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FARMERS' DECISION PROCESSES AND ADOPTION OF CONSERVATION TILLAGE

by

John Westra and Kent Olson

DEPARTMENT OF APPLIED ECONOMICS
COLLEGE OF AGRICULTURAL, FOOD, AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF MINNESOTA

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ABSTRACT

In a transect survey of crop residue levels in 1995 and 1996, two Minnesota counties had very different percentages of cropland with desired residue cover even though the soil types were similar. To gain a better understanding of the reasons behind this difference, the farmers in these two counties were surveyed about their use or lack of use of conservation tillage practices. A statistical logit analysis of survey responses showed farmers are more apt to adopt conservation tillage if they are larger; are more concerned about erosion on their land; have made a recent major investment in the farm; use other producers for tillage information; have the management skill for conservation tillage; and believe conservation tillage will fit with their production goals and the physical setting of their farm. Two counterintuitive findings are the negative effects of the ease of finding information and the degree of control of the adoption decision. The costs and labor requirements of conservation tillage were important but not as statistically significant as those factors just listed. Some variables, that are often listed as potentially important factors, were not found to be important in this survey. These included the long-term viability of the farm; the age, education, and experience of the farmer; the debt level of the farm; whether a family member wanted to continue farming; the proportion of land rented; the use of other sources for tillage information; the complexity of conservation tillage practices; the producer’s planning horizon; the risk of negative returns; the availability of support for conservation tillage systems; and the quality of conservation tillage information.

FARMERS' DECISION PROCESSES AND ADOPTION OF CONSERVATION TILLAGE[1]

John Westra and Kent Olson[2]

Transect surveys in Scott and Le Sueur Counties in east-central Minnesota indicate considerable differences in the amount of cropland that meets residue management targets of the Minnesota River Assessment Project (MPCA). These targets are corn planted into at least 15% crop residue and soybeans planted into at least 30% crop residue. Although adoption of conservation tillage is not universal in either county, just over 20% of surveyed cropland in Scott County met residue management targets and over 50% of surveyed cropland in Le Sueur County met these target in 1995. The transect survey in 1996 again showed a large difference in the percent of cropland meeting residue targets: 44% in Scott County and 73% in Le Sueur County.

Since conservation tillage practices are one of the major ways farmers meet residue targets, the objective of this study was to find the important factors affecting farmers' use or nonuse of these practices. To accomplish this, we surveyed farmers in these two counties about their tillage practices and the factors that may affect their decisions. After a brief discussion of farmers' decision processes, the procedures used to survey the farmers and analyze data are

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[1]This paper is part of the project, Farmers' Decisions Regarding Management and Technology Choices, funded by the Twin Cities Water Quality Initiative of the Metropolitan Council.

[2]Westra is a graduate research assistant and Olson is an associate professor in the Department of Applied Economics, University of Minnesota, St. Paul.

presented. This is followed by a descriptive analysis of the survey results, the estimated predictive models, and our concluding comments.

FARMERS' DECISION PROCESSES

Previous farm management research in economics has concentrated on how farmers should make decisions or on what they should do. However, we know little about how farmers actually make decisions. The Interstate Managerial Study by Johnson et al. (1961) is one of the few studies of how farmers make decisions. Orasanu and Connolly (1993) claim most research on decision making has focused on the decision event, not the process. Johnson (1987) argues the concept of expected utility has been emphasized to the neglect of other aspects of optimization, such as problem definition, learning, analysis, other decision making rules, etc. This lack of knowledge about "how" may be one reason that management information, services, and tools are not being used by farmers to the extent expected (e.g., Batte, Jones and Schnitkey 1990; Putler and Zilberman 1988; Davis, Bagozzi and Warshaw 1989; Brunsson 1985; Brytting 1990; Johannisson 1992). This same lack of knowledge causes problems when supplying information to farmers, developing management assistance, and developing new technologies to reach goals such as reducing non-point source (NPS) pollution. Nowak (1992) points this out specifically when he concludes:

> Unless we begin to spend more time and effort trying to understand all of the complex reasons why farmers are unable or unwilling to adopt new production techniques, our aspirations for wide scale adoption of residue management systems are destined to fail. (p. 16)

For profit-maximizing producers, standard neo-classical economic theory emphasizes that risk, financial, and scale factors usually are considered the most critical issues in technology adoption decisions. A producer will use a production practice if its benefits exceed its costs. Producers with larger operations are likely to attain higher benefits from a given technology adoption decision when capital investment is required. Thus, if rational producers maximize profits, a technology or production practice that has been demonstrated to be profitable presumably would be widely adopted by producers.

However, this is not always the case. For example, Olson and Senjem (1996) show high-residue tillage systems to be more profitable than current practices. Yet these practices are not adopted widely, even though they would be expected to reduce sedimentation and other NPS pollution. This raises the question of why adoption rates of conservation tillage in Minnesota vary widely across the state, even in areas that are similar geographically and agroclimatically.

Nowak (1992) suggests producers do not adopt production technologies such as conservation tillage because they either are unable or unwilling to do so. Ability or willingness to adopt production technology in Nowak's paradigm is not limited to economic factors (costs or scale, for example). A rational producer will not adopt a technology when there is some obstacle or situation preventing the producer from doing so. Reasons for this inability to adopt include: a lack of information; high cost (be it measured in time, expense, or difficulty) of obtaining information; too complex a system; too expensive or costly; excessive labor required; a planning horizon that is too short; limited, inaccessible, or unavailable support system or resources; inadequate management skills; and limited control over adoption decision. Some producers may not have been convinced a production technology (e.g., conservation tillage) is appropriate or will work for their farming system. Nowak identifies these factors of producers unwilling to adopt: inconsistent or conflicting information; irrelevant or inapplicable information (especially locally); new technology and farmer's production goals do not fit well; ignorance of the technology; technology is inappropriate to the farm's physical setting; production practice increases the risk of negative outcomes. Nowak describes why farmers do not adopt a production technology, but he does not present any test of these factors. As a result, we do not know if these factors are equally important, or if, as one would suspect, some are more important than others in determining adoption for a group of producers in a particular region.

SURVEY DEVELOPMENT AND THE ANALYTICAL MODEL

The farmers in Scott and Le Sueur Counties were surveyed about their views and knowledge of conservation tillage and about how they make decisions: what they consider when making a decision, with whom they talk, what values they have concerning their farm and their life, what goals they are striving for, etc. Demographic items (age, experience, gender, education, etc.) were included on the survey. Economic factors and non-economic items were included in the survey--items Nowak suggests as well as items we gathered from conversations with producers and extension people before writing the survey. A sample cover letter and the survey are in Appendix A.

An example of a survey question designed to elicit a rating for one of Nowak's ability factors is:

> "Please place an X anywhere along the line to indicate what you think about the topic compared to the two extremes at either end of the line."

Obtaining information on conservation tillage is:

difficult [---------|---------|---------|---------] easy
10--------20--------30--------40--------50

The numbers beneath the line are not present in the survey. They are presented here to illustrate how an X placed on the line would be translated to a number score for that factor (on a range of 10 to 50).

Following Dillman (1978), the survey was mailed to 1,474 producers in the two counties that Minnesota Agricultural Statistics Service (MNASS) had in their database for these two counties. This was followed-up with a post card two weeks later to remind all producers to return their completed surveys. After an additional two weeks, nonrespondents were mailed another survey and cover letter. Two weeks later, any remaining nonrespondents were contacted by MNASS staff who administered a slightly modified version of the survey over the phone.

