minimum acceptable percentage level of correctly classified adopters (80%). A value of -1.198 was more acceptable since it gave a higher percentage of correctly classified adopters without decreasing the percentage of correctly classified non-adopters. Neither of these values however maintained an acceptable level of correctly classified non-adopters (70%) nor an acceptable percentage of correct classifications for the total group (71%). The hypothesis, therefore, was not supported and the psychographic variable set by itself cannot be used to predict accurately adopters and non-adopters of zero-tillage.

Table 10 demonstrates the correlation between the percentage of correctly classified non-adopters and the overall percentage of correct classifications. Since 92% of the total population were non-adopters, a high degree of prediction accuracy of non-adopters results in a high degree of overall prediction accuracy. For this reason, the minimum acceptable level of 80% is applied to the adopters and not to the non-adopters or total correct classifications. Table 10 also shows that as the number of correctly classified adopters increased, the number of correctly classified non-adopters decreased. This occurs because the prediction score is used as the cut-off value to categorize the adopters and non-adopters. As this value is increased, the percentage of correctly classified adopters increases at the expense of the non-adopters.

Other than psychographic questions, two categories of questions relating to farming behaviour and demographics were asked. They will be labelled Category 1 and Category 2 questions and can be seen in Appendix 5 and Appendix 6, respectively. Category 1 questions were designed such

that the farmer was to select the one response that best answered each question. Category 2 questions were designed such that the farmer could select more than one response to answer the question.

d. Category 1 variables as predictors of adoption/non-adoption

Cateogry 1 variable sets are comprised of questions relating to the demographic and communication behaviour of the farmers and can be seen in Appendix 5.

Forty-four Category 1 variable sets were tested in the psychographic/demographic mail questionnaire. Table 11 contains the Category 1 variable sets, the total number of responses for each variable set and the discriminant equation for each significant variable set (derived as described in the methodology). Equations were derived for 31 of the 44 variable sets. Thirteen variable sets had an F value insufficient for computation. Appendix 5 contains the questions that correspond to each significant variable and its location in the questionnaire.

Table 12 contains the 23 category 1 variable sets which, upon further analysis (as described in the methodology), had an F level sufficient for inclusion. The table is comprised of the unstandardized discriminant function coefficients and the rank of each set as a discriminator. The category 1 variable set that was the best discriminator was farm location. The next best discriminator was attitude towards government. These were followed in descending order of importance by: two opinion leadership variables (opinion leadership 1 and opinion leadership 2), years of farming experience, if he determines the profitability of the farm, number of part-time workers, number of full-time workers, the importance of radio as a communicator, income from the farm, the importance of television as a

TABLE 11. Discriminant Equations of Category 1 Variable Sets

Variable Set Name	Total Number of Responses	Discriminant Equation
Farm location	8	(1.44841 X Location 6[a]) + (5.32504 X Location 8) + (-1.39663 X Location 7) + (-1.39843 X Location 2)
Attitude towards government	6	21.28368 X Government attitude 6
Opinion leadership 1	3	(1.40040 X Opinion 1) + (-1.25537 X Opinion 3)
Opinion leadership 2	4	21.28368 X Opinion 2-4
Years of farming experience	5	(1.73990 X Experience 1) + (1.75199 X Experience 4) + (2.73791 X Experience 5)
If he determines the profitability of farming	3	2.88679 X Profit 1
Number of part-time workers	9	(12.54852 X Workers part-time 7) + (-1.53467 X Workers part-time 2)
Number of full-time workers	7	(2.11796 X Workers full-time 1) + (4.77852 X Workers full-time 4)
The importance of radio as a communicator	5	2.44425 X Rankmedia 4/4
Income from the farm	8	(3.67377 X Income 4) + (2.58045 X Income 6)
The importance of television as a communicator	5	3.18772 X Rankmedia 5/1
Attitude towards planning	3	3.74107 X Hardwork 3
From whom he learns of new idea	7	(1.47565 X Hearidea 7) + (-6.55751 X Hearidea 1)
Where he gets help for implementing new ideas	3	(2.51750 X Gethelp 3) + (2.25355 X Gethelp 4)
Number of farmer broadcasts listened to	1	5.98301 X Broadcast 1
Degree of innovativeness	5	2.24031 X Innovativeness 2
Education level	3	(3.33180 X Education 1) + (1.62490 X Education 2)
Whether he takes the Winnipeg paper	1	2.09594 X Winnipeg paper 3
Number of partners	5	10.67717 X Partners 5
Farming decisions determined by marketing	5	4.98306 X Achievement market 3
Age of respondent	5	(3.07543 X Age 5) + (-1.84734 X Age 2)
Workable land own	5	(0.00015 X WLO B) + (-0.00341 X WLO A) + (-0.00228 X WLO C) + (-0.00245 X WLO D)
% of income derived from farming	1	3.74107 X % Income 1
Where he buys farm supplies	8	(10.49452 X Supplier 7) + (5.07354 X Supplier 8)
The importance of newspapers as a communicator	5	(1.45826 X Rankmedia 3/1) + (1.62820 X Rankmedia 3/2)
The importance of direct mail as a communicator	5	(2.11716 X Rankmedia 1/3) + (1.96142 X Rankmedia 1/5)
The importance of magazines as a communicator	5	(1.56698 X Rankmedia 2/1) + (-1.54668 X Rankmedia 2/3)
Is he asked for advice	4	2.14916 X Advice 2
Whether he is source of new idea	4	(1.30049 X Newidea 1) + (10.20838 X Newidea 4)
Important involvement in a farm organization	4	(4.33799 X Farmorg 1) + (5.20897 X Farmorg 2)
Whether he takes the community paper	3	3.79115 X Community paper 3
What he does when discussing new farming practices	5	Not Significant
Where he looks for best ideas	4	Not Significant
What is most important to be a successful farmer	4	Not Significant
Important characteristics of other job	4	Not Significant
What is a successful farmer	4	Not Significant
How often contacts Ag. rep	4	Not Significant
How often contacts dealer	4	Not Significant
Are farming decisions determined by land	4	Not Significant
How he would react to new idea	4	Not Significant
Has he told anyone of new farming practice	3	Not Significant
Farming decisions depends on neighbours	3	Not Significant
Has he soil tested this year	2	Not Significant
Sex of respondent	2	Not Significant

[a]Refer to Appendix 5 for contents of these variables.

TABLE 12. Unstandardized Discriminant Function Coefficients of Ranked Category 1 Variable Sets

Category 1 Variable Set	Rank as a Discriminator	Unstandardized Discriminant Function Coefficient
Farm location	1	0.03633
Attitude towards government	2	0.05275
Opinion leadership 1	3	0.11752
Opinion leadership 2	4	0.06292
Years of farming experience	5	0.03118
If he determines profitability of the farm	6	0.21557
Number of part-time workers	7	0.03700
Number of full-time workers	8	0.07638
The importance of radio as a communicator	9	-0.04668
Income from the farm	10	-0.03779
The importance of television as a communicator	11	0.18395
Attitude towards planning	12	0.06802
Who he hears a new idea from	13	0.03702
Where he gets help with implementing new ideas	14	-0.06430
Number of farm broadcasts listened to	15	-0.14409
The degree of innovativeness	16	0.06933
Education level	17	0.08864
Whether he takes Winnipeg paper	18	-0.04447
Number of partners in operation	19	0.02708
Farming decisions determined by market	20	-0.03851
Age of respondent	21	0.02759
Workable land own	22	-0.10421
Percent of income derived from farming	23	-0.10476

communicator, attitude towards planning, who he hears a new idea from, where he gets help with implementing new ideas, number of farm broadcasts listened to, the degree of innovativeness, education level, whether he takes Winnipeg paper, number of partners in operation, farming decisions determined by market, age of respondent, workable land own, and percent of income derived from farming. It is important to note that two questions dealing with opinion leadership ranked third and fourth as discriminating variables. The high ranking of these variables concurs with the literature.

e. Prediction results of the category 1 variable prediction equation

A final prediction equation for the category 1 variable sets was produced. The equation was the sum of 23 unstandardized discriminant function coefficients multiplied by their appropriate variable sets. The resultant equation was called the Category 1 Variable Prediction Equation (C1VPE):

C1VPE - (0.03633 X farm location) + (0.05275 X attitude towards government) + (0.11752 X opinion leadership 1) + (0.06292 X opinion leadership 2) + (0.03118 X years of farming experience) + (0.21557 X if he determines profitability of the farm) + (0.38700 X number of part-time workers) + (0.07638 X number of full-time workers) + (-0.04668 X the importance of radio as a communicator) + (-0.3779 X income from the farm) + (0.81395 X the importance of television as a communicator) + (0.06802 X attitude towards planning) + (0.03702 X who he hears a new idea from) + (-0.06430 X where he gets help with implementing new ideas) + (-0.14409 X number of farm broadcasts listened to) + (0.06933 X the degree of innovativeness) + (0.08864 X education level) + (-0.04447 X whether he takes the Winnipeg paper) + (0.02708 X number of partners in operation) + (-0.03851 X farming decisions determined by market) + (0.02759 X age of respondent) + (-0.10421 X workable land own) + (-0.10476 X percent of income derived from farming)

The CIVPE was applied to the data to test the hypothesis -- whether an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage.

The efficiency of the prediction of adopters and non-adopters is demonstrated in Table 13. These data indicated that 1.136 was the prediction score required to give the percentage correctly classified adopters required to accept the hypothesis (80%). The value, however, did not maintain an acceptable level of correctly classified non-adopters (78%) or an acceptable percentage of correct classifications for the total group (78%). The hypothesis, therefore, was not supported and the category 1 variable set by itself cannot be used to predict accurately adopters and non-adopters of zero-tillage.

The category 1 variable set was a slightly better prediction mechanism than the psychographic variable set (78% correct classifications versus 71%, respectively). This increase in prediction accuracy could have been due to the larger number of variable sets found in the category 1 questions. It seems likely that the ability to detect differences between the two groups would be increased with the larger question set. As with the psychographic variable set, there continues to be a correlation between the percentage of correctly classified non-adopters and the overall percentage of correct classifications, again due to the large proportion of non-adopters. Table 13 also shows that as the number of correctly classified adopters increased, the number of correctly classified non-adopters decreased. Once again, the percentage of correctly classified adopters increases at the expense of the non-adopters.

