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WHY DO FARMERS ADOPT NEW TECHNOLOGY?

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1.0 Introduction:

New technologies (e.g practices, products, equipments etc.) are constantly being introduced into the agricultural sector. The decision to adopt one of these new technologies is largely driven by profitability. Early adopters of a profitable new technique will receive the greatest benefits relative to laggards due to the price depressing effect of the enhanced productivity (Cochrane). This treadmill theory of technology in agriculture is very apparent but it raises some fundamental questions about the adoption process. For example, why do not all farmers adopt a new profitable technology within a short time period? Part of the reason may be a lack of information but it may also be that farmers have reasons beside profitability guiding their adoption decisions. Knowledge of the alternative reasons and the socio-economic characteristics of producers with these reasons will help extension efforts in properly targeting programs to inform producers of beneficial new forms of technology.

The main purpose of this paper is to provide insights into the reasons why Ontario hog producers adopt new technologies. The specific objectives are:

(1) To evaluate the rankings of different factors for introducing a new technology.

(2) To examine the structural differences in the adoption factor rankings across sample sub-groups.

(3) To understand the interaction of different farmer and farm characteristics in determining the rankings of different factors for introducing a new technology.

1.1 Outline of the Study:

Section 2.0 contains a brief literature review of previous adoption studies. Section 3.0 contains description of the survey and the data used in the study. Section 4.0 presents the rankings of different factors for introducing a new technology. Section 4.1 discusses the structural differences in adoption

factor rankings. Section 4.2 contains general description of the multinomial logit analysis. Finally, section 4.3 presents results of the multinomial logit analysis.

2.0 Literature Review:

One of the most important stages of the process of technological change is diffusion. The rate of diffusion is defined as the rate at which a new technique is actually put into use and it is a critical determinant of the rate of growth of productivity. The diffusion curve for a new technology may be defined as the proportion of its potential users who have already adopted as a function of time. Certain firms are faster to diffuse a new technology that is they are faster to attain the resulting increases in productivity (Romeo).

The importance of production technology adoption and use rates in helping to explain inter-farm differences in management performance levels has long been recognized in a wide body of "technology adoption diffusion" literature. For example technology adoption rates are affected by the quality and amount of information about the technology available (White 1985), by the degree of riskiness involved (Jensen 1982), by the communication process and farmers' perceptions about the need for a new technology (Tayler and Miller 1978), and by the degree of technical complexity of the technology, its ease of integration within the present farming system, the capital outlay required, etc. (Webster 1986). Methods of speeding adoption rates for new technologies in farming have been explored to some extent. For example, the use of government policies to encourage more rapid adoption rates has been evaluated by Thomsen (1985). These types of prescriptions may be applicable in helping to solve the problem of differential management performance rates across Ontario hog farms, and need to raise these performance levels to ensure the maintenance and/or improvement of the Ontario swine industry's international competitiveness.

Some previous empirical studies of innovation diffusion in agriculture has centred on identification of the major determinants of the speed of diffusion, while others has centred on the characteristics of firms which determine how and why they delay adoption. For example, Griliches (1957) studied factors responsible for cross-sectional differences in the rates of use of hybrid seed corn in the United States finding that observed differences in the rates of adoption of new agricultural technology are explained satisfactorily by differences in profitability.

Rahm and Huffman (1984) presented a model of adoption behaviour and econometric evidence about determinants of reduced tillage adoption and of adoption efficiency. The empirical results showed that the probability of adopting reduced tillage in corn enterprises differs widely across farms and depends on soil characteristics, cropping systems, and size of farming operations. The results also showed that farmers' schooling enhances the efficiency of the adoption decision.

Several agricultural studies support the hypothesis that investments in formal education and extension enhance allocative skills. For example, Fane (1975) measured the influence of education on the cost efficiency with which farms combine various broadly defined inputs. He concluded that at a given scale of production, farmers with above average levels of education managed to operate significantly closer to the theoretically estimated point of minimum cost than producers with average education levels. Studies by Huffman (1977), Khaldi (1982), and Petzel (1976), show that investments in schooling and extension improve farmers' response to economic disequilibria.

Several decision-theoretic approaches to individual firm adoption behaviour also have been developed. Some of these approaches have tended to confine themselves to explaining why and how long a firm would delay its adoption of a capital-embodied innovation. In some models a firm delays its adoption while waiting for its capital in place to deteriorate sufficiently to make adoption profitable (Fellner, 1951). Yet in some other models a firm delays adoption while waiting for the innovation's profitability to increase sufficiently (Salter, 1960). The major limitations in these

approaches are that they are limited to capital embodied innovations and do not take into account the effect of information and management attitudes on firms adoption decision.

Jensen (1982) developed a decision-theoretic model of individual firm adoption behaviour which can be used to view adoption as a problem of decision making under uncertainty when learning can occur. That is, when the innovation is introduced, the firm does not know whether adoption will be profitable or not. It was concluded that a firm will delay its adoption of a good innovation (i.e. one which it would have immediately adopted under certainty) if it is sufficiently sceptical when the innovation appears, but is willing to learn. Finally, given that delayed adoption is optimal for the firm, it is easily seen that the length of delay will tend to be shorter the more optimistic is the firm, the more favourable the information received, the higher the discount rate or period adoption returns, or the lower the cost of adoption.

The optimal adoption rule derived in the above model was also used to analyze the diffusion of a good innovation in a simple industry model. It was found that an innovation will diffuse more rapidly when the industry is more optimistic that the innovation is good. The ambiguity in the effect of a change in variance arises from the fact that a change in variance is equivalent to adding (or subtracting) both more optimistic and more pessimistic firms to the industry. Hence, the duration of diffusion will be longer in an industry whose beliefs about the innovation are more (less) diverse.

Most recently, Batte et al. (1990) used multinomial logit analysis of a random sample of Ohio commercial farmers in order to identify factors influencing farmers' adoption of computers and the number and type of applications for which the computer was used. Results suggested that older farmers were less likely to adopt computers, less likely to find them useful, and made fewer applications of the computers in their business. Education level was positively associated with computer adoption and with increased number of computer applications.

These previous studies on technology adoption in agriculture have focused on identifying the caracteristics associated with firms adopting a new practise or on the factors affecting the speed of diffusion. None of the previous studies have examined the underlying determinants of technology adoption. This study seeks to fill that void by analysing why farmers adopt new technologies and the characteristics associated with their choices. The producers examined in this study are a random sample of Ontario hog producers surveyed by Rosenberg and Turvey.

3.0 Survey Data:

A sample of swine producers was randomly selected from a list of approximately 12,000 swine operators who marketed weaners, sows, boars and market hogs with the Ontario Pork Producer Marketing Board (OPPMB). The survey was designed with the intent to identify factors most likely to affect producer classifications. The sampling technique consisted of a simple random design. To obtain the sample the OPPMB was asked to provide every fourth name on their producer list.

A week ahead of the survey mailing the OPPMB sent a letter to each producer informing them of the existence and purpose of the study. A mail survey to 1,920 randomly selected swine producers was mailed out at the end of September 1989. A total of 1,145 producers returned the completed survey, which means a 60 percent response from the survey was obtained. About 120 surveys were discarded because they did not want to participate on the survey (Rosenberg and Turvey, 1991). The remaining sample was categorized into weiner, farrowing and farrow-finish operations.

4.0 Rankings of Different Factors for Introducing a New Technology:

Along with questions on technical, financial and demographic aspects of the farm, the survey contained a list of eight factors (costs of new technology, availability of grants or subsidies, increase

production, use by other farmers, improve efficiency in production, increase profit, tax benefits and ease of use) which may affect the farm decision making for introducing a new technology (e.g. practices, products, equipment, etc.) on the farm. Farmers were asked to rank the various factors in order of importance with 1 being most important and 8 least important. Table 1 indicates the factors which producers felt as most important when adopting new technology.

4.0.1 All Farms:

The factor most frequently cited as "most important" for adoption decisions by all farms was to increase profits, with 38.7 percent of the respondents in this category (Table 1). The costs of new technology and improved efficiency in production ranked second and third with about 21 percent and 20 percent of the observations, respectively. Increased production, ease of use and use by other farmers ranked fourth, fifth and sixth with 8.7 percent, 6.1 percent and 2.1 percent of the observations, respectively. Availability of grants or subsidies and tax benefits ranked seventh and eighth with only 1.4 and 0.8 percent of the observations, respectively. This suggests that these factors do not unduly influence the adoption decisions.

Table 1: Factors Declared Most Important for Introducing a New Technology (e.g Practices, Products, Equipment etc.) for all Farms.

Adoption Factor	All Farms		Weaner		Farrow-Finish		Finish	
	%	Rank	%	Rank	%	Rank	%	Rank
Cost of new technology	21.2	2	22.2	2	19.6	3	23.3	2
Availability of grants or subsidies	1.4	7	-	-	1.8	6	1.5	7
Increase production	8.7	4	10.0	4	10.7	4	5.4	5
Use by other farmers	2.1	6	-	-	1.5	7	4.5	6
Improve efficiency in production	20.7	3	21.0	3	21.4	2	19.8	3
Increase profit	38.7	1	42.0	1	37.9	1	37.1	1
Tax benefits	0.8	8	1.0	6	0.6	8	1.0	8
Ease of use	6.1	5	5.0	5	5.8	5	6.9	4

4.0.2 Weaner Operators:

As with all farms, the factor most frequently cited as "most important" for adoption decisions by the weaner operators was to increase profits, with 42 percent of the respondents in this category (Table 1). Costs of new technology and improved efficiency in production ranked second and third with about 22 percent and 21 percent of the observations, respectively. Increased production, ease of use and tax benefits ranked fourth, fifth and sixth with 10 percent, 5 percent and 1 percent of the observations, respectively. None of the weaner producers ranked availability of grants or subsidies or use by other farmers as their most important factor when introducing a new technology on their farms.