Roughly one-half (47%) of survey responses were usable in both counties (Table 1). Many surveys were not useable since this was the first time MNASS had surveyed their entire sample frame for both counties. The "not usable" group primarily consisted of deceased producers (2% of total surveyed), whole farm in Conservation Reserve Program (CRP) (6%), no longer farming (18%), incomplete survey (4%), inaccessible (8%), or refused to answer (15%). The only difference between the two counties in terms of non-usable surveys was the CRP category--2% of producers surveyed in Scott County had their whole farm in CRP, in Le Sueur County, 9% were in CRP. Of all usable surveys 42% were from Scott County and 58% were from Le Sueur.

In the analysis that follows, only the last three conservation tillage response categories are used: know of it but rejected, tried and rejected, and currently using. Considering only these three categories, 18% of producers from both counties (i.e., 50+56=106 producers) know of conservation tillage but rejected it, 11% tried and rejected it, and 71% currently are using it. (The distribution within the two counties is similar to the combined distribution described above). For the analysis, the first two categories were combined to form the non-user group of producers (29% of producers), while the user group consisted solely of producers currently using conservation tillage (71% of producers).

For the analysis, a logit model was used to investigate the relationship between the response probability (that is, membership in one of the two groups being analyzed: current users of conservation tillage and producers who investigated or tried conservation tillage but are not current users) and several independent, explanatory variables. The linear logistic model is of the more general form:

$$\text{logit}(p) = \log(p/(1-p)) = \alpha + \boldsymbol{\beta}'\mathbf{x}$$

where α is the intercept parameter, $\mathbf{x}$ is a vector of independent variables, and $\boldsymbol{\beta}$ is a vector of regression parameters. The Maximum Likelihood Estimates (MLEs) of the regression parameters are calculated via the Iteratively Reweighted Least Squares (IRLS) algorithm.

Using the parameter estimates from a model comparing users and nonusers of conservation tillage, for example, we are able to calculate the estimated logit of the probability of membership in the conservation tillage group. In this example, probability (p) of membership in the conservation tillage group was derived by:

$$p = e^{\text{logit}(p)}/(1 + e^{\text{logit}(p)})$$

For the linear logistic model, coefficients of parameter estimates can be interpreted as influencing the probability of membership in the group of producers using conservation tillage. Negative coefficients reduced the probability a producer would be using conservation tillage while positive coefficients increased that probability.

Five logit models are presented and analyzed in this study: Base, Economic, Nowak, A Priori, and Final. These models contain different sets of variables describing farm and farmer characteristics. The appropriateness of the models are evaluated on the basis of explanatory power and the "correctness" of the estimated coefficients.

The "Base" model contains sets of factors or variables that may influence the adoption of conservation tillage. These sets include elements related to the farm itself, characteristics of the producer, ability factors, and willingness factors. The other models examined contained subsets of these factors based on economics; Nowak's discussion; a priori discussion with farmers, agency employees, and other people close to the conservation tillage technology; and a final selection of those factors which were found to be important in the previous models.

The "Economic" model contains variables considered influential only if economic factors are relevant to the producer when deciding to adopt conservation tillage; these consist of cost, scale, and risk factors. Testing this model against the "Base" model would help determine if economic factors alone are critical to conservation tillage adoption.

The "Nowak" model contains only those factors described by Nowak in his article. This model may shed some light on the relative importance of the ability and willingness factors Nowak described. A test of this model against the "Base" model would help us understand the importance of ability and willingness factors alone (exclusive of farm or producer characteristics) in explaining adoption of conservation tillage.

The "A Priori" model contains select Nowak factors as well as the farm and producer factors identified (before distributing the survey) as possibly explaining differences in adoption rates. Testing this model against the "Base" would be an indication of the importance of all farm and producer characteristics and select Nowak factors relative to all identified factors.

The "Final" model is a refined version of the "Base" model as it includes selected factors significant in the other three models. By comparing this model with the "Base" model we may test the importance of selected factors as opposed to all identified factors in distinguishing users from non-users.