TABLE 13. Prediction Results of All Category 1 Variable Sets at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
1.163	26/35 = 74%	331/418 = 79%	357/453 = 79%
1.140	27/35 = 77%	326/418 = 78%	353/453 = 78%
1.136	28/35 = 80%	325/418 = 78%	353/453 = 78%
1.092	29/35 = 83%	317/418 = 76%	346/453 = 76%
0.963	30/35 = 86%	297/418 = 71%	327/453 = 72%

f. Category 2 variables as predictors of adoption/non-adoption

Category 2 variable sets are comprised of questions relating to the demographic characteristics of the farmers and can be seen in Appendix 6.

Five category 2 variable sets were tested in the psychographic demographic mail questionnaire. Table 14 contains the category 2 variable sets, the total number of responses for each variable set and the discriminant equation for each significant variable set (derived as described in the methodology). Equations were derived for four of the five variable sets. One set had an F level insufficient for inclusion. Appendix 6 contains the questions that correspond to each significant variable and its location in the questionnaire.

TABLE 14. Discriminant Equations of Category 2 Variable Sets

Total Number of Responses	Variable Set	Discriminant Equation
9	Type of farm records used	(14.28389 X Records 7[a]) + (2.34192 X Records 8)
26	Farm magazines read	(1.52593 X Farm mag 6) + (-1.78078 X Farm mag 8) + (2.61495 X Farm mag 13) + (-1.23195 X Farm mag 14) + (3.95327 X Farm mag 20)
8	How decides number of acres of cereals to plant	(1.38815 X Decide 1) + (3.39688 X Decide 4)
9	Type of farm	3.89853 X Farm type 8
9	How the records are used	Not Significant

[a]Refer to Appendix 6 for content of these variables.

Table 15 contains the four category 2 variable sets which were found to have an F level sufficient for inclusion of further analysis (as described in the methodology). The table is comprised of the unstandardized discriminant function coefficients and the rank of each set as a discriminator. The category 2 variable set that was the best discriminator was type of records used. The next best discriminator was farm magazines read. These were followed in descending order of importance by: how he decides the number of acres of cereals to plant, and type of farm.

TABLE 15. Unstandardized Discriminant Function Coefficients of Ranked Category 2 Variable Sets

Category 2 Variable Set	Rank as a Discriminator	Unstandardized Discriminant Function Coefficient
Type of farm records used	1	0.72952
Farm magazines read	2	0.53359
How decided cereal acreage	3	0.23424
Type of farm	4	0.16001

g. Prediction results of the category 2 variable prediction equation

A final prediction equation for the category 2 variable sets was developed. The equation was the sum of the four unstandardized discriminant function coefficients multiplied by their appropriate variable sets. The resultant equation was called the Category 2 Variable Prediction Equation (C2VPE):

C2VPE = (0.72952 X types of farm records used) + (0.53359 X farm magazines read) + (0.23424 X how decides cereal acreage) + (0.16001 X type of farm)

The C2VPE was applied to the data to test the hypothesis -- whether an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage.

The efficiency of the prediction of adopters and non-adopters is demonstrated in Table 16. These data indicated that 33.108 was the prediction score required to give 80% correctly classified adopters and thus accept the null hypothesis. At this value, both the percent correctly classified non-adopters and the percent of correct classifications for the total group fell below 50% accuracy (46% and 49%, respectively). The hypothesis was not supported and the category 2 variable set by itself cannot, therefore, be used to predict accurately adopters and non-adopters of zero-tillage.

Of the three variable sets tested alone, category 2 was the least accurate. When 80% of the adopters were correctly classified, fewer than 50% of both the non-adopters and the total group were correctly classified. This low prediction accuracy was likely due to the low number of variable sets in category 2. There were five variable sets compared to eleven in the psychographic and 44 in the category 1 variable sets.

As with the two previous variable sets, there is a correlation between the percentage of correctly classified non-adopters and the overall percentage of correct classifications (Table 16). In addition, Table 16 shows that as the number of correctly classified adopters increased, the number of correctly classified non-adopters decreased. As with the previous

two variable sets, the percentage of correctly classified adopters increases at the expense of the non-adopters.

TABLE 16. Prediction Results of Category 2 Variable Sets at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
32.623	18/35 = 51%	323/418 = 77%	341/453 = 75%
32.921	19/35 = 43%	315/418 = 75%	334/453 = 74%
33.090	27/35 = 77%	197/418 = 47%	234/453 = 52%
33.108	28/35 = 80%	194/418 = 46%	222/453 = 49%

When the values for the three types of questions were ranked, the category 1 questions were the best predictors, followed by psychographic questions, and then category 2 questions. When considered alone, none of these types of questions gave an acceptable prediction accuracy; however, combinations of the three provided a higher degree of accuracy.

Next, the three types of questions, psychographic, category 1, and category 2 were analysed in all possible combinations to determine each combination's prediction efficiency.

h. Psychographic and category 2 variables as predictors of adoption/non-adoption

Once the Psychographic Variables Prediction Equation (PVPE) and the Category 2 Variables Prediction Equation (C2VPE) were derived, the two equations were combined. Unstandardized discriminant function coefficients

were produced for the PVPE and the C2VPE (Table 17). A new equation was produced by summing the products of the corresponding unstandardized discriminant function coefficients of the PVPE and the C2VPE. This new euqation was called the Psychographic Category 2 Variable Prediction Equation (PC2VPE):

PC2VPE = (0.67340 X Psychographic Variable Set) + (0.72777 X Cateogry 2 Variable Set)

TABLE 17. Unstandardized Discriminant Function Coefficients of Psychographic and Category 2 Variable Sets

Variable Set	Unstandardized Discriminant Function Coefficient
Psychographic Variable Set	0.67340
Category 2 Variable Set	0.72777

The PC2VPE was tested to determine if it supported the hypothesis -- that an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage. The efficiency of the prediction equation can be seen in Table 18. These data indicate that 23.057 was the prediction score required to give 80% correctly classified adopters. The value 23.069 was more acceptable, however, since it gave a higher percentage of correctly classified adopters without decreasing the percentage correctly classified non-adopters. Neither of these prediction scores maintained an acceptable level of correctly classified non-adopters (71%) nor an acceptable percentage of correct

classifications of the total group (72%). The hypothesis, therefore, was not supported by the combination of the psychographic category 2 variable sets.

The combination gave a slight increase in the prediction accuracy when compared to the psychographic variable set alone (72% vs. 71%). This demonstrates the lack of importance of the category 2 variables to increasing the prediction accuracy. When compared to the prediction accuracy of the category 2 variable set alone, there was a marked improvement when the variable sets were combined (49% vs. 72%). This also demonstrates the importance of the psychographic variable sets to the prediction accuracy.

TABLE 18. Prediction Results of Psychographic and Category 2 Variable Sets at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
22.600	23/35 = 66%	366/418 = 88%	389/453 = 86%
22.778	26/35 = 74%	344/418 = 82%	370/453 = 82%
22.997	27/35 = 77%	309/418 = 74%	336/453 = 74%
23.057	28/35 = 80%	298/418 = 71%	326/453 = 72%
23.069	29/35 = 83%	296/418 = 71%	325/453 = 72%
23.246	31/35 = 86%	256/418 = 61%	287/453 = 63%

Normal curves (Figure 3a) were drawn for the adopters and non-adopters. There does not appear to be a good separation of adopters and non-adopters

FIGURE 3a. Normal curves for adopters and non-adopters for psychographic and Category 2 variable sets

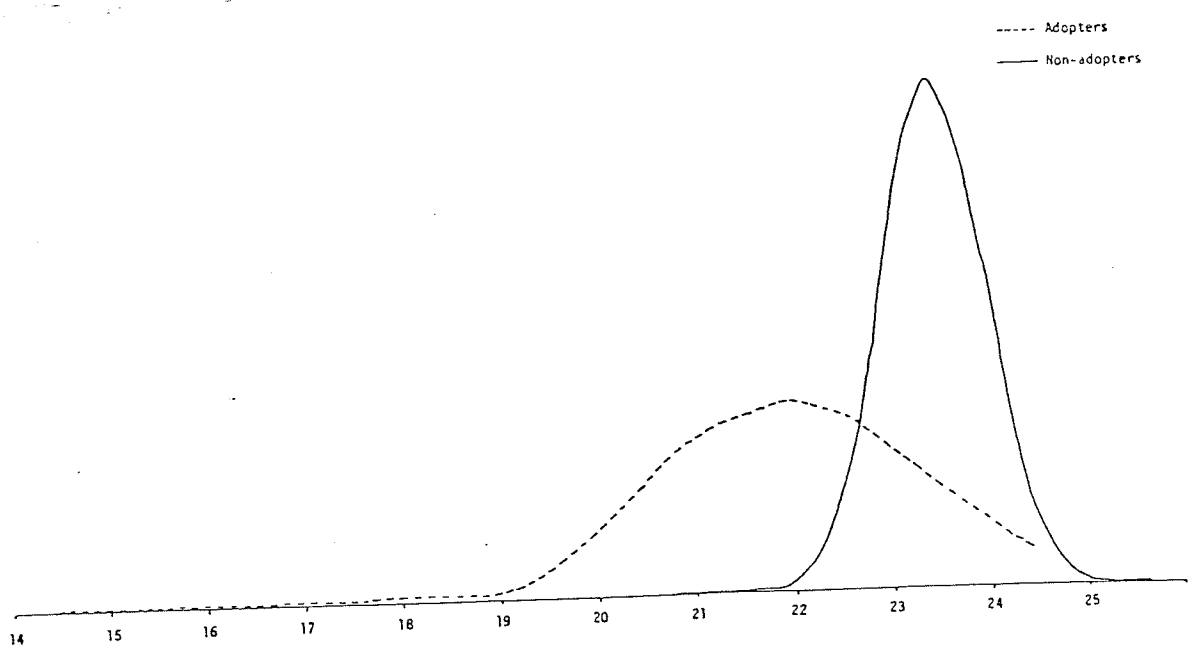
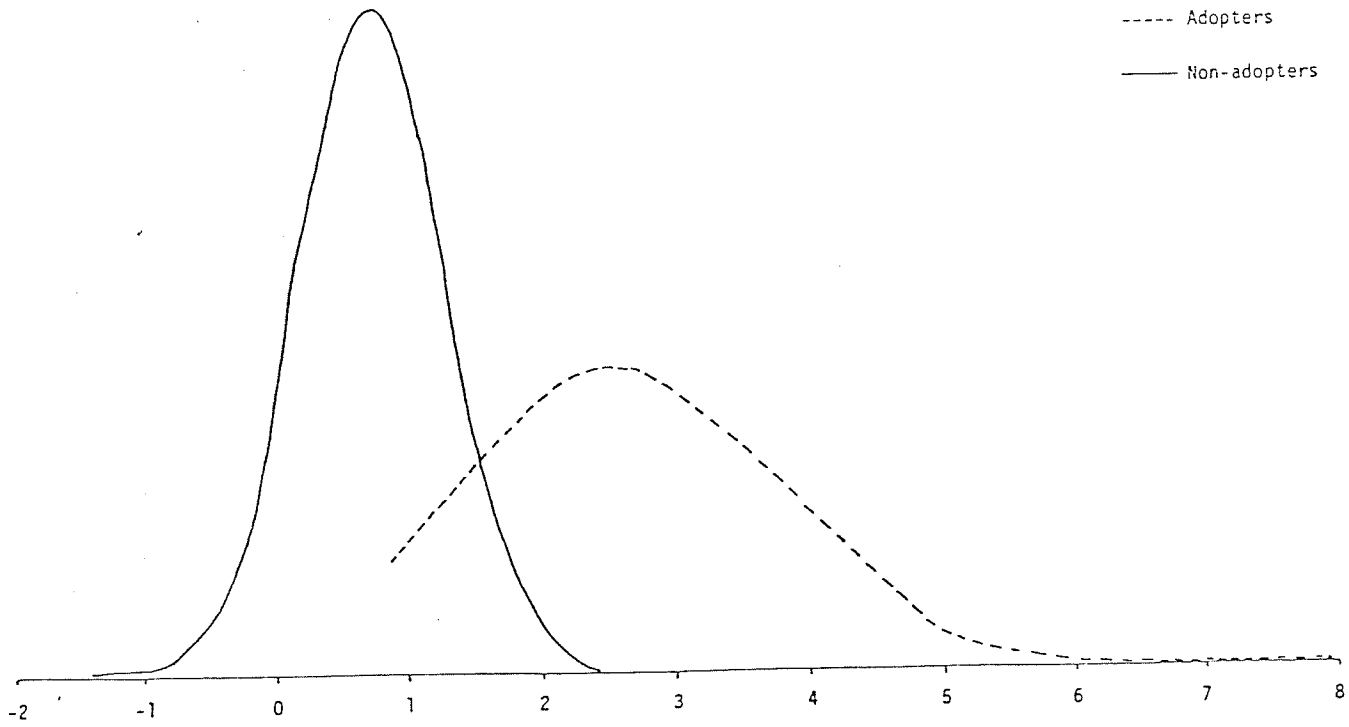