4.0.3 Farrow-Finish Operators:

The factor most frequently cited as "most important" for adoption decisions by the farrow-finish operators was to increase profits, with 37.9 percent of the respondents in this category (Table 1). Improved efficiency in production and costs of new technology ranked second and third with 21.4 percent and 19.6 percent of the observations, respectively. Costs of new technology and improved efficiency in production switched rankings as second and third most important as compared with all farms and farm types. Increased production, ease of use and availability of grants or subsidies ranked fourth, fifth and sixth with 10.7 percent, 5.8 percent and 1.8 percent of the observations, respectively. Use by other farmers and tax benefits ranked seventh and eighth with 1.5 percent and 0.6 percent of the observations, respectively. This suggests that these factors do not unduly influence the adoption decisions for this farm type.

4.0.4 Finish Operators:

As with all farms and other farm types, the factor most frequently cited as "most important" for adoption decisions by the finish operators was increase profits, with 37.1 percent of the respondents in this category (Table 1). Costs of new technology and improved efficiency in production ranked second and third with 23.3 percent and 19.8 percent of the observations, respectively. Ease of use, increased production, and use by other farmers ranked fourth, fifth and sixth with 6.9 percent, 5.4 percent and 4.5 percent of the observations, respectively. Availability of grants or subsidies and tax benefits ranked seventh and eighth with 1.5 percent and 1 percent of the observations, respectively.

Increased profit retained its first place ranking when second and third most important votes were included for all farms and all three farm types. Under this criteria, however, improved efficiency in production and increased production substantially increased their percentage of votes. They are more frequently cited as the second or third most useful factor than as the most important factor affecting adoption decisions. This suggests a strong supporting role for these factors. On the other hand, response percentages for the costs of new technology decline substantially with addition of second and third most important responses. This result implies that those farmers who find costs to be important tend to view them as their primary adoption decision.

4.1 Structural Differences in Adoption Factor Rankings:

The potential benefits of new technology will vary among individuals because of their differing farm management capabilities. As a result, systematic differences were expected in the rankings of different factors when introducing a new technology by farmers of differing age, education level, farm size, number of years managing own farm, proportion of total labour time spent on swine operation, farm related educational meeting attended and by weaning age. These hypothesis were statistically

tested by examining differences in adoption factor rankings across sample sub-groups. Adoption factors rankings were judged by the most important adoption factor. Each farmer's most important indication placed that farmer within a single ranking category. If for example, increased profits were indicated as most important, the farmer was said to consider the profitability of new technology first before introducing a new technology on his farm. Overall farmers tended to rank increased profits (39 percent) and costs of new technology (21 percent) as the most important factors when deciding to adopt a new technology (Table 2).

The sample was then subdivided into two sub-groups based on the characteristics of farm size, number of hogs marketed, age, education level, years managing own farm, proportion of total labour time spent on swine operation, farm related educational meetings attended and weaning age (Table 2). The sample was divided for these characteristics at approximately the sample means for farm size, market hogs, years managing own farm, meetings attended and into lower education (less than high school) or completed high school or more, less than 46 years of age or 46 years or older, less than 36 days of weaning age or 36 days or more. Variations in the adoption factors rankings were tested based on proportion differences between sub-groups using a Mann-Whitney nonparametric test. This test does not require distributional assumptions about the sample populations and is necessary given the categorical nature of the data.

There were statistically significant differences between small and large farm groups. There are several measures of farm size used to define the sub-groups. The observation that increased profits was given as the most important reason for technology adoption by a greater proportion of large farms in comparison to smaller farms held when farm size was measured by the number of tillable acres, horsepower of the largest tractor and number of hogs marketed. With these same definitions of farm size, the costs of new technology was cited as the most important

Table 2. Proportion of Farmers Indicating Adoption Factors as Most Important with Comparisons among Sample Sub-Groups for All Farms[a]

Farm and Farmer Characteristics	N	Adoption Factors: Cost	Grant	Increase Production	Use by Other Farmers	Improve Efficiency in Production	Increase Profit	Tax Benefit	Case of Use
All farms	651	0.21	.01	0.09	0.02	0.21	0.39	0.008	0.06
Tillable Acres									
Less than 185 acres	406	0.23	0.02	0.08	0.01	0.21	0.38	0.007	0.06
185 acres or more	217	0.18*	0.01**	0.09*	0.03*	0.20*	0.42*	0.0009***	0.06*
HP of Largest Tractor									
Less than 96 hp	301	0.25	0.007	0.07	0.03	0.20	0.36	0.007	0.08
96 hp or more	230	0.18*	0.01***	0.10*	0.02*	0.23*	0.40*	0.009	0.04*
Average No. of Sows									
Less than 58 sows	269	0.23	0.02	0.08	0.01	0.17	0.41	0.004	0.06
58 sows or more	160	0.13	0.006	0.14	0.01	0.27	0.37	0.01	0.06
Market Hogs (head)									
Less than 583 hogs	156	0.25	0.01	0.08	0.03	0.18	0.37	0.006	0.08
583 hogs or more	434	0.19*	0.01**	0.09*	0.02*	0.21*	0.40*	0.009	0.06*
Age									
Less than 46 years	400	0.23	0.015	0.10	0.01	0.19	0.41	0.008	0.05
46 years or older	247	0.19*	0.01*	0.06*	0.04*	0.25*	0.36*	0.008	0.08*

[a] A Mann-Whitney nonparametric test was used to test the hypothesis test response distributions were identical for sub-groups

* Group means are different at 1 percent level of significance

** Group means are different at 5 percent level of significance

*** Group means are different at 10 percent level of significance

Table 2. Proportion of Farmers indicating Adoption Factors as Most Important with Comparisons among Sub-Groups for all Farms[a] (Continued)

Farm and Farmer Characteristics	N	Adoption Factors: Cost	Grant	Increase Production	Use by Other Farmers	Improve Efficiency in Production	Increase Profit	Tax Benefit	Case of Use
All farms	651	0.21	.01	0.09	0.02	0.21	0.39	0.008	0.06
Education									
Lower	305	0.21	0.01	0.08	0.03	0.21	0.39	0.01	0.07
Higher	343	0.25*	0.02**	0.09*	0.02*	0.20*	0.39*	0.003*	0.05*
Years Raising Pigs									
Less than 18 years	393	0.22	0.01	0.09	0.01	0.19	0.42	0.005	0.05
18 years or more	243	0.19	0.02	0.08*	0.03	0.25	0.34	0.01	0.08
Years Managing Own Farms									
Less than 18 years	392	0.31	0.01	0.08	0.01	0.19	0.42	0.008	0.05
18 years or more	242	0.18*	0.02**	0.09*	0.03	0.24*	0.34*	0.008***	0.09*
Pigtime									
Less than 511	445	0.22	0.01	0.09	0.03	0.18	0.38	0.007	0.07
511 or more	192	0.18*	0.02**	0.08*	0.01*	0.27*	0.40*	0.001***	0.04*
Meetings Attended									
Less than 3	342	0.24	0.02	0.06	0.01	0.18	0.39	0.003	0.02
3 or more	291	0.17*	0.003***	0.11*	0.02*	0.23*	0.40*	0.01	0.05*
Weaning Age									
Less than 36 days	125	0.15	-	0.12	-	0.26	0.41	0.008	0.06
36 days or more	305	0.22*	0.02	0.10*	0.02	0.20*	0.39*	0.006	0.06*

[a] A Mann-Whitney nonparametric test was used to test the hypothesis test response distributions were identical for sub-groups

* Group means are different at 1 percent level of significance

** Group means are different at 5 percent level of significance

*** Group means are different at 10 percent level of significance

factor by a statistically significant greater proportion of smaller farms than large farms. The smaller farms were also more likely to give ease of use as the most important adoption factor in comparison to larger farms whereas larger farms were more likely to cite improved efficiency in production and increased production relative to the proportion of smaller farms choosing these adoption reasons as most important. There was no statistical differences in the proportions cited for any of the eight possible adoption factors between small and large farms when size was measured by the average number of sows.

Response distributions were also different among farmers by age. Farmers less than 46 years of age more frequently cited increased profits (41 percent) than did farmers older than 46 years (36 percent). A higher percentage of younger farmers were also more likely, to rate costs of new technology and increased profits as the most important reason for technology adoption. In contrast, older farmers were more likely than younger producers to adopt if the technology increases production efficiency, easy to use and is presently used by other farmers.

Response distributions also differed among farmers by education level. Farmers with higher education (completed high school or more) were more likely to indicate costs of new technology (26 percent) and increased production (9 percent) as their most important adoption factor as compared to 20 percent and 8 percent, respectively, citation rate for the lower education (less than high school) group. Production efficiency, ease of use and use by other farmers were more important to producers with a lower level of education than those who had completed high school.