RESULTS

The survey responses are analyzed in three ways in this section. First, the differences between the two counties are noted using descriptive statistics. Second, as a preliminary view of the importance of various variables, descriptive statistics are used to find differences between users and nonusers of conservation tillage. Third, logit analysis is used to show which variables are important in explaining whether a farmer uses of does not use conservation tillage. For this analysis, a subset of the survey variables is used (Table 2). A complete listing of the variables from the survey is in Appendix B.

County Differences

Farms in Le Sueur County are significantly larger than those of Scott County (ACRES; Table 3). However, the survey shows no difference in debt level (FARMDEBT), perception of farmers to control long-term viability (VIABLTY), years of farming experience (FARMEXP), employment of full-time workers (FTEMPLOY), perception of labor requirements for conservation tillage (LABOREQ), and perception of increased negative risk from conservation tillage (NEGRISK) between Scott and Le Sueur counties. Additionally, though the producers in Le Sueur County consider conservation tillage to be more costly than farmers of Scott County (COSTSCT), the 1996 transect survey shows more cropland in Le Sueur County (73%) is meeting target levels for residue management than Scott County (44%). Overall physical conditions would not appear to be a factor as both counties are on the east side of the Minnesota River and have similar soil types and agro-climatic conditions (PHYSICL). Similarly, erosion does not appear to be a distinguishing factor of the two counties (EROSION).

Apparently, factors other than economic and physical are influencing adoption of conservation tillage in these two counties of Minnesota. Geographical location may be a factor; Scott County is situated in the southwest corner of the Minneapolis/St. Paul metro area and Le Sueur County is located just south of Scott County. Since it is closer to the metropolitan area, Scott County is experiencing greater development pressure than Le Sueur County. Because of these development pressures, producers in Scott County may have less incentive to adopt production technology such as conservation tillage. Evidence of this may be that producers in Scott County are less likely to have a family member farming their farm in the future

(FAMCONT), are less likely to have made recent major investments in their farming operation (MAJINVST), and have a shorter planning horizon (PLANHZN).

Another element contributing to differences in adoption rates in the two counties may be that producers in Le Sueur County appear to be more quantitative in nature (ESTNFIN) than those in Scott County. However, when producers have more control (CONTROL) over the adoption decision, as they appear to do in Scott County, they are less likely to adopt it.

Finally, as Nowak and others have indicated, information may play a crucial role in any adoption decision. Le Sueur County producers are much more likely to use other farmers as a primary source of information on conservation tillage than Scott County producers (FARMERS). Counterintuitively, producers in Scott County indicated information on conservation tillage was easier to obtain (OBTINFO), was less complex (COMPLXT), and was more consistent and reliable (QUALINF) than those in Le Sueur. This may be due to differences in the way information on conservation tillage is disseminated by various parties (extension service, state agencies, implement dealers, etc.) or received by farmers in the two counties. Alternatively, it may be a situation in which it is easy to obtain information on conservation tillage that consistently is negative; yet it may be more difficult to obtain consistent information about residue management applicable to a specific individual's operation.

User-nonuser Differences

The farms of conservation tillage users have more cropland (ACRES), are more likely to employ at least one full-time employee (FTEMPLOY), have had a recent major investment made (MAJINVST), and have erosion as more of a perceived problem (EROSION) than farms of non-users. The producers who use conservation tillage are more likely to be quantitative in nature (ESTNFIN), have someone willing to continue farming the farm (FAMCONT), and use other producers as a primary source of information on conservation tillage (FARMERS) than non-users.

There were significant difference in several factors Nowak described as affecting a producer's ability to adopt conservation tillage. Users of conservation tillage indicated the practices or systems were less complex (COMPLXT), more economical (COSTSCT), and more labor-saving (LABOREQ) than those producers not using conservation tillage. Conservation tillage users also had a longer planning horizon (PLANHZN) and had more adequate conservation tillage management skill (MNGMSKL) than did non users.