FIGURE 3b. Normal curves for adopters and non-adopters for psychographic and Category 1 variable sets



in this figure. There is a large area of overlap in the two curves demonstrating poor prediction ability. The curve for the adopters was lower and had a larger range, indicating that the adopters were a more heterogeneous group than the non-adopters. It therefore appears to be more difficult to categorize the adopters than the non-adopters.

i. Psychographic and category 1 variable sets as predictors of adoption/non-adoption

The Psychographic Variables Prediction Equation (PVPE) was combined with the Category 1 Variables Prediction Equation (C1VPE) and unstandardized discriminant function coefficients were produced (Table 19). A new equation was produced by summing the products of the corresponding unstandardized discriminant function coefficients of the PVPE and C1VPE. This new equation was called the Psychographic Category 1 Variable Prediction Equation (PC1VPE):

PC1VPE = (-0.37541 X Pscyhographic Variable Set) + (0.83969 X Category 1 Variable Set)

TABLE 19. Unstandardized Discriminant Function Coefficients of Psychographic and Category 1 Variable Sets

Variable Set	Unstandardized Discriminant Function Coefficient
Psychographic Variable Set	-0.37541
Category 1 Variable Set	0.83969

The PC1VPE was tested to determine if it supported the hypothesis -- that an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage. The efficiency of the prediction equation can be seen in Table 20. These data demonstrate that 1.369 was the prediction score required to give 80% correctly classified adopters. This prediction score also maintained an acceptable level of correctly classified non-adopters (80%) and an acceptable percentage of correct classification of the total group (80%). The hypothesis was supported by the combination of the psychographic category 1 variable sets. The combination of the two variable sets improved the efficiency of the two component parts (80% vs. 71% for the psychographic questions and 78% for the category 1 questions). Clearly the nature of the question was very important in increasing the efficiency of prediction, however this phenomenon is likely due to the fact that the total number of questions increased with the combination.

TABLE 20. Prediction Results of Psychographic and Category 1 Variable Sets at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
1.469	26/35 = 74%	346/418 = 82%	372/453 = 82%
1.404	27/35 = 77%	340/418 = 81%	367/453 = 81%
1.369	28/35 = 80%	334/418 = 80%	362/453 = 80%
1.284	29/35 = 83%	320/418 = 77%	349/453 = 77%
1.052	30/35 = 86%	277/418 = 66%	307/453 = 68%

Normal curves (Figure 3b) were drawn for the adopters and non-adopters. These curves showed that the degree of separation was better than when the PC2VPE values were used, and the adopter and non-adopter groups were more distinct. The curve for the adopters was lower and had a larger range than that of the non-adopters, indicating that the adopters were a more heterogeneous group than the non-adopters. As in the previous equation, adopters appear to be more difficult to categorize.

j. Category 1 and category 2 variable sets as predictors of adoption/non-adoption

The Category 1 Variables Prediction Equation (C1VPE) was combined with the Category 2 Variables Prediction Equation (C2VPE). Unstandardized discriminant function coefficients were produced (Table 21) and a prediction equation was developed by summing the products of the unstandardized discriminant function coefficients with their corresponding C1VPE and C2VPE. This new euqation was called the Category 1 Category 2 Variable Prediction Equation (C1C2VPE);

C1C2VPE = (0.81746 X Category 1 Variable Set) + (=0.47768 X Category 2 Variable Set)

TABLE 21. Unstandardized Discriminant Function Coefficients of Category 1 and Category 2 Variable Sets

Variable Set	Unstandardized Discriminant Function Coefficient
Category 1 Variable Set	0.81746
Category 2 Variable Set	-0.47768

The C1C2VPE was tested to determine if it supported the hypothesis -- that an equation could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage. The efficiency of the prediction equation can be seen in Table 22. These data demonstrate that the prediction score requried to support the null hypothesis (80% correct classifications) was -14.365. Not only does this score correctly classify 80% of the adopters, but it correctly classifies 82% of the non-adopters and 82% of the total group. The C1C2VPE, therefore, supported the hypothesis. Correct classification of adopters and non-adopters was achieved (with 80% accuracy) with the C1C2VPE equation. The combination of the two variable sets improved the efficiency of the two component parts (82% vs. 78% for the category 1 questions and 49% for the category 2 questions). This was likely due to the increase in the total number of questions on which the prediction was based.

TABLE 22. Prediction Results of Category 1 and Category 2 Variable Sets at Various Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
-14.587	26/35 = 74%	349/418 = 83%	375/453 = 83%
-14.614	27/35 = 77%	345/418 = 83%	372/453 = 82%
-14.635	28/35 = 80%	343/418 = 82%	371/453 = 82%
-14.686	29/35 = 83%	336/418 = 80%	365/453 = 80%
-14.796	30/35 = 85%	316/418 = 76%	346/453 = 76%

Normal curves (Figure 3c) were drawn for adopters and non-adopters. These curves show that the degree of separation between the adopters and non-adopters was better than when the PC1VPE or the PC2VPE values were used. The figure demonstrates the effectiveness in the C1C2VPE.

k. Psychographic category 1 and category 2 variable sets as predictors of adoption/non-adoption

All the equations PVPE, C1VPE, and C2VPE were analysed together and unstandardized discriminant function coefficients were produced (Table 23). A prediction equation was developed by summing the products of the unstandardized discriminant function coefficients with their corresponding equations. The equation was called the Psychographic Category 1 Category 2 Variable Prediction Equation (PC1C2VPE):

PC1C2VPE = (-0.34620 X Psychographic Variable Set) + (0.68514 X Category 1 Variable Set) + (-0.45806 X Category 2 Variable Set)

TABLE 23. Unstandardized Discriminant Function Coefficients of Psychographic, Category 1, and Category 2 Variable Sets

Variable Set	Unstandardized Discriminant Function Coefficient
Psychographic Variable Set	-0.34620
Category 1 Variable Set	0.68514
Category 2 Variable Set	-0.45806

FIGURE 3c. Normal curves for adopters and non-adopters for Category 1 and Category 2 variable sets