Statistically significant differences were also found between farmers managing their farm for less than 18 years and farmers managing their farm for 18 years or more. Farmers who managed their farm for less than 18 years more frequently cited increased profits (42 percent) and costs of new technology (31 percent) as their most important factor as compared to 34 percent and 18 percent, respectively, of farmers who managed their farms for 18 years or more. The large difference in the

proportion of relatively new farmers who use cost as the major determinant of technology adoption relative to established producer (31 vs 18 percent) could be due to credit constraints facing new entrants. Conversely, farmers who managed their farms for 18 years or more were significantly more likely to cite improved efficiency in production (24 percent) and ease of use (9 percent) as their most important factor as compared to 19 percent and 5 percent, respectively, citation rate for farmers who managed their farm for less than 18 years.

Response distributions were also analyzed by the proportion of total labour time spent on the swine operation which resulted in response differences that were statistically significant for all adoption factors. Farmers who spent 51 percent or more labour time on swine operation more frequently cited increased profits (40 percent) improved efficiency in production (27 percent) than did the farmers who spent less than 51 percent of labour time on swine operation. However, costs of new technology (22 percent) and ease of use (7 percent) were more frequently cited by the farmers who spent less than 51 percent of labour time as compared to 18 percent and 4 percent, respectively, by the farmers who spent 51 percent or more labour time on swine operation.

Response distributions differed among farmers by the number of farm related educational meetings attended. Farmers who attended 3 or more meetings as compared to farmers who attended less than 3 meetings were more likely to indicate increased profit, improved efficiency in production and ease of use as their most important factor. On the other hand, farmers who attended less than 3 meetings were more likely to indicate costs of new technology as their most important factor.

Analysis of adoption factor indicated as most important by weaning age resulted in response differences that were statistically significant for four adoption factors. Farmers who weaned their piglets less than 36 days more frequently cited increased profit (41 percent), improved efficiency in production (26 percent) and increased production (12 percent) than did their counterparts who weaned their piglets at 36 days or more. Conversely, farmers who weaned their piglets 36 days or

more significantly more likely to cite costs of new technology (22 percent) as the most important factor as compared to a 15 percent citation rate for the farmers who weaned their piglets less than 36 days. Thus, those producers appear to be efficient on the basis of the weaning age criteria tend to be more interested in the economic consequences of new technology (profits, efficiency, reduced costs) than the other group of farmers.

4.2 Multinomial Logit Analysis

The previous two subsections have examined the percentage of farmers who ranked the eight possible reasons for technology adoption as most important (Table 1) and how these proportions differed among sub groups distinguished by various socio-economic characteristics (Table 2). The focus has been on the reasons chosen most important but additional information can be obtained by examining the factors which influence the relative rankings of the adoption factors for an individual farmers. For example, only 2 percent of swine farmers cited the use of technology by other farmers as the major reason for its adoption but this may still be an important consideration for some producers when evaluating technology while is may be inconsequential to others. A technique to analyze such a question is multinomial logit.

A multinomial logit analysis is a procedure for the estimation of regression models with qualitative (categorical) dependent variables by the method of maximum likelihood. These models are appropriate for the analysis of qualitative dependent variables where the dependent variables is restricted to the integer values 1 to k, and k is any integer. Multinomial logit is typically applied to the analysis of choice behaviour where there are k options, one of which is chosen.

When the dependent variable involves two or more discrete choices, the logit model can be a good way of examining the determinants of these choices. There are three types of multinomial logit models. One, when the independent variables consist entirely of characteristics of the options,

Table 3. Summary Statistics of Random Sample of Ontario Hog Producers

Variable	Mean	Std. Deviation
T_1 (1 if weaner operator)	0.17	0.37
AGE (1 if > 46 years)	0.46	0.49
EDUCAT (1 if completed high school)	0.44	0.49
FLOOR (1 if cement flooring in barn)	0.38	0.48
WASH (1 if pen wash)	0.38	0.48
PIGTIME (1 if > 50% of labor time spent on swine operation)	0.27	0.44
VISIT (1 if preschedule herd health visits)	0.21	0.41
SOIL (1 if soil test regularly)	0.39	0.48
ACCOUNT (1 if cash accounting system)	0.59	0.49
NFINC (1 if net farm income > $30,000)	0.32	0.47
OWNER (1 if individual or partnership ownership)	0.85	0.36
REASAN (1 if records kept for tax purposes only)	0.75	0.46
HP (horsepower of largest tractor)	96.79	41.38
MEET (number of educational meetings attended)	3.09	3.99
LEASE (1 if any equipment leased)	0.08	0.26
FULPER (number of full-time persons working on farm)	1.52	1.01
PARTPER (number of part time persons working on farm)	2.57	1.81
PERPIG (1 if > 60% of farm receipts from swine)	2.23	2.90
DAR (debt to asset ratio)	0.28	0.29
HEDGE (1 if outputs or inputs hedged)	0.08	0.27
INSUR (1 if crop insurance taken annually)	0.31	0.46
COMPUTER (1 if using or considering a computer)	0.18	0.39
NO OTHER (1 if off farm income earned)	0.44	0.50
NO PLAN (1 if do not particpate in government programs)	0.29	0.45
TILAC (tillable acres)	185.34	241.45

the conditional logit model is generated. Two, when the independent variables consists entirely of characteristics of the chooser, the polytomous logit model is generated. The polytomous logit model can be thought of as being applied to the analysis of K separate populations. Third category is mixed models in which both characteristics of the chooser and of the choices appear as independent variables may be estimated. The purpose of the procedure is to produce estimates of the probability that the dependent variable is equal to particular value for any observation, and to identify those factors statistically significant in determining the value of that probability.

Polytomous logit analysis is used here to understand the interaction of different farmer and farm characteristics in determining the rankings of different factors for introducing a new technology. Responses to the question of "how would you rank the different factors for introducing a new technology"? were used to construct a three level categorical dependent variable. The dependent variable is valued at one if a particular factor is ranked 1st and 2nd most important factor in introducing a new technology. Those farms who ranked 3rd, 4th and 5th most important and 6th, 7th and 8th most important factor in introducing a new technology are given dependent variable values of two and three, respectively. A polytomous logit model was specified as follows:

$$\ln(P_i/P_j) = B_{0ij} + B_{1ij} T_1 + B_{2ij} \text{AGE} + B_{3ij} \text{EDUCAT} + B_{4ij} \text{FLOOR} + B_{5ij} \text{WASH} + B_{6ij} \text{PIGTIME} + B_{7ij} \text{VISIT} + B_{8ij} \text{SOIL} + B_{9ij} \text{ACCOUNT} + B_{10ij} \text{NFINC} + B_{11ij} \text{OWNER} + B_{12ij} \text{REASON} + B_{13ij} \text{TILAC} + B_{14ij} \text{MEET} + B_{15ij} \text{OWNING} + B_{16ij} \text{LEASE} + B_{17ij} \text{FULPER} + B_{18ij} \text{PERPIG} + B_{19ij} \text{DAR} + B_{20ij} \text{HEDGE} + B_{21ij} \text{INSUR} + B_{22ij} \text{COMPUTER} + B_{23ij} \text{NOTHER} + B_{24ij} \text{NOPLAN}$$

where

subscript i = ith class of the qualitative dependent variable

subscript j = jth class of the qualitative dependent variable

$\ln(P_i/P_j)$ = natural logarithm of the probability of a class i relative to the probability

of a class j.

T_1 is weaner operators, AGE is years in age (1 if >46 years, 0 if<46 years), EDUCAT is education level (1 if completed high school or more, 0 if less high school), FLOOR is the type of flooring in weaner and/or finishing area (1 if cement, 0 if partially or fully slatted), WASH is washing of pens between batches of weaner and/or finishing pigs (1 if yes, 0 if no), PIGTIME is the proportion of total labour hours spent on the swine operation (1 if >51%, 0 if <50%), VISIT is the prescheduled herd health visits (1 if one or more, 0 if none), SOIL is soil testing (1 of between one and five years, 0 if never or once in six years or more), ACCOUNT is the accounting system for tax purposes (1 if cash, 0 if accrual or don't know), NFINC is on-farm income before tax (1 if >$30,000, 0 if <$30,000), OWNER is the ownership arrangement (1 if individual owner or partnership, 0 if corporation), REASON is the most important reason for record keeping (1 if tax purposes or government programs requirements, 0 if enterprise analysis or market strategy), TILAC is the farm size (total tillable aces), MEET is the total number of farm related educational meetings attended during a year, OWNING is the number of years managing and/or owning the farm, LEASE is leasing of any of the farm equipment (1 if yes, 0 if no), FULPER is the number of full-time persons working on the farm, PERPIG is the proportion of farm receipts attributed to the swine enterprise (1 if >61%, 0 if <60%), DAR is the debt to asset ratio, HEDGE is hedging of crop or hog production (1 if yes, 0 if no), INSUR is holding crop insurance every year (1 if yes, 0 if no), COMPUTER is computer use for farm management and/or record keeping purposes (1 if use or considering to buy, 0 if never buy or may consider to buy), NOTHER is off-farm sources of income (1 if yes, 0 if no) and NOPLAN is participation in government programs (1 if yes, 0 if no). The summary statistics for these exogenous variables are given in Table 3.

The estimated coefficients of the polytomous logit model represent the log of the ratio of the probability of being in one category of the dependent variable relative to another category. All

categories are mutually exclusive. That is, the farmer has indicated one category as the most important. For a three level categorical dependent variable, three equations exist which express the probability of membership in one class relative to another. For a particular equation, $\ln(P_i/P_j)$, a positive regression coefficient for an independent variable indicates that an increase in that independent variable is associated with an increase in the probability of an observation being classified in class i relative to class j.