All five of Nowak's willingness factors are significantly different between users and non-users in this sampled population. Conservation tillage users were more likely to view information on conservation tillage as being reliable and consistent (QUALINF) and more relevant to their farm (RELEVNC) than non-users. Additionally, conservation tillage fits in better with the production goals (PRDGOAL) and the physical setting of the farms (PHYSICL) of users than non-users. Finally, users are more likely to view conservation tillage as decreasing the risk of negative outcomes (NEGRISK) than non-users.

Logit Analysis

To determine the importance of the factors in determining use of conservation tillage, five logit models were estimated. The significance of the coefficients for each factor show if that factor explains the probability that a farmer will use or not use conservation tillage. Even though the means of some factors for users and nonusers are significantly different, these factors may not be as important as others in distinguishing between users and nonusers. The logit analysis helps determine which are important.

For the “Base” model, factors associated with a significant ($p<0.1$) increase in the probability of membership in the conservation tillage user’s group are: the size of the farm (ACRES), erosion being perceived as a serious problem for a producer’s farm (EROSION), having recently made a major investment for the farming operation (MAJINVST), using other producers as a primary source of information on conservation tillage (FARMERS) (Table 4).

As described previously, the descriptive statistics showed some significant differences in characteristics of producers in the two counties sampled, however, including COUNTY by itself was not significantly important in distinguishing users from non-users. Ability factors that significantly increased the probability a producer used conservation tillage for the “Base” model were: viewing conservation tillage as labor saving (LABOREQ) and having the relevant management skills (MNGMSKL). One ability factor significantly decreased the probability a farmer used conservation tillage and that was control over the decision to adopt (CONTROL). Thus, the more producers felt they had control over the decision to adopt conservation tillage, the less likely they were to adopt. Two willingness factors increased the likelihood a producer used conservation tillage--the more conservation tillage fit within the farmer’s production goals (PRDGOAL) or was more appropriate to the farm’s physical setting (PHYSICL), the more likely producers were to adopt it. All other variables did not significantly ($p>0.1$) improve the model’s ability to predict membership in the group of conservation tillage users.

For the “Economic” model, three factors significantly increased the probability a producer was a conservation tillage user. As farm size (ACRES) increased likelihood of adoption increased. Producers who viewed conservation tillage as less costly (COSTSCT) were more apt to adopt it. Finally, the more farmers perceived the risk of negative outcomes from adoption as decreasing (NEGRISK) the more likely they were to adopt it.

On the basis of the log-likelihood ratios (LR), the “Base” model does significantly better at explaining differences between users and non-users (i.e., probability of membership in the user group) than the “Economic” model. Apparently, economic factors alone do not explain the different rates of adoption in conservation tillage.

The “Nowak” model only contained ability and willing factors that Nowak identified as influencing adoption of conservation tillage. Results of this model indicate that as producers feel they have more relevant management skills (MNGMSKL) the probability they will use conservation tillage increases. Counterintuitively, as the CONTROL over the decision to adopt conservation tillage increases the probability producers will do so decreases. However, the more conservation tillage fits with producer's production goals (PRDGOAL) and the farm's physical setting (PHYSICL) the more likely producers will adopt it.

On comparing the log-likelihood ratios, the “Nowak” model does a much better job at explaining membership in the group of conservation tillage users than does the “Economic” model. However, as with the “Economic” model, the “Nowak” model does not explain as well as the “Base” model the differences in rates of adoption of conservation tillage. Thus, factors other than ability and willingness prevent producers from adopting (or encourage them to adopt) conservation tillage practices.