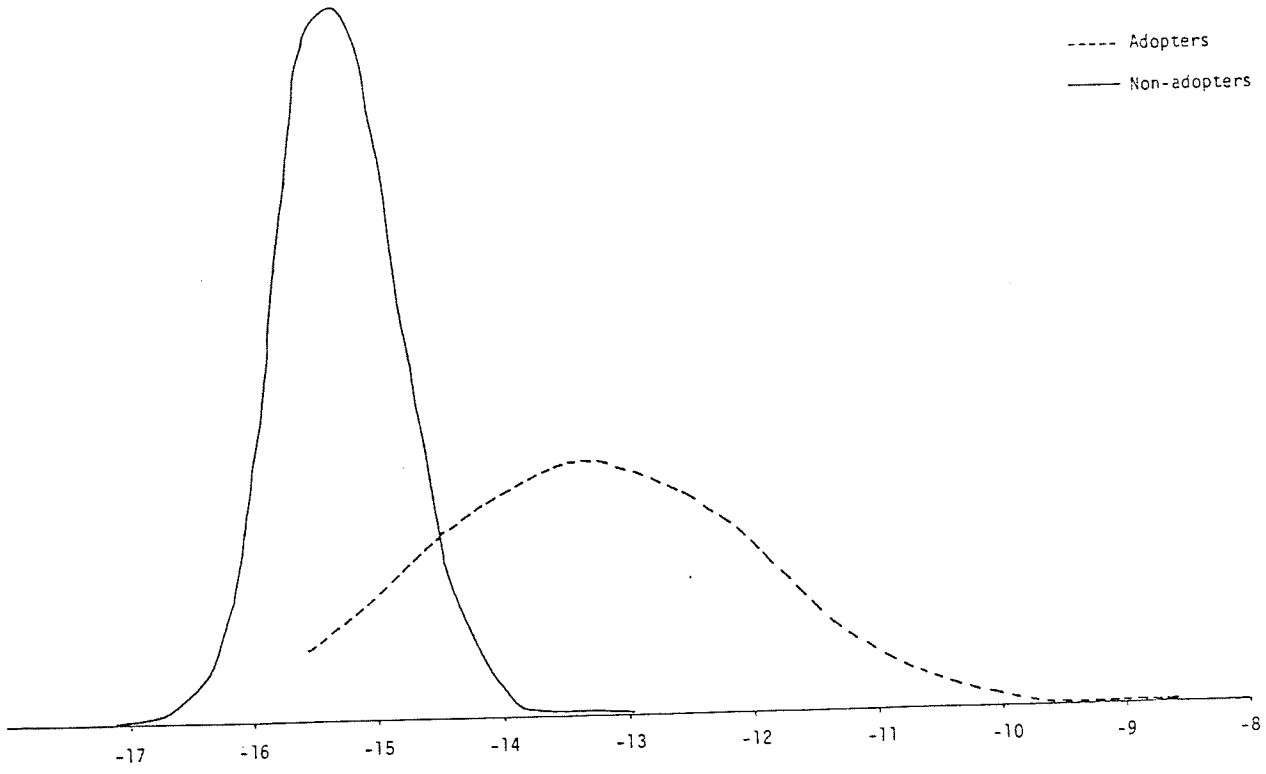
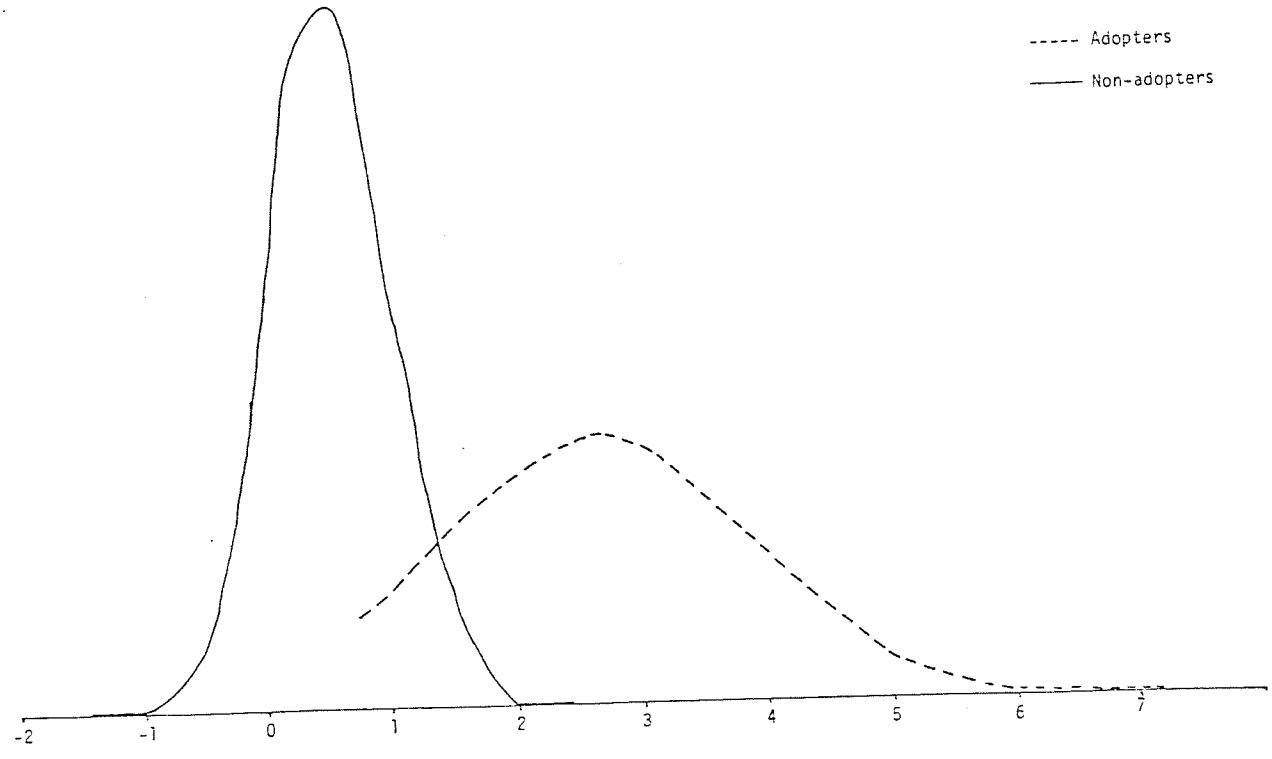


FIGURE 3d. Normal curves for adopters and non-adopters for psychographic, Category 1 and Category 2 variable sets



The PC1C2VPE was tested to determine its effectiveness in predicting adopters and non-adopters. The efficiency of the prediction equation can be seen in Table 24. These data demonstrate that the prediction score required to support the hypothesis (80% correct classifications) was -13.776. At this prediction score, 85% of the non-adopters and 85% of the total group were correctly classified. This was the most efficient prediction equation of all those evaluated. This was likely due to the fact that the total number of questions on which the prediction was based was the greatest.

TABLE 24. Prediction Results of Psychographic, Category 1 and Category 2 Variable Sets at Various Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
-13.625	26/35 = 74%	369/418 = 88%	395/453 = 87%
-13.676	27/35 = 77%	366/418 = 88%	393/453 = 87%
-13.776	28/35 = 80%	355/418 = 85%	383/453 = 85%
-13.786	29/35 = 83%	353/418 = 84%	382/453 = 84%
-13.841	30/35 = 86%	343/418 = 82%	373/453 = 82%
-14.066	31/35 = 89%	369/418 = 72%	332/453 = 73%

Normal curves (Figure 3d) were drawn for adopters and non-adopters. These curves demonstrate the improvement in prediction efficiency obtained from combining the three variable sets and shows the effectiveness of the PC1C2VPE equation. The curve for the adopters was lower and had a larger

range than the non-adopter curve, indicating that the adopter group was more heterogeneous than the non-adopter group.

1. Comparison of the prediction accuracy of the variable sets from the psychographic-demographic questionnaire

The accuracy of the prediction of adopters and non-adopters utilizing the variable sets alone and in combination can be seen in Table 25. These data indicate that the hypothesis (80% prediction accuracy) was supported in three of the four variable combinations and not at all when the variable sets were analysed alone. The most discriminating single variable set was the Category 1 Variable Set (78%) followed by the Psychographic (71%) and Category 2 Variable Sets (49%). When the variable sets were combined, the prediction accuracy of all combinations improved compared to the prediction accuracy of each alone. This was understandable since the stepwise method of multiple discriminant analysis only includes those variables that improve the prediction accuracy.

The combination of the three variable sets was the most effective overall predictor (84%). The next most discriminating variable set was the combination of Category 1/Category 2 (82%). This was followed by the Psychographic/Category 1 variable set (80%). The Psychographic/Category 2 combination (72%) was the poorest of the variable set combinations and performed even more poorly than the Category 1 variable set alone.

Table 26 shows the correlation between the prediction accuracy of the variable sets both alone and in combination, and the number of variables contained therein. With the exception of the Psychographic/Category 1 Variable Set, there was a direct relationship between the number of variable

TABLE 25. Prediction Accuracy of the Variable Sets From the Psychographic Demographic Survey

		Psychographic/Category 1/ Category 2 Variable Set		Category 1/Category 2 Variable Set		Psychographic/Category 1 Variable Set		Category 1 Variable Set		Psychographic/Category 2 Variable Set		Psychographic Variable Set		Category 2 Variable Set	
Adoption Category	No. of Cases	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters
Adopters	35	29	6	28	7	28	7	28	7	29	6	29	6	28	7
		83%	17%	80%	20%	80%	20%	80%	20%	80%	20%	83%	17%	80%	20%
Non-Adopters	418	65	353	75	343	84	334	93	325	122	296	124	294	224	194
		16%	84%	18%	82%	20%	80%	22%	78%	29%	71%	30%	70%	54%	46%
% Correct Classifications		84%		82%		80%		78%		72%		71%		49%	

sets and the prediction accuracy. This was expected since the multiple discriminant analysis program utilizes the answers to the variable sets to discriminate between adopters and non-adopters. It stands to reason, therefore, that the greater the number of variable sets, the more points there are in which the two populations can differ, and the greater the prediction accuracy.

TABLE 26. The Correlation Between Prediction Accuracy of the Variable Sets and the Number of Variables

Variable Set	Rank as a Discriminator	Number of Variables	Number of Individual Questions
Psychographic/Category 1/Category 2	1	60	97
Category 1/Category 2	2	49	49
Psychographic/Category 1	3	55	95
Category 1	4	44	44
Psychographic/Category 2	5	16	56
Psychographic	6	11	51
Category 2	7	5	5

B. PREDICTION BASED ON THE PERCEIVED ATTRIBUTES TELEPHONE QUESTIONNAIRE

The telephone questionnaire contained two types of questions: (1) questions that determined how the farmers perceived the attributes of zero-tillage (called the perceived attribute questions) and,

(2) questions that determined the adoption tendencies of the farmers (called the adoption questions). The perceived attribute questions were analysed alone and in combination with the adoption question utilizing the stepwise method of multiple discriminant analysis.

a. Perceived attribute questions as predictors of adoption/non-adoption

Thirteen of the 19 questions in the telephone questionnaire (Appendix 3) specifically related to how the farmers perceived the attributes of zero-tillage. These questions dealt with the observability of zero-tillage, the compatibility of zero-tillage, the amount of risk associated with the adoption of zero-tillage, and the relative advantage of zero-tillage. The questions were analysed as described in the materials and methods.

Before the analysis was done, the 13 questions were broken into 46 sub-components utilizing the technique described in the materials and method. Of the initial 46 questions, 15 had an F level sufficient for inclusion (Table 27).

A prediction equation was developed for the perceived attribute questions. This equation was the sum of the unstandardized discriminant function coefficients multiplied by the response to the corresponding perceived attribute question. The resultant equation was called the Perceive Attribute Prediction Equation (PAPE):

PAPE = (1.04640 X OB1) + (1.04973 X C42) + (0.65019 X RV3) + (-0.63645 X C22) + (-0.73035 X C52) + (-0.57699 X R14) + (0.82132 X R33) + (1.71410 X R11) + (0.54437 X OH1) + (0.43365 X C32) + (1.03454 X PR4) + (0.73143 X PR3) + (-0.42240 X O22) + (-0.38171 X OP1) + (-1.18375 X C51).