Polytomous logit models were estimated for each of the eight adoption factors using a set of 24 explanatory variables. The results of the polytomous logit models for each of the eight possible adoption reasons are presented in tables 4-19. The dependent variable in each model is the logarithm of likelihood of odds of membership in two groups. The direction of association of explanatory variables with the dependent variable show how these variables would influence the log-likelihood of odds. The marginal probability is the derivative of the function with respect to named independent variable evaluated with all other variables at their mean. This represents an estimated change in probability associated with a unit increase in the named independent variable. The marginal probabilities for explanatory variables for each adoption factor appear in tables 11-18. A discussion of the results for each adoption factor follows.

4.2.1 Increase Profits

The model examining the factors affecting the relative ranking of the profitability criterion in technology adoption was highly significant as indicated by the likelihood ratio test (Table 4). About 18 percent of the variation in the categorical dependent variable is explained by the model. Twelve of the 24 explanatory variables were statistically significant at least at 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. The variables that were positively associated with the membership in group

one relative to group three were total tillable acres (TILAC), debt to asset ratio (DAR) and proportion of the total labour hours spent on the swine operation (PIGTIME). The results for TIlAC and PIGTIME are consistent with previous results which indicated that large farms and those specializing in swine are more likely to rank profitability as the most important reason for technology adoption. The results for DAR suggest that producers in tighter financial conditions have to place more importance on the net returns generated by new technology than those producers without the same financial constraints. The marginal probabilities in Table 5 suggests that PIGTIME is the dominating of these three variables. Farmers who spend more than 61% of total labour hours on swine enterprise increased probability by 0.37 of ranking profitability as either first or second most important in technology adoption (group one). The variables that were negatively associated with membership in group one relative to group three were weaner operators (T_1), soil testing (SOIL), record keeping for tax purposes only rather than enterprise analysis (REASON), number of farm related educational meetings attended (MEET), and computer use (COMPUTER). The marginal probabilities of T_1, SOIL, REASON and COMPUTER belonging to group one decreased by 0.32, 0.31, 0.30, 0.50, respectively.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were negatively associated with membership in group two relative to group three were weaner operators (T_1) soil testing (SOIL) number of farm related educational meetings attended (MEET) computer use (COMPUTER). The marginal probabilities of T_1, SOIL MEET and COMPUTER belonging to group two relative to three decreased by 0.37, 0.29, 0.03 and 0.57 respectively. Only debt to asset ratio (DAR) variable was positively associated with group two membership relative to group three.

Table 4. Polytomous Logit Model of Increase Profits[1].

	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
VARIABLE	B	SE	B	SE	B	SE
CONSTANT	5.137	1.86***	4.838	1.88***	0.299	0.771
T_1	-1.396	0.783*[2]	-1.659	0.805**	0.263	0.398
AGE	1.018	0.981	0.287	1.003	0.730	0.438*
EDUCAT	0.312	0.759	0.365	0.769	-0.053	0.314
FLOOR	-0.228	0.744	0.398	0.755	-0.626	0.309**
WASH	-0.657	0.740	-0.514	0.751	-0.143	0.301
PIGTIME	1.613	0.938*	1.001	0.950	0.612	0.351*
VISIT	-0.828	0.841	-0.933	0.859	0.105	0.359
SOIL	-1.374	0.719*	-1.310	0.732*	-0.064	0.311
ACCOUNT	0.159	0.675	-0.223	0.682	0.382	0.283
NFINC	-0.081	0.711	0.047	0.722	-0.128	0.299
OWNER	0.174	0.952	-0.029	0.958	0.203	0.427
REASON	-1.425	0.641**	-0.864	0.640	-0.461	0.280*
TILAC	0.004	0.002*	0.003	0.002	0.001	0.0009
MEET	-0.128	0.072*	-0.123	0.075*	-0.005	0.037
OWNING	-0.041	0.044	-0.038	0.045	-0.003	0.021
LEASE	-0.679	1.253	-0.634	1.258	-0.005	0.463
FULPER	-0.356	0.399	-0.302	0.407	-0.053	0.176
PERPIG	-0.123	0.133	-0.021	0.135	-0.102	0.057*
DAR	5.688	2.14***	4.523	2.146**	1.163	0.534**
HEDGE	-0.941	1.032	-0.940	1.064	-0.0009	0.480
INSUR	-0.910	0.676	-0.982	0.692	0.072	0.293
COMPUTER	-2.203	0.84***	-2.524	0.86***	0.320	0.362
NOTHER	0.499	0.710	0.345	0.722	0.154	0.286
NOPLAN	-0.701	0.836	0.251	0.843	-0.952	0.382**
N			313			
LOG LIKELIHOOD			-223.245			
MODEL CHI-SQUARE			66.893			
PSEUDO R-SQUARE[3]			0.176			

1 Adoption factor groups are: 1=most important, 2=2nd most important, 3=3rd most important.

2 Single, double and triple asterisk means significant at 10%, 5% and 1% level, respectively.

3 Pseudo R-Square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. This is a measure of goodness of fit, restricted to lie between zero and one. This measure does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

Table 5. Marginal Probabilities Associated with Increase Profits[4].

INDEPENDENT VARIABLE	$\ln(P_1/P^3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	-0.318	-0.371	0.059
AGE	0.232	0.064	0.166
EDUCAT	0.071	0.082	-0.012
FLOOR	-0.052	0.089	-0.143
WASH	-0.149	-0.115	-0.033
PIGTIME	0.367	0.224	0.139
VISIT	-0.188	-0.209	0.024
SOIL	-0.313	-0.292	-0.015
ACCOUNT	0.036	-0.050	0.087
NFINC	-0.018	0.011	-0.029
OWNER	0.040	-0.006	0.046
REASON	-0.302	-0.193	-0.105
TILAC	0.002	0.0008	0.0002
MEET	-0.029	-0.028	-0.001
OWNING	-0.009	-0.008	-0.0008
LEASE	-0.155	-0.151	-0.001
FULPER	-0.081	-0.068	-0.012
PERPIG	-0.028	-0.005	-0.023
DAR	1.295	1.012	0.265
HEDGE	-0.214	-0.210	-0.0002
INSUR	-0.207	-0.220	0.016
COMPUTER	-0.501	-0.565	0.073
NOTHER	0.114	0.077	0.035
NOPLAN	-0.160	0.056	-0.217

[4] This is derivative of the function with respect to the independent variable with all other variables at their mean (Maddala, p. 23).

The last comparison involved identifying producer and production characteristics that differentiated farmers who ranked profitability one or two (group one) from those who ranked it three, four or five (group two). The variables that were negatively associated with membership in group one relative to group two were cement type of flooring (FLOOR), reason for record keeping (REASON), proportion of farm receipts attributed to swine enterprise (PERPIG) and participation in government programs (PLAN). The marginal probabilities of FLOOR, REASON, and PERPIGPLAN belonging to group one decreased by 0.14, 0.11 and 0.22 respectively. Proportion of total labour hours spent on swine enterprise (PIGTIME) and debt to asset ratio (DAR) variables were positively associated with group two membership. The marginal probabilities of PIGTIME and DAR belonging to group one increased by 0.14 and 0.27, respectively.

4.2.2 Increase Production

The model was highly significant as indicated by the likelihood ratio test (Table 5). About 17 percent of the variation in the categorical dependent variable is explained by the model. Seven of the 24 explanatory variables were statistically significant the 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. The variables that were positively associated with the membership in group one relative to group three were weaner operators (T_1) and computer use (COMPUTER). The variables that were negatively associated with membership in group one relative to group three were education level (EDUCAT) and off-farm sources of income (NOTHER). The marginal probabilities of EDUCAT and NOTHER belonging to group one decreased by 0.19 and 0.13, respectively.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were negatively associated with membership in group two relative to group three were cement flooring in the weaner and/or finishing area (FLOOR) and hedging of crop or hog production (HEDGE). The marginal probabilities of

FLOOR and HEDGE belonging to group two relative to group three decreased by 0.23 and 0.33 respectively. Only computer use for farm management and/or record keeping variable was positively associated with group two membership suggesting that farmers who are now using a computer or considering purchasing a computer are more likely to rank increased production as the 3rd, 4th or 5th most important factors than a lower ranking. The marginal probability of COMPUTER belonging to group two relative increased by 0.46.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. Only cement flooring in the weaner and/or finishing area (FLOOR) and number of full-time persons working on the farm (FULPER) were significant and positively associated with group one membership relative to group two membership. These results suggest that farmers with cement floors and with more full-time persons working on the farm are more likely to rank increase production as 1st or 2nd most important factors than in the middle category. The marginal probabilities of FLOOR and FULPER belonging to group one increased by 0.20 and 0.88, respectively.

4.2.3 Improve Efficiency in Production:

About 20 percent of the variation in the categorical dependent variable is explained by the model (Table 8). Only four of the 24 explanatory variables were statistically significant at least at 10 percentlevel. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. Only number of farm related educational meetings attended (MEET) variable was significant and positively associated with

Table 6. Polytomous Logit Model of Increase Production[5].