TABLE 27. Discriminant Equations and Step of Entry into the Equation of Perceived Attribute Questions

Perceived Attribute Variable	Question	Total Number of Responses	Step of Entry	Discriminant Equation
Observability	What thinks of zero-tillage neighbour	1	1	(1.04640 X OB1[a])
Compatibility	Will zero-tillage require more planning and attention	2	2	(1.04973 X C42)
Relative Advantage	What happens to yields under zero-tillage	3	3	(0.65019 X RV3)
Compatibility	Will adaptions keep from adopting	4	4	(-0.63645 X C22)
Compatibility	Will it fit your practices	5	5 15	(-1.18375 X C52) (-0.73035 X C51)
Relative Advantage	What happens to total farming costs with zero-tillage	5	6 8	(-0.57699 X R14) (1.71410 X R11)
Relative Advantage	What happens to soil structure	3	7	(0.82132 X R33)
Observability	Observability at harvest	3	9	(0.54437 X OH1)
Compatibility	Will zero-tillage cause major change in operation	3	10	(0.43365 X C32)
Perceived Risk	Risk if adopt zero-tillage	4	11 12	(1.03454 X PR4) (0.73143 X PR3)
Observability	What thinks of zero-tillage farmer	3	13	(-0.42240 X O22)
Observability	Observability after planting	3	14	(-0.38171 X OP1)

[a]Refer to Appendix 7 for content of these variables.

The PAPE was applied to the data to test the hypothesis -- that a prediction could be developed that could predict, with 80% accuracy, if an individual was an adopter or non-adopter of zero-tillage.

The efficiency of the prediction of adopters and non-adopters is demonstrated in Table 28. These data indicate that 7.520 was the prediction score required to give an acceptable level of correctly classified adopters (80%). The value however, does not maintain an acceptable level of correctly classified non-adopters (62%) or an acceptable percentage of correct classifications for the total group (63%). The hypothesis, therefore, was not supported by the perceived attribute questions and the perceived attribute questions alone cannot be used to classify adopters and non-adopters,

TABLE 28. Prediction Results of the Perceived Attribute Questions at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
7.458	26/35 = 74%	262/418 = 63%	288/453 = 64%
7.511	27/35 = 77%	260/418 = 62%	287/453 = 63%
7.520	28/35 = 80%	257/418 = 62%	287/453 = 63%
7.546	29/35 = 83%	256/418 = 61%	285/453 = 63%
7.579	30/35 = 86%	251/418 = 60%	281/453 = 62%

Normal curves (Figure 4a) were drawn for the adopters and non-adopters. There was a large area of overlap between the two curves, indicating

FIGURE 4a. Normal curves for adopters and non-adopters for perceived attribute variable sets

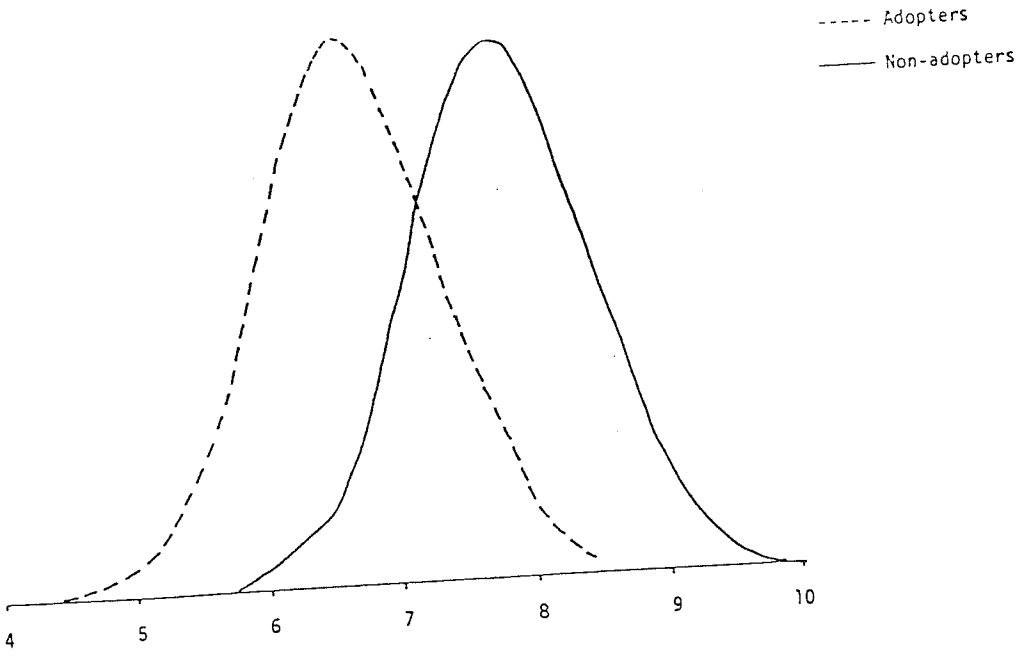
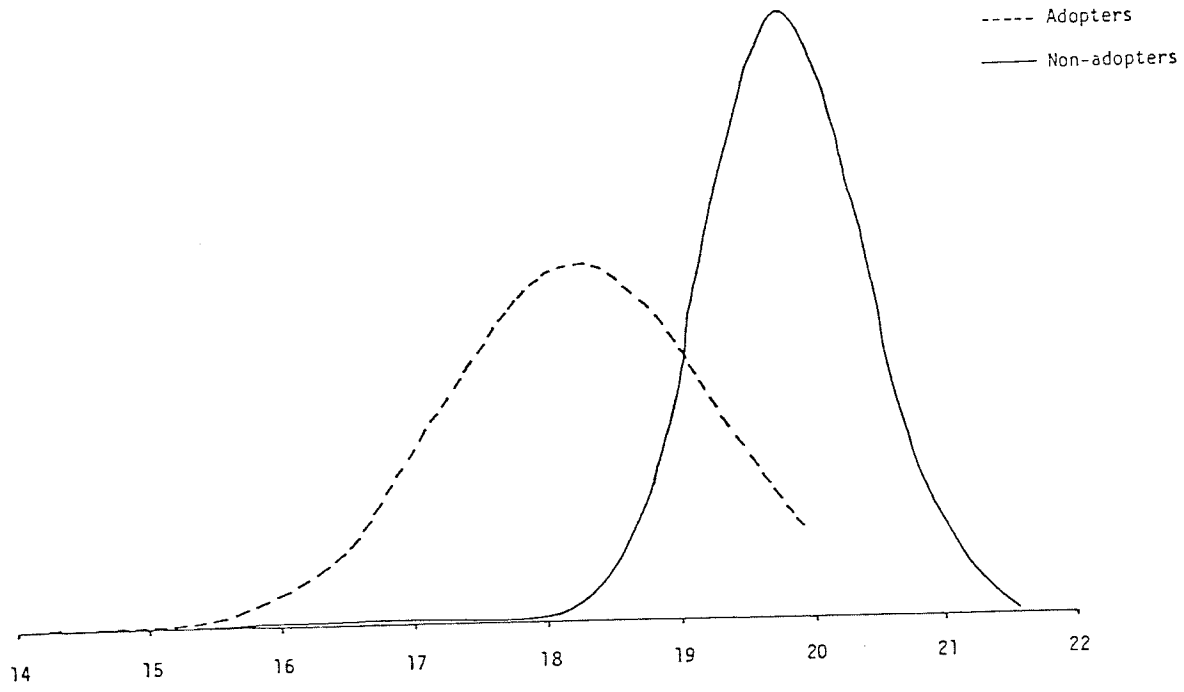


FIGURE 4b. Normal curves for adopters and non-adopters for perceived attribute and adoption variable sets



poor separation of the two groups and, therefore, poor predictability. The curves for adopters and non-adopters are similar in shape and have similar ranges. This indicates the homogeneity of both populations is the same. This was not consistent with the results of the psychographic demographic mail questionnaire. It may be due to the relatively small number of questions asked or the type of questions asked.

A summary table of the significant perceived attribute questions can be seen in Table 29. Thirteen of the 46 questions made a significant contribution to the development of a prediction model. No single perceived attribute dominated the number of significant questions. Approximately 25-30% of the expanded questions made a significant contribution to the prediction equation.

TABLE 29. Summary Table of Perceived Attribute Questions

Attribute	Number of Questions	Number of Expanded Questions	Number of Significant Questions
Observability	4	12	4
Compatibility	5	17	4
Relative Advantage	3	13	3
Perceived Risk	1	4	1
TOTAL	13	46	12

b. Perceived attribute questions plus adoption questions as predictors of adoption/non-adoption

All 19 questions in the telephone questionnaire (13 perceived attribute and 6 adoption questions) were analysed. Before the analysis was completed the 19 questions were extended to 72 new questions utilizing the technique described in the materials and method. Of the initial 72 questions, 19 had an F level sufficient for inclusion (Table 30).

A prediction equation was developed for the perceived attribute and adoption questions. This equation was the sum of the unstandardized discriminant function coefficients multiplied by the corresponding questions. The resultant equation was called Perceived Attribute Adoption Prediction Equation (PAAPE):

PAAPE = (4.38146 X A11) + (0.43277 X A21) + (0.72417 X OB1) + (-0.73337 X C22) + (1.69994 X A12) + (0.89177 X SY2) + (0.80652 X A31) + (0.67694 X C42) + (1.40933 X R11) + (0.30971 X OH1) + (-0.38664 X R14) + (-0.66063 X RV2) + (0.87211 X PR4) + (-0.37256 X 022) + (0.38722 X PR3) + (0.42730 X R33) + (0.41876 X R12) + (-0.54906 X SY3) + (-0.73988 X RV1)

The PAAPE was applied to the data to test the hypothesis -- that a prediction could be developed that could predict, with 80% accuracy, whether an individual was an adopter or non-adopter of zero-tillage.

The efficiency of the prediction of adopters and non-adopters is demonstrated in Table 31. These data indicated that a prediction score of 19.469 was required to give the percentage correctly classified adopters that was necessary to accept the null hypothesis (80%). This value, however, did not maintain an acceptable level of correctly

TABLE 30. Summary Table of Unstandardized Discriminant Function Coefficients for Perceived Attribute and Adoption Questions and the Step of Entry to the Equation

Perceived Attribute	Question	Total Number of Response Options	Step of Entry/Removal	Discriminant Equation
Adopt	Will you try zero-tillage in 1976	5	1 5	(4.38146 X A11[a]) (1.69994 X A12)
Adopt	Will you try in 1977	3	2	(0.43277 X A22)
Observability	What thinks of zero-tillage neighbour	3	3	(0.72417 X OB1)
Compatibility	Will adaptations keep from adopting	3	4	(-0.63337 X C22)
Symbolic	Would you have adopted	5	6 19 14/21	(0.89177 X SY2) (-0.54906 X SY3)
Adopt	Will you ever try zero-tillage	5	7	(0.80652 X A31)
Compatibility	Will zero-tillage require more planning and attention	3	8	(0.67694 X C42)
Relative Advantage	What happens to total farming costs with zero-tillage	5	9 11 18	(1.40933 X R11) (-0.38664 X R14) (0.41876 X R12)
Observability	Observe at harvest	3	10	(0.30971 X OH1)
Relative Advantage	What happens to yields with zero-tillage	5	12 20	(-0.66063 X RV2) (-0.73988 X RV1)
Perceived Risk	Risk if adopt zero-tillage	4	13 16	(0.87211 X PR4) (0.38722 X PR3)
Observability	What thinks of zero-tillage farmer	3	15	(-0.37256 X O22)
Relative Advantage	What happens to soil structure	3	17	(0.42730 X R33)

[a]Refer to Appendix 8 for content of these variables.

classified non-adopters (70%) nor an acceptable percentage of correct classifications of the total group (71%). The hypothesis, therefore, was not supported by the perceived attribute plus adoption questions and these questions cannot be used to classify adopters and non-adopters at such a high level of accuracy.

The combination of the perceived attribute and adoption questions, however, was more efficient than the perceived attributes alone in correctly classifying non-adopters and the total group (70% and 71% vs. 62% and 63%, respectively). This was expected since the combination contained more questions and therefore more points on which the adopters and non-adopters could deviate.

TABLE 31. Prediction Results of the Perceived Attribute and Adoption Questions at Several Prediction Scores

Prediction Score	% Correctly Classified Adopters	% Correctly Classified Non-Adopters	% of Correct Classifications
19.113	25/35 = 71%	348/418 = 83%	373/453 = 82%
19.159	26/35 = 74%	341/418 = 82%	367/453 = 81%
19.464	27/35 = 77%	301/418 = 72%	328/453 = 72%
19.469	28/35 = 80%	294/418 = 70%	322/453 = 71%
19.531	29/35 = 83%	286/418 = 68%	315/453 = 70%

Normal curves (Figure 4b) were drawn for adopters and non-adopters of zero-tillage. These curves showed that the adopter and non-adopter groups were more distinct than those produced using the PAPE. However, an acceptable degree of separation was not produced from this prediction

equation and there continued to be a large number of incorrectly classified farmers. The curve for adopters was lower and had a larger range than that of the non-adopters, indicating that the adopters were a more heterogeneous group than the non-adopters. The opposite was observed when the perceived attributes were analysed separately (Figure 4a). There does not appear to be an explanation for this difference.

Overall, when the Perceived Attribute Telephone Survey was compared to the Psychographic/Demographic Mail Survey, the former was a more efficient predictor. Although the latter gave the desired level of prediction accuracy, it did so using a large number of questions (97). The Perceived Attribute Telephone Survey contained a total of 19 questions, however, and correctly classified 71% of the total population. This level was not acceptable, however, it certainly can be considered useful. Perhaps with the addition of a few more questions, the level of correct classifications could be raised to 80%.

C. EFFECTIVENESS OF THE MARKETING TREATMENT

a. Overall effectiveness of the marketing treatment

Four marketing treatments (Appendix 2a to k) were developed and sent to 220 of the 456 farmers that had completed the 1976 Farmer Survey (Appendix 1b). The treatments contained information on zero-tillage and were designed to persuade the recipients to try zero-tillage in 1976. The remaining 236 farmers were not sent the marketing treatments. This is not to say they were not aware of zero-tillage, however, any information they obtained on the subject was due to their own initiative.

The farmers who received the marketing treatments were called the treated group; those who did not were called the untreated group.

Of the 456 farmers in the sample, 35 adopted zero-tillage in 1976. Nineteen of these adopters were treated and 16 were untreated. In the original selection of the treated and untreated groups, a paired selection technique was utilized. Because of this, the adopters were identified with their paired partners. If the partner was also an adopter, both were removed. In this study, there was only one case where two adopters were paired. The remaining population of adopters was 33, comprised of 18 treated adopters and 15 untreated adopters.

Although a slightly larger number of treated farmers were adopters (18 vs. 15) there was no significant difference between the two groups (Table 32). The marketing treatments, therefore, did not achieve their objective of persuading recipients to adopt zero-tillage in 1976. The ineffectiveness of the marketing treatment may be due to the traditional attitude of the farmers. Zero-tillage, as an agricultural practice, was totally at odds with current farming practices. This study showed that a series of marketing packages were not effective in persuading the farmers to adopt zero-tillage. If this innovation was not so radical as it appears, perhaps the marketing treatments would have been effective.

While the marketing treatments did not persuade the recipients to adopt zero-tillage, the treatments may have affected the way the concept was perceived. If this were so, perhaps the time period required for an individual to adopt zero-tillage could be shortened through the use of such marketing treatments. With this in mind, analysis was conducted to determine if the marketing treatments resulted in more positive attitudes towards zero-tillage.

TABLE 32. The Relationship[a] Between the Marketing Treatments and the Adoption of Zero-Tillage

Group Membership \ Adoption Category	Adopters	Non-Adopters	Total
Treated			
Frequency	18	201	219
%	8	92	100
Untreated			
Frequency	15	217	232
%	6	94	100
Total			
Frequency	33	418	451
%	7	93	100

[a]Calculated $\chi^2 = 0.513$ Tabulated $\chi^2 (1,0.05) = 3.84$

The perceived attribute telephone questionnaire was used to elicit how the farmers perceived zero-tillage. Twelve of the thirteen questions were found to make a significant contribution to the development of a prediction model. These 12 questions were then analysed to determine if the marketing treatment had an effect on how the recipients perceived the conept of zero-tillage.

To facilitate analysis, two tests were used to determine the effectiveness of the marketing treatment. The Mann-Whitney-Wilkoxon Rank Sum Test (hereinafter called the rank sum test) was conducted on those questions for which it was possible to rank the values in the sample.

The Binomial test was administered for those questions in which it was not possible to rank the values in the sample.

The questions related to the compatibility of zero-tillage, the relative advantage of zero-tillage, the risk associated with the adoption of zero-tillage and the observability of zero-tillage.

b. Effectiveness of the marketing treatments in altering how a farmer perceived the compatibility of zero-tillage

Compatibility is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of the receivers. Five of the six compatibility questions asked in the telephone questionnaire made a signficiant contribution to the prediction model and were, therefore, included in the analysis.

TABLE 33. The Ralationship[a] Between the Marketing Treatments and the Responses to Whether Zero-Tillage Will Require More Planning and Attention to Agricultural Practices

Response	Untreated		Treated		Total	
	Frequency	%	Frequency	%	Frequency	%
(1) Yes	198	88	186	85	384	86
(2) No	22	10	22	10	44	10
(3) Don't know	5	2	12	5	17	4
TOTAL	225	100	220	100	445	100

[a]If $\alpha = 0.05$ R:Z $\geq$ 1.645 Calculated Z $\geq$ 0.327 Not Significant

The marketing treatments did not alter how the farmers felt about the compatibility of zero-tillage (Table 33). Zero-tillage does require more planning and attention to agricultural practices. Eighty-six percent (384) of the total population realized this. Both the treated and untreated farmers were realistic about the specialized requirements of zero-tillage and it was not necessary to convey this message through the marketing treatments.

Eighty-one farmers (both treated and untreated) expanded on their thoughts that zero-tillage would require more planning and attention to agricultural practices. Seventy-one percent (58) of those felt weed control would be an important factor under zero-tillage. Fertilizer was also mentioned by 7% (6) of the farmers as one area that would require more attention under zero-tillage.

TABLE 34. The Relationship[a] Between the Marketing Treatments and the Responses to Whether Zero-Tillage Would Require a Major Adaptation to Most Farmers' Equipment

Response	Untreated		Treated		Total	
	Frequency	%	Frequency	%	Frequency	%
(1) Yes	99	43	110	50	209	47
(2) No	118	51	93	42	211	47
(3) Don't know	12	5	17	8	29	6
TOTAL	229	100	220	100	449	100

[a] If $\alpha = 0.05$ R:Z $\geq$ 1.645 Calculated Z $\geq$ 0.917 Not Significant

The marketing treatments did not alter the attitudes of the recipients regarding adaptations required to implement zero-tillage (Table 34). The treatments were designed to show that a farmer with some welding experience could adapt a double disc press drill to a triple disc zero-tillage drill. These changes certainly could not be considered major adaptations. Obviously this message was not received by the treated sample as 50% (110) of the treated farmers felt it would require a major adaptation as compared to only 43% (99) of the untreated.

Forty-one farmers (both treated and untreated) elaborated on this question. Twenty-one percent (9) of these felt that with zero-tillage the farmer would need less equipment.

TABLE 35. The Relationship[a] Between the Marketing Treatments and the Response to Whether the Required Adaptations Could Keep a Farmer from Adopting Zero-Tillage

Response	Untreated		Treated		Total	
	Frequency	%	Frequency	%	Frequency	%
(1) Yes	31	31	42	37	73	34
(2) No	54	54	61	53	115	53
(3) Don't know	15	15	12	10	27	13
TOTAL	100	100	115	100	215	100

[a] If $\alpha = 0.05$ R:Z ≤ -1.645 Calculated Z ≤ -0.991 Not Significant

The marketing treatments did not affect the farmers' attitudes about whether or not the required adaptations would prevent a farmer

from adopting zero-tillage (Table 35). This question was only asked of those 215 respondents who felt zero-tillage would require a major adaptation to most farmers' equipment. Fifty-three percent (115) of the treated and untreated farmers felt the adaptations would not keep a farmer from adopting zero-tillage. Although these farmers felt the adaptations were major, they did not consider them major enough to keep them from adopting zero-tillage at some future time. There was a slight trend for a greater proportion of the treated group to feel that the necessary adaptations could hinder zero-tillage adoption as compared to the untreated group. Six percent more treated than untreated farmers felt these adaptations could keep a farmer from adopting zero-tillage (37% vs. 31%, respectively) and five percent fewer treated than untreated were not sure (10% vs. 15%, respectively).