	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
VARIABLE	B	SE	B	SE	B	SE
CONSTANT	1.688	1.143	2.970	1.07***	-1.281	0.812
T_1	1.247	0.708*[6]	1.044	0.673	0.202	0.402
AGE	0.305	0.647	-0.034	0.598	0.339	0.454
EDUCAT	-0.997	0.473**	-0.576	0.426	-0.421	0.344
FLOOR	0.094	0.447	-0.958	0.413**	1.052	0.34***
WASH	-0.001	0.445	0.168	0.399	-0.169	0.330
PIGTIME	0.145	0.528	0.619	0.488	-0.474	0.382
VISIT	0.384	0.577	0.570	0.538	-0.186	0.378
SOIL	-0.709	0.455	-0.430	0.402	-0.279	0.356
ACCOUNT	-0.072	0.424	0.148	0.383	-0.219	0.309
NFINC	-0.040	0.442	0.080	0.397	-0.120	0.328
OWNER	-0.368	0.687	-0.343	0.642	-0.025	0.456
REASON	0.031	0.379	-0.110	0.362	0.141	0.301
TILAC	0.0008	0.002	0.002	0.001	-0.0008	0.0009
MEET	-0.014	0.049	-0.054	0.048	0.040	0.038
OWNING	-0.032	0.030	-0.021	0.027	-0.118	0.022
LEASE	0.057	0.664	-0.019	0.641	0.077	0.481
FULPER	0.120	0.254	-0.341	0.233	0.462	0.19***
PERPIG	0.016	0.083	-0.070	0.076	0.856	0.062
DAR	-0.002	0.812	0.611	0.723	-0.613	0.578
HEDGE	-0.673	0.627	-1.401	0.59***	0.728	0.507
INSUR	-0.193	0.433	-0.208	0.395	0.014	0.315
COMPUTER	1.684	0.67***	1.943	0.64***	-0.260	0.379
NOTHER	-0.696	0.421*	-0.581	0.375	-0.115	0.317
NOPLAN	-0.220	0.571	-0.162	0.500	-0.057	0.437
N		313				
LOG LIKELIHOOD		-268.465				
MODEL CHI-SQUARE		65.390				
PSEUDO R-SQUARE[7]		0.173				

[4] Adoption factor groups are: 1=most important, 2=2nd most important, 3=3rd most important.

[6] Single, double and triple asterisk denotes significant at the 10%, 5% and 1%, respectively.

Table 7. Marginal Probabilities[8] Associated with Increase Production.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	0.239	0.247	0.039
AGE	0.058	-0.008	0.065
EDUCAT	-0.191	-0.136	-0.081
FLOOR	0.018	-0.226	0.201
WASH	-0.0003	0.039	-0.032
PIGTIME	0.028	0.146	-0.091
VISIT	0.073	0.135	-0.036
SOIL	-0.136	-0.102	-0.053
ACCOUNT	-0.014	0.035	-0.042
NFINC	-0.008	0.019	-0.023
OWNER	-0.070	-0.081	-0.005
REASON	0.006	-0.026	0.027
TILAC	0.0002	0.0004	-0.0001
MEET	-0.003	-0.013	0.008
OWNING	-0.006	-0.005	-0.002
LEASE	0.011	-0.005	0.015
FULPER	0.023	-0.081	0.088
PERPIG	0.003	-0.016	0.016
DAR	-0.0003	0.144	-0.117
HEDGE	-0.129	-0.331	0.139
INSUR	-0.037	-0.491	0.003
COMPUTER	0.322	0.459	-0.050
NOTHER	-0.133	-0.137	-0.022
NOPLAN	-0.042	-0.038	-0.011

[7] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. This is a measure of goodness of fit, restricted to lie between zero and one. This does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

[8] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

the membership in group one relative to group three. The marginal probability of MEET belonging to group one relative to group three increased by 0.07. Only holding crop insurance (INSUR) variable was significant and negatively associated with membership in group one relative to group three suggesting that farmers who hold crop insurance every year are less likely to rank improve efficiency in production as 1st and 2nd most important factors. The marginal probabilities of INSUR belonging to group one decreased by 0.41.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were negatively associated with membership in group two relative to group three were prescheduled herd health visits (VISIT) and holding crop insurance (INSUR). The marginal probabilities of VISIT and INSUR belonging to group two decreased by 0.31, and 0.33 respectively. Only number of farm related educational meetings attended (MEET) and debt to asset ratio (DAR) variables were significant and positively associated with group two membership. The marginal probability of MEET and DAR belonging to group two increased by 0.66 and 0.42, respectively.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. Only weaner operators (T_1)and leasing of any of the farm equipments (LEASE) were significant and negatively associated with group one membership relative to group two membership. The marginal probabilities of T_1 and LEASE belonging to group one decreased by 0.12 and 0.20, respectively. Only washing of pens between batches of weaner and/or

Table 8. Polytomous Logit Model of Improve Efficiency in Production[9].

	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
VARIABLE	B	SE	B	SE	B	SE
CONSTANT	1.078	1.506	1.541	1.513	-0.463	0.763
T_1	0.139	0.804	1.072	0.783	-0.879	0.390**[10]
AGE	-0.358	0.832	-0.077	0.834	-0.281	0.410
EDUCAT	-0.391	0.589	-0.690	0.590	0.299	0.306
FLOOR	0.371	0.635	0.482	0.635	-0.111	0.296
WASH	0.575	0.587	-0.282	0.592	0.857	0.29***
PIGTIME	0.573	0.772	0.291	0.784	0.283	0.340
VISIT	-0.804	0.694	-1.276	0.706*	0.472	0.355
SOIL	-0.038	0.594	0.240	0.592	-0.278	0.304
ACCOUNT	0.725	0.538	0.752	0.538	-0.028	0.282
NFINC	-0.347	0.543	-0.575	0.546	0.227	0.294
OWNER	0.153	0.835	-0.004	0.849	0.157	0.436
REASON	-0.067	0.570	-0.015	0.571	-0.052	0.265
TILAC	-0.0005	0.002	-0.002	0.002	0.001	0.0009
MEET	0.271	0.132**	0.269	0.132**	0.002	0.033
OWNING	-0.043	0.037	-0.042	0.036	-0.001	0.020
LEASE	0.052	1.170	0.862	1.155	-0.810	0.438*
FULPER	0.330	0.326	0.305	0.327	0.025	0.170
PERPIG	0.181	0.116	0.104	0.117	0.077	0.055
DAR	1.296	1.030	1.714	1.030*	-0.418	0.492
HEDGE	0.035	0.956	0.316	0.955	-0.281	0.449
INSUR	-1.651	0.57***	-1.354	0.57***	-0.298	0.288
COMPUTER	-0.322	0.716	0.111	0.713	-0.432	0.343
NOTHER	0.757	0.558	0.735	0.560	0.023	0.280
NOPLAN	0.171	0.704	-0.715	0.716	0.886	0.385**
N			313			
LOG LIKELIHOOD			-247.534			
MODEL CHI-SQUARE			76.148			
PSEUDO R-SQUARE[11]			0.196			

[9] Adoption factor groups are:1=most important,2=2nd most important,3=3rd most important.

[10] Single, double and triple asterisk means significant at 10%, 5% and 1% level, respectively.

Table 9. Marginal Probabilities[12] Associated with Improve Efficiency in Production.

INDEPENDENT VARIABLE	$\ln(P_1/P_3$	$\ln(P_2/P_3$	$\ln(P_1/P_2)$
T_1	0.035	0.250	-0.219
AGE	-0.089	-0.019	-0.070
EDUCAT	-0.097	-0.170	0.074
FLOOR	0.092	0.119	-0.028
WASH	0.143	-0.069	0.214
PIGTIME	0.142	0.072	0.070
VISIT	-0.200	-0.314	0.118
SOIL	-0.009	0.059	-0.069
ACCOUNT	0.181	0.185	-0.007
NFINC	-0.087	-0.141	0.057
OWNER	0.038	-0.0009	0.039
REASON	-0.017	-0.004	-0.013
TILAC	-0.0001	-0.0004	0.0003
MEET	0.068	0.066	0.0006
OWNING	-0.011	-0.010	-0.0003
LEASE	0.013	0.212	-0.202
FULPER	0.082	0.075	0.006
PERPIG	0.045	0.026	0.019
DAR	0.323	0.422	-0.104
HEDGE	0.009	0.078	-0.070
INSUR	-0.412	-0.333	-0.074
COMPUTER	-0.080	0.027	-0.108
NOTHER	0.189	0.181	0.006
NOPLAN	0.043	-0.176	0.221

[11] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. This is a measure of goodness of fit, restricted to lie between zero and one. This does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

[12] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

finishing pigs (WASH) and participation in government plans (PLAN) were significant and positively associated with group one membership. The marginal probabilities of WASH and PLAN belonging to group one increased by 0.21 and 0.22, respectively.

4.2.4 Costs of New Technology:

About 17 percent of the variation in the categorical dependent variable is explained by the model (Table 10). Only four of the 24 explanatory variables were statistically significant at the at 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. The variables that were significant and negatively associated with membership in group one relative to group three were age of owner/operator (AGE) and number of full-time persons working on the farm (FULPER). The marginal probabilities of AGE and FULPER belonging to group one decreased by 0.23 and 0.08, respectively. Only leasing farm equipment (LEASE) variable was significant and positively associated with group one membership suggesting that farmers who lease any of the farm equipment are more likely to rank cost of new technology as 1st or 2nd most important factors than in the bottom three rankings. The marginal probability of LEASE belonging to group one membership increased by 0.17.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. Only washing of pens between batches of weaner and/or finishing pigs (WASH) was significant and positively associated with group two than group three membership. WASH belonging to group two relative to group three increased by 0.15.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. Only leasing farm equipment (LEASE) variable was significant and positively associated with group one membership. The marginal probability of LEASE belonging to group one membership increased by 0.22.

Table 10. Polytomous Logit Model of Costs of New Technologies[13].