Thirty-eight farmers, from both the treated and untreated groups, made additional comments to this question. Twenty-one percent (8) of these felt these adaptations would not keep a farmer from adopting zero-tillage. This indicated that although these respondents were "doubters" they still felt zero-tillage might be an acceptable practice in the future.

The treatments were not effective in convincing farmers that zero-tillage could fit into their current farming plans (Table 36). This question was asked of the 206 farmers who stated they definitely would not try zero-tillage or who were uncertain or felt they probably would not adopt zero-tillage. This feeling was understandable since these farmers had already indicated that they would not adopt zero-tillage (in their answers to the previous question). The marketing treatment

TABLE 36. The Relationship[a] Between the Marketing Treatments and the Responses to Whether the Farmer Felt Zero-Tillage Could Fit into His Current Farming Operations

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Definitely could	6	6	2	2	8	4
(2) Probably could	33	31	30	34	63	31
(3) Uncertain	9	8	15	17	34	16
(4) Probably could not	24	22	17	19	41	20
(5) Definitely could not	36	33	24	27	60	29
TOTAL	108	100	88	100	206	100

[a] If $\alpha = 0.05$ R:Z ≤ -1.645 Calculated Z ≤ -0.604 Not Significant

did not soften this position. There was a trend for the treated farmers to be less pessimistic about zero-tillage fitting into their current practices. Nine percent more treated than untreated farmers felt either neutral or optimistic about zero-tillage (17% vs. 8%).

The marketing treatments were not effective in convincing farmers that only minor changes in their overall operations were required to convert to zero-tillage (Table 37). Sixty percent of the total population (268) felt that converting to zero-tillage would necessitate either a minor change or no change.

TABLE 37. The Relationship[a] Between the Marketing Treatments and the Responses to the Type of Change a Farmer Would be Faced with Under Zero-Tillage

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) A major change	95	42	83	38	178	40
(2) A minor change	119	52	130	59	249	56
(3) No change in his overall operation	13	6	6	3	19	4
TOTAL	234	100	219	100	446	100

[a] If $\alpha = 0.05$ R:Z ≥ 1.645 Calculated Z ≥ 1.474 Not Significant

In summary, the marketing treatments did not alter how the group perceived the compatibility of zero-tillage with their current farming practices.

c. Effectiveness of the marketing treatments in altering how a farmer perceived the relative advantage of zero-tillage

Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. All three questions that dealt with the relative advantage of zero-tillage made a significant contribution to the prediction model and were, therefore, included in the analysis.

TABLE 38. The Relationship[a] Between the Marketing Treatments and the Responses to the Effect of Zero-Tillage on Total Farm Costs

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Much higher	3	1	6	3	9	2
(2) Slightly higher	19	8	14	6	33	7
(3) Remain the same	26	11	38	18	64	14
(4) Slightly lower	79	35	83	38	162	37
(5) Much lower	100	44	76	35	175	40
TOTAL	227	100	217	100	444	100

[a]If $\alpha = 0.05$ R:Z $\geq$ 1.645 Calculated Z $\geq$ 1.055 Not Significant

The marketing treatments were ineffective in altering how the treated farmers perceived the effects of zero-tillage on farming costs (Table 38). Nine percent fewer treated farmers than untreated farmers felt the costs would be much lower (35% vs. 44%). The marketing treatments contained several references to the effectiveness of zero-tillage in cutting farming costs (Appendix 2b, 2c, and 2e). However, this message was not effectively conveyed.

The marketing treatments were effective in conveying that under zero-tillage, yields would be equal to or slightly higher than conventional tillage (Table 39). There were 16% more treated than untreated farmers who felt the yields under zero-tillage would remain the same (37% vs. 21%)

TABLE 39. The Relationship[a] Between the Marketing Treatments and the Responses to the Effect of Zero-Tillage on Yields

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Much higher	1	0	2	1	3	1
(2) Slightly higher	17	8	15	7	32	7
(3) Remain the same	46	21	78	37	124	29
(4) Slightly lower	82	37	81	38	163	38
(5) Much lower	75	34	37	17	112	26
TOTAL	221	100	213	100	434	100

[a] If $\alpha = 0.05$ R:Z $\geq$ 1.645 Calculated Z $\geq$ 3.64 **

and 17% fewer treated farmers than untreated farmers who felt zero-tillage would result in much lower yields (17% vs. 34%). These shifts in attitude can be attributed to the marketing treatment.

TABLE 40. The Relationship[a] Between the Marketing Treatments and the Responses to Whether Zero-Tillage Would Have a Harmful Effect on Soil Structure

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Yes	80	35	61	28	141	31
(2) No	132	58	131	59	263	59
(3) Don't know	17	7	28	13	45	10
TOTAL	229	100	220	100	449	100

[a] If $\alpha = 0.05$ R:Z $\geq$ 1.645 Calculated Z $\geq$ 0.786 Not Significant

The marketing treatments were not effective in convincing more of the treated farmers that zero-tillage would not have a harmful effect on the soil structure (Table 40). This point was emphasized in the marketing treatments (Appendix 2g) but was not effectively stressed.

Only 31% (141) of the total sample felt zero-tillage would have a harmful effect on soil structure. This figure is surprisingly low as soil compaction has been a fear of most skeptics of zero-tillage.

Comments were recorded from 82 treated and 72 untreated farmers. Twenty-one percent (15) of the untreated farmers commented that soil compaction would be a problem while only 11% (9) of the treated farmers made a similar response. Eleven percent (9) of the treated farmers felt the soil structure would be improved as compared to 7% (5) of the untreated farmers. Two percent (2) of the treated farmers thought that the amount of soil compaction would depend on the soil type, compared to 11% (8) of the untreated farmers. These trends indicate that the marketing treatments may have altered slightly the perceptions of the farmers, although the shift was not statistically significant.

In summary, the marketing treatments were effective in altering only one of three questions relating to the advantages of zero-tillage.

d. Effectiveness of the marketing treatments in altering how a farmer perceived the risk involved with the adoption of zero-tillage

Perceived risk is the degree to which risks are perceived as associated with the innovation. There was one question that dealt with the amount of risk a farmer felt was associated with the adoption of zero-tillage. The question made a significant contribution to the prediction model and was, therefore, included in the analysis.

TABLE 41. The Relationship[a] Between the Marketing Treatment and the Responses to the Amount of Risk Associated with the Adoption of Zero-Tillage

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) A large risk	93	41	54	25	147	33
(2) A moderate risk	94	42	136	63	230	52
(3) A low risk	31	14	19	9	50	11
(4) No risk at all	8	3	8	3	16	4
TOTAL	226	100	217	100	443	100

[a]If $\alpha = 0.05$ R:Z ≥ 1.645 Calculated z ≥ 4.439**

The treatments were effective in making the farmers perceive that there was only a moderate and not a large risk associated with the adoption of zero-tillage (Table 41). The marketing treatments resulted in 21% more treated than untreated farmers who felt that the adoption of zero-tillage was a moderate risk proposition (63% vs. 42%). There were 16% fewer treated than untreated farmers who felt that zero-tillage adoption contained a high degree of risk (41% vs. 25%). The treatments, therefore, were effective in reducing the perceived risk of zero-tillage.

Only 4% of both treated and untreated adopters felt there was no risk associated with zero-tillage. These data demonstrate the realistic attitude of both groups regarding zero-tillage.

e. Effectiveness of the marketing treatments in altering how a farmer perceived the observability of zero-tillage

Observability is the degree to which the results of an innovation are visible to the receiver and to others. Four observability questions were asked. All four made a significant contribution to the prediction and were, therefore, included in the analysis.

TABLE 42. The Relationship[a] Between the Marketing Treatments and the Responses to Whether a Farmer Could Identify a Zero-Tillage Field After the Crop had Emerged

Response	Untreated		Treated		Total	
	Frequency	%	Frequency	%	Frequency	%
(1) Yes	173	74	146	66	319	70
(2) No	33	14	27	12	60	13
(3) Don't know	27	12	48	22	75	17
TOTAL	233	100	221	100	454	100

[a]If $\alpha = 0.05$ R:Z ≥ 1.645 Calculated Z ≥ 1.814 *

The treatments were effective in altering how the treated farmers perceived the observability of zero-tillage after the crop had emerged (Table 42). Ten percent more of the treated than untreated farmers were not sure they could tell the difference between zero and conventional tillage (22% vs. 12%). This difference was primarily caused by a reduction in the number of treated farmers who felt they could tell the difference.

Comments were recorded from 70 treated and untreated farmers. Thirty-one percent (22) felt that they would be able to see the stubble if a farmer were to adopt zero-tillage. Sixteen percent (11) thought that the observability depended on the type of soil in which the crop was grown. Eleven percent (8) felt that the trash from the previous crop would be evident. The majority of the comments were positive towards zero-tillage. There was only one farmer who thought the crop would be poor; he was in the untreated group.

TABLE 43. The Relationship[a] Between the Marketing Treatments and Whether a Farmer Could Identify a Zero-Tillage Field at Harvest

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Yes	136	58	107	48	243	53
(2) No	49	21	55	25	104	23
(3) Don't know	48	21	59	27	107	24
TOTAL	233	100	221	100	454	100

[a] If $\alpha = 0.05$ R:Z ≥ 1.645 Calculated Z ≥ 1.924 *

The marketing treatments were effective in altering how the treated farmers perceived the observability of zero-tillage at harvest (Table 43). Ten percent fewer treated than untreated farmers felt that at harvest time they would be able to tell if a farmer had used zero-tillage (48% vs. 58%). Although the makreting treatment appears to have altered this

opinion slightly, 48% treated farmers still felt they could tell if a farmer were using zero-tillage.

Comments were recorded from 76 treated and untreated farmers. Twelve percent (9) of the farmers who made comments thought they would be able to see the stubble from the previous crop at harvest, while 8% (6) felt they could tell from the trash cover on the ground at harvest.

TABLE 44. The Relationship[a] Between the Marketing Treatment and How the Farmer Felt About a Zero-Tillage Farmer

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Good farmer	54	24	76	35	130	29
(2) Poor farmer	95	41	55	26	150	34
(3) No opinion	80	35	84	39	164	37
TOTAL	229	100	215	100	444	100

[a]If $\alpha = 0.05$ R:Z ≤ -1.645 Calculated Z ≤ -1.988 *

The marketing treatment was effective in altering what the treated farmers would think if they saw a farmer seeding directly into stubble (Table 44). The treated farmers showed a more positive attitude towards a farmer doing this than the untreated farmers. Eleven percent more treated than untreated farmers felt a zero-tillage farmer was a good farmer (35% vs. 24%). Also, there were 15% fewer treated than untreated farmers who thought adopters of zero-tillage were poor farmers (26% vs. 41%).

TABLE 45. The Relationship[a] Between the Marketing Treatments and How The Farmer Felt About a Zero-Tillage Farmer

Response	Untreated Frequency	%	Treated Frequency	%	Total Frequency	%
(1) Poor farmer	78	34	57	26	135	30
(2) Good farmer	66	29	65	29	131	29
(3) No opinion	83	37	98	45	181	41
TOTAL	227	100	220	100	447	100

[a]If $\alpha = 0.05$ R:Z ≥ 1.645 Calculated Z ≥ 1.938 *

The marketing treatment was effective in altering how the treated farmers felt towards a farmer who left one of his fields untilled until seeding (Table 45). Eight percent fewer treated than untreated farmers felt a zero-tillage farmer would be a poor farmer (26 vs. 34). The same proportion of treated and untreated farmers felt an adopter of zero-tillage was a good farmer, however, there were 8% more treated than untreated farmers who had no opinion (45% vs. 37%). It is heartening to observe that fewer than 35% of both treated and untreated farmers felt an adopter of zero-tillage would be a poor farmer. This would indicate that there was potential for a large percent of the population to adopt zero-tillage.

Comments for this question were recorded from 99 treated and untreated farmers. Twenty-five percent (25) of those responding felt that if a farmer had adopted zero-tillage he would be experimenting. Thirteen

percent (13) said their decision regarding whether he was a good or poor farmer depended on the outcome of the practice. Six percent (6) felt a zero-tillage farmer was progressive. Four of these farmers were from the treated group, indicating the marketing treatment influenced their perception of zero-tillage. An additional 6% (6) thought an adopter of zero-tillage would be trying something new. In total, 37% (37) felt a zero-tillage farmer would be trying out a new farming practice.

In all four observability questions, the marketing treatments had an effect on how the treated farmers perceived the observability of zero-tillage.

Overall, the marketing treatments had a marginal effect on how a farmer perceived the characteristics of zero-tillage. The marketing treatments were effective in altering the perceived characteristics of zero-tillage in only 6 of the 13 questions that made a significant contribution to the development of a prediction model (Table 46). It is important to note, however, that the treatments were effective in all four questions relating to observability as well as the one question dealing with the risk associated with the adoption of zero-tillage. The treatments showed limited success in altering the farmers' opinions concerning the relative advantages (effective in 1 out of 3 questions) and were totally unsuccessful in changing the treated farmers' opinions of the compatibility of zero-tillage.

TABLE 46. Summary Table of Overall Effectiveness of the Marketing Treatments in Altering the Farmers' Perceived Attributes of Zero-Tillage

Perceived Attribute Variable	Number of Questions	Significance
Observability	4	4
Perceived Risk	1	1
Relative Advantage	3	1
Compatibility	4	0

D. COMPARISON OF DEMOGRAPHIC CHARACTERISTICS AND COMMUNICATION CHARACTERISTICS OF ADOPTERS AND NON-ADOPTERS OF ZERO-TILLAGE

The answers to several questions in the psychographic demographic mail questionnaire (Appendix 1b) were evaluated to determine if there were differences between adopters and non-adopters in their demographic characteristics and communication patterns. An attempt was made to identify an adoptive "type" and to develop a composite sketch of an adoptive farmer. Such a composite sketch could be used in future to help identify that portion of the population that would be most receptive not only to zero-tillage but also to other agricultural innovations.

Eighteen questions were analysed using the Chi square test of statistical significance. Ten dealt with the demographic characteristics and eight with the communication patterns. Of the 18 questions, farm location was the only question for which there was a significant difference between adopters and non-adopters of zero-tillage (Table 47). There were no significant differences between adopters and non-adopters in

the remaining 17 questions; however, some trends were evident. The 17 non-significant variables were sex, experience, education level, age, farm income, percent of income derived from the farm, size of farm, number of workable acres on the farm, type of farm, number of farm broadcasts listened to, number of times he contacts the agricultural representative, whether he takes the community papar and/or the Winnipeg paper, from whom he most often - hears about a new idea, gets information about an idea, and gets help in implementing this idea.

a. Demographic characteristics of adopters and non-adopters of zero-tillage

A significant difference in farm location existed between adopters and non-adopters of zero-tillage (Table 47). Twice as many adopters as non-adopters farmed in Northwestern Manitoba (34% vs. 17%, respectively). There were no adopters from the Interlake, nor Southeastern Manitoba, although 9% (39) and 5% (2) of the total population were located in these areas. There was also a larger percentage of adopters from Northern Manitoba (6% vs. 1%)

Seventy-five percent of the adopters of zero-tillage were found in Western Manitoba (Table 47). This could be due to the lack of soil moisture and the possibility of soil erosion that has prevailed in these areas. Zero-tillage would offer a solution to both of these problems.

In the fall of 1976, the Manitoba Department of Agriculture initiated a zero-tillage project in the Western region. Results of this study indicate the choice of location was very appropriate. Ten farmers (none of whom were in this study) grew a zero-tillage crop in 1977. Results were encouraging with all but one continuing in the program in 1978.

Certainly zero-tillage has made inroads in the Western area.

TABLE 47. The Relationship[a] Between Farm Location and the Adoption of Zero-Tillage

Category \ Location	Winnipeg	S.E. Man.	S.C. Man.	C. Man.	S.W. Man.	N.W. Man.	Inter Lake	N. Man.	Total
Adopters									
Frequency	2	0	4	4	11	12	0	2	35
%	6	0	11	11	31	34	0	6	8
Non-Adopters									
Frequency	18	20	63	49	152	73	39	4	418
%	4	5	15	12	36	17	9	1	92

[a]Calculated $\chi^2 = 15.98$ Tabulated χ^2 (7, 0.05) = 14.07

There was a trend for the adopters of zero-tillage to be older than the non-adopters (Table 48). Forty percent (14) of the adopters were over 54 years old compared to 27% (111) of the non-adopters. This could be attributed to the fact that the older, more established farmers are prepared to take the risk associated with zero-tillage. The younger farmers who are possibly still in debt or who have just invested in larger tillage equipment may be more reluctant to look at a farming method that will eliminate the need for this equipment. In addition, the older farmers have observed a great many changes in agriculture by nature of their age and may be more receptive to change than the

younger ones. There were 3% (1) adopters under 34 years old while 15% (64) non-adopters fit this age bracket.

TABLE 48. The Relationship[a] Between Age and the Adoption of Zero-Tillage

Category \ Age	24 or Younger	25-34	35-44	45-54	55-64	Over 65	Total
Adopters							
Frequency	0	1	8	12	9	5	35
%	0	3	23	34	26	14	100
Non-Adopters							
Frequency	10	54	107	133	88	23	415
%	2	13	26	32	21	6	100
Total							
Frequency	10	55	115	145	97	28	450
%	2	12	16	32	22	6	100

[a]Calculated $\chi^2 = 8.00$ Tabulated $\chi^2 = (5, 0.05) = 11.07$

Along with this trend for the adopters being older, there was an expected trend for the adopters to have more years of farming experience (Table 49). Ninety-one percent (32) adopters had 15 or more years of farming experience, while only 72% (300) non-adopters had the same.

TABLE 49. The Relationship[a] Between Years of Farming Experience and Adoption of Zero-Tillage

Category \ Years	5	6 - 10	10 - 15	15 - 30	30	Total
Adopters						
Frequency	2	0	1	13	19	35
%	6	0	3	37	54	100
Non-Adopters						
Frequency	24	36	56	154	146	416
%	6	9	13	37	35	100
Total						
Freuqency	26	36	57	167	165	451
%	6	8	13	37	37	100

[a]Calculated $\chi^2 = 9.15$ Tabulated $\chi^2 = (4, 0.05) = 9.49$

There was a trend for the adopters to have a lower level of education (Table 50). Sixty-three percent (22) adopters had less than grade nine education compared to 45% (186) non-adopters. Ten percent fewer adopters than non-adopters had grade 10-12 education (26% vs. 36%) while 8% fewer adopters than non-adopters had post-secondary education (11% vs. 19%). These data were not consistent with what was found in the literature (Rogers, 1959). This inconsistency may be due to the type of innovation that was studied. Perhaps the more educated were prepared to adopt innovations that can be purchased, whereas the less educated are more

prepared to adopt something that has to be made to work. Also, the farmers with less education may be the ones who were more experienced and better established and were prepared to take the risk.

TABLE 50. The Relationship[a] Between Level of Education and Adoption of Zero-Tillage

Category \ Education	Grade 6	Grade 7-9	Grade 10-12	Post Secondary	Total
Adopters					
Frequency	4	18	9	4	35
%	11	52	26	11	100
Non-Adopters					
Frequency	23	163	151	79	416
%	6	39	36	19	100
Total					
Frequency	27	181	160	83	451
%	6	40	36	18	100

[a]Calculated $\chi^2 = 5.02$ Tabulated $\chi^2 = (3, 0.05) = 7.82$

The populations proved to be similar in terms of gross farm income (Table 51). There were, however, 9% more adopters than non-adopters with a total farm income over $30,000 (66% vs. 57%). Perhaps these farmers were prepared to risk a small portion of their total gross income to try zero-tillage, whereas the lower income farmers could not afford

to take the risk. Over one-half (66% adopters and 57% non-adopters) fell into the upper limit of the classification (over $30,000).

TABLE 51. The Relationship[a] Between 1975 Total Farm Gross Income and Adoption of Zero-Tillage

Category \ Income	$4,999	5,000-7,999	8,000-11,999	12,000-14,999	15,000-19,999	20,000-24,999	25,000-30,000	Over 30,000	Total
Adopters									
Frequency	1	2	2	0	3	1	3	23	35
%	3	6	6	0	8	3	8	66	100
Non-Adopters									
Frequency	13	17	25	19	33	38	34	233	412
%	3	4	6	5	8	9	8	57	100
Total									
Frequency	14	19	27	19	36	39	37	256	447
%	3	5	6	5	8	8	8	57	100

[a]Calculated $\chi^2 = 3.81$ Tabulated $\chi^2 = (7, 0.05) = 14.07$

There was very little difference in the percentage of the adopters' and non-adopters' income that was derived from the farm (Table 52). There was, however, a slight trend for the adopters to obtain a larger percentage of their income from the farm.