VARIABLE	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
	B	SE	B	SE	B	SE
CONSTANT	1.308	0.970	0.786	0.939	0.523	0.822
T_1	-0.122	0.485	-0.445	0.486	0.323	0.411
AGE	-0.954	0.526*	-0.737	0.512	-0.216	0.454
EDUCAT	0.506	0.390	0.532	0.383	-0.025	0.327
FLOOR	0.251	0.391	0.131	0.383	0.120	0.318
WASH	0.520	0.388	0.611	0.375*	-0.092	0.310
PIGTIME	-0.573	0.450	-0.296	0.426	-0.277	0.372
VISIT	-0.575	0.476	-0.063	0.437	-0.512	0.376
SOIL	-0.072	0.381	-0.427	0.385	0.355	0.325
ACCOUNT	0.444	0.359	0.266	0.349	0.177	0.302
NFINC	-0.345	0.370	-0.097	0.360	-0.248	0.319
OWNER	-0.032	0.541	0.205	0.511	-0.237	0.480
REASON	0.146	0.343	-0.232	0.346	0.378	0.292
TILAC	-0.001	0.001	-0.0002	0.0009	-0.001	0.001
MEET	-0.060	0.045	-0.056	0.042	-0.004	0.037
OWNING	0.011	0.024	0.004	0.024	0.007	0.022
LEASE	1.262	0.670*	0.345	0.681	0.917	0.469*
FULPER	-0.353	0.214*	-0.182	0.207	-0.171	0.186
PERPIG	-0.074	0.073	-0.045	0.071	-0.029	0.059
DAR	0.589	0.708	1.053	0.695	-0.464	0.521
HEDGE	0.507	0.699	0.472	0.670	0.035	0.464
INSUR	0.086	0.372	-0.056	0.357	0.142	0.302
COMPUTER	0.057	0.477	0.312	0.449	-0.255	0.357
NOTHER	-0.331	0.358	-0.158	0.351	-0.173	0.301
NOPLAN	0.011	0.481	-0.058	0.491	0.068	0.409
N			312			
LOG LIKELIHOOD			-300.342			
MODEL CHI-SQUARE			64.472			
PSEUDO R-SQUARE[15]			0.171			

[13] Adoption factor groups are 1=1st & 2nd most important, 2=3rd, 4th & 5th most important, 3=6th, 7th & 8th most important.

[14] Singe, double and triple asterisk denotes significant at 10%, 5% and 1% level, respectively.

Table 11. Marginal Probabilities[16] Associated with Costs of New Technology.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	-0.029	-0.109	0.076
AGE	-0.225	-0.180	-0.051
EDUCAT	0.120	0.130	-0.006
FLOOR	0.059	0.032	0.028
WASH	0.123	0.149	-0.022
PIGTIME	-0.135	-0.072	-0.065
VISIT	-0.136	-0.015	-0.121
SOIL	-0.017	-0.104	0.084
ACCOUNT	0.105	0.065	0.042
NFINC	-0.081	-0.024	-0.058
OWNER	-0.008	0.050	-0.056
REASON	0.034	-0.057	0.089
TILAC	-0.0003	-0.00006	-0.0003
MEET	-0.014	-0.014	-0.0009
OWNING	0.003	0.0009	0.002
LEASE	0.298	0.084	0.216
FULPER	-0.083	-0.045	-0.040
PERPIG	-0.017	-0.011	-0.007
DAR	0.139	0.257	-0.109
HEDGE	0.120	0.115	0.008
INSUR	0.020	-0.014	0.034
COMPUTER	0.013	0.076	-0.060
NOTHER	-0.078	-0.039	-0.041
NOPLAN	0.002	-0.014	0.016

[15] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. This is a measure of goodness of fit, restricted to lie between zero and one. This does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

[16] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

4.2.5 Availability of Grants:

The model was highly significant as indicated by the likelihood ratio test (Table 13). About 21 percent of the variation in the categorical dependent variable is explained by the model. Nine of the 24 explanatory variables were statistically significant at least at 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. The variables that were positively associated with the membership in group one relative to group three were age of the owner operator (AGE), education level (EDUCAT), cement flooring in the weaner and/or finishing area (FLOOR) and net farm income (NFINC). The variables that were negatively associated with membership in group one relative to group three were tillable acres (TILAC) and number of farm related educational meetings attended (MEET).

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were positively associated with the membership in group two relative to group three were age of the owner operator (AGE), education level (EDUCAT) and holding crop insurance every year (INSUR). The marginal probabilities of AGE and EDUCAT associated with group two membership increased by 0.18 and 0.13, respectively (Table 14). Pre-scheduled herd health visits by veterinarian (VISIT) and number of full-time persons (FULPER) working on the farm variables were negatively associated with group two membership. The marginal probabilities of VISIT and FULPER decreased by 0.13 and 0,06, respectively.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. The variables that were positively associated with the membership in group one relative to group three were cement flooring in the weaner and/or finishing area (FLOOR), net farm income (NFINC) and debt to asset ratio (DAR). The variables

that were negatively associated with membership in group one relative to group three were tillable acres (TILAC) and number of farm related educational meetings attended (MEET).

4.2.6 Ease of Use

About 16 percent of the variation in the categorical dependent variable is explained by the model (Table 16). Five of the 24 explanatory variables were statistically significant at the 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. Only cement flooring in the weaner and/or finishing area (FLOOR) variable was significant and negatively associated with group one membership. The marginal probability of FLOOR associated with group one membership increased by 0.11.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were negatively associated with the membership in group two relative to group three were type of flooring in the weaner and/or finishing area (FLOOR), leasing of farm equipment (LEASE) and holding crop insurance every year. The marginal probabilities of FLOOR and LEASE belonging to group two decreased by 0.15 and 0.22, respectively. Only using an accounting system for tax purposes (ACCOUNT) variable was significant and positively associated with group two membership. This result suggest that farmers who use cash method of accounting for income tax purposes are more likely to rank ease of use as 3rd, 4th or 5th most important factors than in the last three rankings.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. Only washing pens between batches of weaners and/or finishing pigs (WASH) and accounting system for tax purposes (ACCOUNT) variable was significant and negatively associated with group two membership. The marginal probability of

Table 12. Polytomous Logit Model of Availability of Grants[17].

VARIABLE	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
	B	SE	B	SE	B	SE
CONSTANT	-3.928	2.298*	-1.969	0.846	-1.960	2.353
T_1	0.567	0.923	0.295	0.419	0.272	0.949
AGE	2.495	1.322*	0.911	0.448	1.584	1.347
EDUCAT	2.052	0.920**	0.650	0.341	1.402	0.940
FLOOR	1.633	0.821*	0.226	0.328	1.407	0.845*
WASH	-0.479	0.856	0.219	0.311	-0.698	0.870
PIGTIME	0.104	0.967	-0.163	0.373	0.267	0.984
VISIT	-0.185	1.059	-0.670	0.387	0.484	1.079
SOIL	0.633	0.967	-0.483	0.348	1.116	0.986
ACCOUNT	-1.088	0.741	-0.460	0.305	-0.627	0.763
NFINC	1.417	0.803*	0.093	0.323	1.325	0.824*
OWNER	0.293	1.099	0.722	0.526	-0.429	1.170
REASON	0.066	0.653	-0.013	0.285	0.079	0.652
TILAC	-0.010	0.006*	0.0004	0.0009	-0.011	0.006*
MEET	-0.521	0.276*	0.024	0.035	-0.545	0.276**
OWNING	-0.033	0.062	0.008	0.021	-0.040	0.063
LEASE	-16.232	4238.754	0.156	0.488	-16.388	4238.754
FULPER	-0.269	0.545	-0.307	0.187	0.038	0.558
PERPIG	-0.086	0.170	0.039	0.060	-0.126	0.173
DAR	1.699	1.169	-0.438	0.568	2.137	1.232*
HEDGE	-16.415	3477.461	0.052	0.449	-16.467	3477.461
INSUR	1.128	0.850	0.667	0.295	0.461	0.867
COMPUTER	-0.842	1.339	-0.054	0.354	-0.788	1.356
NOTHER	0.932	0.841	0.080	0.308	0.851	0.861
NOPLAN	-0.716	1.161	-0.512	0.465	-0.203	1.217
N			312			
LOG LIKELIHOOD			-195.568			
MODEL CHI-SQUARE			82.748			
PSEUDO R-SQUARE[18]			0.210			

[17] Adoption factor groups are: 1=1st & 2nd most important, 2=3rd, 4th & 5th most important and 3=6th, 7th & 8th most important.

[18] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. Pseudo R-square is a measure of goodness of fit, restricted to lie between zero and one. This measure does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

Table 13. Marginal Probabilities[19] Associated with Availability of Grants.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	0.00008	0.058	0.00004
AGE	0.0003	0.179	0.0002
EDUCAT	0.0003	0.128	0.0002
FLOOR	0.0002	0.044	0.0002
WASH	-0.00006	0.043	-0.00009
PIGTIME	0.00001	-0.032	0.00004
VISIT	-0.00002	-0.132	0.00006
SOIL	0.00008	-0.095	0.0001
ACCOUNT	-0.0001	-0.090	-0.00008
NFINC	0.0002	0.018	0.0002
OWNER	0.00004	0.142	-0.00006
REASON	0.00000	-0.003	0.00001
TILAC	-0.00000	0.00008	-0.00000
MEET	-0.00007	0.005	-0.00007
OWNING	-0.00000	0.001	-0.00000
LEASE	-0.002	0.031	-0.002
FULPER	-0.00004	-0.060	0.00000
PERPIG	-0.00001	0.008	-0.0000
DAR	0.0002	-0.086	0.0003
HEDGE	-0.002	0.010	-0.002
INSUR	0.0002	0.131	0.00006
COMPUTER	-0.0001	-0.011	-0.0001
NOTHER	0.0001	0.016	0.0001
NOPLAN	-0.00009	-0.101	-0.00003

[19] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

WASH and ACCOUNT associated with group two membership decreased by 0.08 and 0.07, respectively.

4.2.7 Use by Other Farmers

The model was highly significant as indicated by the likelihood ratio test (Table 16). About 20 percent of the variation in the categorical dependent variable is explained by the model. Nine of the 24 explanatory variables were statistically significant at the 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. Only holding crop insurance every year (INSUR) variable was significant and positively associated with group one membership relative to group three. This result suggest that farmers who take out crop insurance every year may be risk averse and wish to observe the success or failure or new technology by other producers before adopting it themselves. The variables that were negatively associated with group one membership were proportion of total labour hours spent on the swine operation (PIGTIME) and net farm income (NFINC) suggesting farmers who spend more than 51% of total labour hours on the swine operation and farmers with higher net farm income are more likely to rank use by other farmers as their bottom choice rather than their 1st or 2nd most important factor for technology adoption.

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were positively associated with the membership in group two relative to group three were educational level (EDUCAT), pre-scheduled herd health visits by veterinarian (VISIT), number of full-time persons working on the farm (FULPER) and participation in government programs (PLAN). The marginal probabilities of EDUCAT, VISIT, FULPER and NOPLAN belonging to group two membership relative to group three increased by 0.13, 0.13, 0.06 and 0.14, respectively (Table 18). Only washing of pens between

batches of weaners and/or finishing pigs (WASH) and total tillable acres (TILAC) variables were significant and negatively associated with group two membership relative to group three.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. Only net farm income (NFINC) and holding crop insurance every year (INSUR) variables were significant and positively associated with group one membership relative to group two. These results suggest that farmers higher net farm income and farmers who take out crop insurance every year are more likely to rank use by other farmers as the 1st or 2nd most important factor than 3rd, 4th or 5th. The variables that were negatively associated with group one membership relative to group two were education level (EDUCAT), proportion of total labour hours spent on the swine operation (PIGTIME) and number of full-time persons working on the farm (FULPER).

4.2.8 Tax Benefits:

The model was highly significant as indicated by the likelihood ratio test (Table 18). About 21 percent of the variation in the categorical dependent variable is explained by the model. Ten of the 24 explanatory variables were statistically significant at least at 10 percent level. The first comparison involved identifying producer and production characteristics that differentiated group one farmers from group three. The variables that were positively associated with the membership in group one relative to group three were pre-scheduled herd health visits by veterinarian (VISIT), soil testing (SOIL), net farm income (NFINC) and holding crop insurance every year (INSUR). The variables that were negatively associated with membership in group one relative to group three were age of the owner operator (AGE) and education level (EDUCAT) suggesting that older farmers and farmers with higher educational level are less likely to rank tax benefits as 1st or 2nd most important factors and likely to rank it 6th, 7th or 8th.

Table 14. Polytomous Logit Model of Ease of Use[20].

VARIABLE	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
	B	SE	B	SE	B	SE
CONSTANT	-0.427	1.183	0.962	0.812	-1.389	1.080
T_1	0.512	0.541	-0.504	0.414	0.556	0.517
AGE	-0.469	0.644	-0.309	0.457	-0.160	0.581
EDUCAT	0.166	0.478	-0.237	0.333	0.403	0.437
FLOOR	-0.993	0.48**	-0.604	0.321*	-0.388	0.442
WASH	-0.301	0.489	0.433	0.322	-0.735	0.440*
PIGTIME	-0.638	0.585	0.013	0.365	-0.651	0.540
VISIT	0.434	0.549	0.204	0.372	0.230	0.503
SOIL	0.283	0.450	0.077	0.338	0.207	0.401
ACCOUNT	0.083	0.415	0.692	0.301**	-0.609	0.383*
NFINC	0.079	0.441	0.074	0.320	0.005	0.396
OWNER	0.117	0.607	-0.333	0.469	0.450	0.627
REASON	0.378	0.430	0.143	0.283	0.235	0.402
TILAC	-0.002	0.001	-0.0006	0.0009	-0.001	0.001
MEET	0.031	0.058	0.022	0.038	0.009	0.053
OWNING	0.017	0.029	0.002	0.022	0.015	0.026
LEASE	-0.893	0.834	-0.930	0.441**	0.037	0.832
FULPER	0.067	0.262	0.035	0.183	0.032	0.237
PERPIG	0.031	0.086	0.037	0.060	-0.006	0.078
DAR	-1.217	0.806	-0.194	0.521	-1.023	0.766
HEDGE	0.275	0.788	0.403	0.487	-0.129	0.722
INSUR	-0.677	0.448	-0.748	0.31***	0.071	0.415
COMPUTER	0.579	0.531	0.152	0.372	0.427	0.482
NOTHER	0.291	0.429	0.396	0.307	-0.105	0.384
NOPLAN	0.095	0.535	-0.536	0.427	0.631	0.478
N			313			
LOG LIKELIHOOD			-272.467			
MODEL CHI-SQUARE			60.299			
PSEUDO R-SQUARE[22]			0.161			

[20] Adoption factor groups are: 1=1st & 2nd most important, 2=3rd, 4th & 5th most important and 3=6th, 7th & 8th most important.

[21] Single, double and triple asterisk means significant at the 10%, 5% and 1% level.

Table 15. Marginal Probabilities[23] Associated with Ease of Use.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	0.006	-0.121	0.060
AGE	-0.051	-0.075	-0.017
EDUCAT	0.018	-0.057	0.044
FLOOR	-0.107	-0.146	-0.042
WASH	-0.033	0.104	-0.079
PIGTIME	-0.069	0.003	-0.070
VISIT	0.047	0.049	0.025
SOIL	0.031	0.018	0.022
ACCOUNT	0.009	0.167	-0.066
NFINC	0.009	0.018	0.0006
OWNER	0.013	-0.080	0.049
REASON	0.041	0.035	0.025
TILAC	-0.0002	-0.0002	-0.0001
MEET	0.003	0.005	0.001
OWNING	0.002	0.0004	0.002
LEASE	-0.097	-0.224	0.004
FULPER	0.007	0.008	0.003
PERPIG	0.003	0.009	-0.0006
DAR	-0.132	-0.047	-0.111
HEDGE	0.029	0.097	-0.014
INSUR	-0.073	-0.180	0.008
COMPUTER	0.063	0.037	0.046
NOTHER	0.031	0.095	-0.011
NOPLAN	0.010	-0.129	0.068

[22] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. It is a measure of goodness of fit, restricted to lie between 0 and 1. This measure does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

[23] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

The second comparison involved identifying producer and production characteristics that differentiated group two farmers from group three. The variables that were positively associated with the membership in group two relative to group three were total tillable acres (TILAC), number of full-time persons (FULPER) working on the farm and holding crop insurance every year (INSUR). The marginal probabilities of FULPER and INSUR belonging to group two membership relative to group three decreased by 0.14 and 0.18, respectively (Table 20). Education level (EDCAT) and computer use for farm management and/or record keeping purposes (COMPUTER) variables were negatively associated with group two membership relative to group three.

The last comparison involved identifying producer and production characteristics that differentiated group one farmers from group two. The variables that were positively associated with the membership in group one relative to group three were pre-scheduled herd health visits by veterinarian (VISIT), soil testing (SOIL), net farm income (NFINC) and computer use for farm management and/or record keeping purposes (COMPUTER). The variables that were negatively associated with membership in group one relative to group two were age of the owner/operator (AGE) and type of flooring in the weaner and/or finishing area (FLOOR). These results suggest that older farmers and farmers with cement floors are less likely to rank tax benefits as their 1st or 2nd most important factor.

5.0 Summary

This paper has examined the reasons why Ontario hog producers adopt new technologies. Approximately 40 percent of a random survey of Ontario hog farmers cited increased profitability as the most important reason for adopting new technology. The cost of new technology and an improvement in production efficiency were the most important adoption factors for approximately 20 percent of the farmers. However, the response percentages for these two factors differ significantly when the second and third most important choice was included in the rankings.

Improved production efficiency was more frequently cited than technology and as the second or third most useful factor affecting adoption suggesting it plays a strong supporting role while those farmers who find costs to be important tend to view them as their primary adoption decision. The rankings of the technology adoption factors were affected by socio-economic variables. Larger farms operated by younger and better educated farmers were more likely to cite increased profitability as their most important technology adoption criterion whereas smaller operations, older farmers and those who had not completed high school found production efficiency of use and use by other producers as relatively more important adoption factors. The large difference in the proportion of new entrants who use cost as the major determinant of technology adoption relative to established producers could be due to credit constraints.

The variables affecting the relative rankings of each factor for an individual farmer were analyzed using multinomial logit. Large farms specializing in swine and those with a high debt to asset ratio were more likely to rank profitability as one of the most important criterion. In contrast, keeping records for taxes only, cement flooring and the number of educational meetings attended were all found to be negatively associated with the probability of ranking profitability high in their adoption decision. Attending educational meetings was found to be positively associated with the probability of ranking increased production efficiency as an important factor in technology adoption while holding crop insurance had a negative effect. Younger farmers and those leasing equipment were more likely to rank cost of new technology highly in their adoption decision. The importance of grant availability increased with the age of the producer and the education level while decreasing with farm size. The use of cement flooring was negatively associated with the ranking of the technology's ease of use in the adoption decision while pen washing and record keeping for tax purposes only had a positive impact. Farmers who take out crop insurance every year were more likely to highly rank use by other farmers when evaluating new technology which is consistent with their risk averse behaviour.

Table 16. Polytomous Logit Model of Use by Other Farmers[24].

VARIABLE	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
	B	SE	B	SE	B	SE
CONSTANT	-3.154	2.414	-1.404	0.899	-1.749	2.499
T_1	-18.632	3226.497	0.080	0.415	-18.712	3226.497
AGE	-1.934	1.590	-0.340	0.503*	-1.594	1.637
EDUCAT	-1.655	1.079	0.830	0.383	-2.485	1.116**
FLOOR	-0.833	1.130	0.130	0.353	-0.964	1.162
WASH	-1.045	1.061	-0.658	0.371*	-0.388	1.108
PIGTIME[25]	-2.684	1.425*	-0.325	0.425	-2.359	1.471*
VISIT	0.967	1.047	0.816	0.397**	0.151	1.080
SOIL	-0.751	0.968	0.434	0.352	-1.185	0.999
ACCOUNT	-0.362	0.886	-0.347	0.324	-0.015	0.920
NFINC	1.537	0.887*	-0.045	0.352	1.583	0.927*
OWNER	-1.299	1.099	-0.411	0.472	-0.889	1.129
REASON	0.902	0.772	-0.217	0.342	1.119	0.828
TILAC	-0.0004	0.003	-0.002	0.001**	0.002	0.003
MEET	0.141	0.108	0.008	0.041	0.133	0.113
OWNING	0.089	0.070	0.017	0.023	0.073	0.072
LEASE	-16.186	4294.339	0.701	0.488	-16.887	4294.339
FULPER	-0.736	0.607	0.379	0.198	-1.114	0.625*
PERPIG	0.096	0.182	-0.038	0.068	0.133	0.191
DAR	-1.823	2.164	-0.453	0.573	-1.371	2.209
HEDGE	-16.341	4216.073	0.670	0.521	-17.011	4216.073
INSUR	1.924	1.032*	-0.042	0.341	1.967	1.069*
COMPUTER	-0.265	1.376	-0.185	0.394	-0.079	1.407
NOTHER	1.117	0.869	-0.164	0.330	1.281	0.901
NOPLAN	1.391	1.209	0.876	0.414	0.515	1.237
N			313			
LOG LIKELIHOOD			-172.438			
MODEL CHI-SQUARE			78.572			
PSEUDO R-SQUARE[26]			0.201			

[24] Adoption factor groups are: 1=1st & 2nd most important, 2=3rd, 4th & 5th most important and 3=6th, 7th & 8th most important.

[25] Single, double and triple asterisk means significant at the 10%, 5% and 1% level.

[26] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. It is a measure of goodness of fit, restricted to lie between 0 and 1. This measure does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

Table 17. Marginal Probabilities[27] Associated with Use by Other Farmers.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	-0.0003	0.012	-0.0003
AGE	-0.00003	-0.053	-0.00003
EDUCAT	-0.00003	0.129	-0.00004
FLOOR	-0.00001	0.203	-0.00001
WASH	-0.00002	-0.103	-0.000007
PIGTIME	-0.00005	-0.051	-0.00004
VISIT	0.00002	0.127	0.000003
SOIL	-0.00001	0.068	-0.00002
ACCOUNT	-0.000006	-0.054	-0.0000003
NFINC	0.00003	-0.007	0.00003
OWNER	-0.00002	-0.064	-0.00001
REASON	0.00001	-0.034	0.00002
TILAC	-0.000000007	-0.0004	0.00000003
MEET	0.000002	0.001	0.000002
OWNING	0.000002	0.003	0.000001
LEASE	-0.0003	0.109	-0.0003
FULPER	-0.00001	0.059	-0.00002
PERPIG	0.000002	-0.006	-0.00000
DAR	-0.00003	-0.071	0.00002
HEDGE	-0.0003	0.104	-0.0003
INSUR	0.00003	-0.006	-0.00003
COMPUTER	-0.000005	-0.029	0.00000
NOTHER	0.00002	-0.026	-0.00002
NOPLAN	0.00002	0.137	0.000009

[27] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

Table 18. Polytomous Logit Model of Tax Benefits[28].

VARIABLE	$\ln(P_1/P_3)$		$\ln(P_2/P_3)$		$\ln(P_1/P_2)$	
	B	SE	B	SE	B	SE
CONSTANT	-22.477	4273.063	-2.822	0.94***	-19.655	4273.063
T_1	0.994	1.191	0.201	0.472	0.792	1.240
AGE	-3.300	1.949*[29]	0.558	0.508	-3.859	1.979**
EDUCAT	-2.292	1.333*	-1.125	0.38***	-1.167	1.372
FLOOR	-1.464	1.096	0.438	0.378	-1.902	1.134*
WASH	-0.608	1.085	-0.073	0.363	-0.535	1.115
PIGTIME	0.028	1.352	0.515	0.434	-0.487	1.379
VISIT	2.285	1.188*	0.130	0.469	2.156	1.243*
SOIL	2.857	1.22***	0.469	0.372	2.389	1.250*
ACCOUNT	-0.345	1.019	-0.263	0.343	-0.828	1.049
NFINC	1.784	1.068*	-0.112	0.363	1.895	1.099*
OWNER	17.145	4273.062	0.329	0.544	16.819	4273.062
REASON	0.543	1.191	0.296	0.334	0.158	1.222
TILAC	0.002	0.003	0.003	0.001**	-0.324	0.003
MEET	-0.195	0.176	0.013	0.049	-0.208	0.180
OWNING	0.913	0.088	-0.011	0.024	0.102	0.089
LEASE	1.460	1.711	-0.197	0.562	1.657	1.766
FULPER	-0.431	0.709	0.385	0.199*	-0.816	0.721
PERPIG	-1.133	0.204	0.007	0.070	-0.139	0.209
DAR	-1.446	2.192	-0.819	0.683	-0.627	2.258
HEDGE	1.538	1.378	-0.699	0.724	2.238	1.508
INSUR	1.782	1.069*	0.802	0.373**	0.979	1.109
COMPUTER	1.592	1.211	-1.425	0.58***	3.017	1.323**
NOTHER	-0.168	1.027	-0.034	0.342	-0.134	1.053
NOPLAN	-1.426	1.451	0.637	0.455	-2.063	1.491
N			312			
LOG LIKELIHOOD			-151.490			
MODEL CHI-SQUARE			85.667			
PSEUDO R-SQUARE[30]			0.215			

[28] Adoption factor groups are: 1=1st & 2nd most important, 2=3rd, 4th & 5th most important and 3=6th, 7th & 8th most important.

[29] Single, double and triple asterisk means significant at the 10%, 5% and 1% level.

[30] Pseudo R-square is calculated as $R^2=C/(N+C)$, where C is the chi-squared statistic and N is the sample size. It is a measure of goodness of fit, restricted to lie between 0 and 1. This measure does not incorporate an adjustment for the number of degrees of freedom (Aldrich and Nelson, p.57).

Table 19. Marginal Probabilities[31] Associated with Tax Benefits.

INDEPENDENT VARIABLE	$\ln(P_1/P_3)$	$\ln(P_2/P_3)$	$\ln(P_1/P_2)$
T_1	0.0004	0.025	0.0004
AGE	-0.0001	0.069	-0.002
EDUCAT	-0.001	-0.139	-0.0005
FLOOR	-0.0006	0.054	-0.0008
WASH	-0.0003	-0.009	-0.0002
PIGTIME	0.00001	0.064	-0.0002
VISIT	0.001	0.016	0.001
SOIL	0.001	0.058	0.001
ACCOUNT	-0.0002	-0.032	-0.00004
NFINC	0.0008	-0.014	0.0008
OWNER	0.008	0.041	0.008
REASON	0.0002	0.037	0.00007
TILAC	0.00000	0.0003	-0.00000
MEET	-0.00009	0.002	-0.00009
OWNING	0.00004	-0.001	0.00005
LEASE	0.0006	-0.024	0.0007
FULPER	-0.0002	0.048	-0.0004
PERPIG	-0.00006	0.0008	-0.00006
DAR	-0.0006	-0.101	-0.0003
HEDGE	0.0007	-0.086	0.001
INSUR	0.0008	0.099	0.0004
COMPUTER	0.0007	-0.176	0.001
NOTHER	-0.00008	-0.004	-0.00006
NOPLAN	-0.0006	0.079	-0.0009

[31] This is the derivative of the function with respect to the named independent variable evaluated with all other variables at their mean (Maddala, p.23).

The study has two major implications for research and policy. The first is that part of the popular treadmill theory of technology adoption in agriculture does not appear to be supported by this study. The use by other farmers is the major determination for only 2 percent of the farmers and its relative importance increases for educated farmers who pre-scheduled herd health visits and participate in government programs rather than producers who are slow to adopt recommended practices as suggested by the treadmill theory. The second is that the development and presentation of extension packages must be tailored to individual producers. If a new practice is perceived to be beneficial to a producer, faster adoption and better use may be encouraged by examining the reasons behind the producer's adoption decision. For example, an older producers will b more receptive if the technology's ease of use and acceptance by other famrers is emphasized whereas a younger producer is more concerned with the economic consequences of the new technology.

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