The “A Priori” model includes farm, producer, and select ability and willing factors that may influence adoption of conservation tillage. For this model as in the base model, larger farm size (ACRES) and higher concern for erosion (EROSION) are associated with greater adoption of conservation tillage. If producers made a major investment in their farm in the last five years (MAJINVST) they were more likely to have adopted conservation tillage. Farmers who use other farmers as a primary source of information on conservation tillage (FARMERS) are more likely to adopted it. Producers who viewed conservation tillage as less costly (COSTSCT) were more apt to adopt it. The more conservation tillage fit with producer's production goals (PRDGOAL) the more likely producers adopted it. The more farmer's perceived the risk of negative outcomes from adoption as decreasing (NEGRISK) the more likely they were to adopt.

Even though the “A Priori” model is better than the “Economic” model at predicting whether a producer uses conservation tillage (using the log-likelihood ratio), it is not significantly different from the “Nowak” model. As with the “Economic” and “Nowak” models, the “A Priori” model does not explain as well as the “Base” model the differences in rates of adoption of conservation tillage (comparing the log-likelihood ratio). Thus, the selected factors assumed a priori to affect technology adoption decisions were not better at predicting use of conservation tillage than the complete set of factors (“Base” model).

For the “Final” model, we included farm, producer, ability and willing factors that most influenced adoption of conservation tillage in the previous models. As in preceding models, as farm size (ACRES) or concern for erosion (EROSION) increased adoption likelihood increased. If producers made a major investment in their farm in the last five years (MAJINVST), they were more likely to have adopted conservation tillage. If farmers used other farmers as a primary source of information on conservation tillage (FARMERS), they were more likely to have adopted it. As producers feel they have more relevant management skills (MNGMSKL) the probability they will use conservation tillage increases. The more conservation tillage fits with producer's production goals (PRDGOAL) and the farm's physical setting (PHYSICL) the more likely producers will be using it. Paradoxically, the easier producers obtained information on conservation tillage (OBTINFO) or the more control producers felt they have over the adoption decision (CONTROL) the less likely they were to adopt it.

To help interpret the results of the “Final” model (as well as any other model from this analysis), the probabilities that two hypothetical producers use conservation tillage are calcualted using the averages for user and non-users. By doing this we can see how certain characteristics are associated with membership in either group and how they contribute to the probability of membership in the user group. The coefficients of each factor in the estimated “Final” model (from Table 4) are multiplied by the corresponding average values for user and non-user (from Table 3) and then summed to determine the logit (p) (Table 5). The probability is calculated from the logit (p) as described above in the Model section. Based on the “Final” model, the average user has a probability of 0.94 of using conservation tillage; the average non-user, 0.30.

CONCLUDING COMMENTS

What factors influence adoption of conservation tillage? Neither exclusively economic factors nor exclusively ability and willingness factors predict whether or not a producer will adopt conservation tillage practices. This analysis shows a combination of economic, ability, and willingness factors, as well as some characteristics of the farm and the producer, are the most critical factors in an adoption decision.

In two counties in east-central Minnesota, farmers are more apt to adopt conservation tillage if they have larger farms; they are more concerned about erosion on their land; they have made a recent major farm investment; they use other farmers as a primary source of information on conservation tillage; they have the management skills for conservation tillage; they believe conservation tillage fits with their production goals and the physical setting of their farm.

Two counter-intuitive findings are the negative effects on adoption from the ease of finding information and the degree of control of the decision. The first negative effect may be related to the relative difficulty of obtaining specific conservation tillage information relevant to a particular producers situation that some producers expressed when interviewed. Alternatively, for a nonuser of conservation tillage, it may have been easier to find information validating their reservations about the usefulness of conservation tillage to their situation. The second negative effect may have to do with participation in commodity programs in which producers are required to be in compliance with certain conservation provisions to be eligible for program payments. However, producers do have control over the decision to participate or not in the commodity programs. No questions were asked directly regarding participation in commodity programs. When discussing these results with farmers in Le Sueur County, they cautioned against reading too much into this second negative effect; they felt it may be a spurious result.

Some variables, that are often listed as potentially important factors, were found to be not significant ($p>0.1$) in this analysis. These included the long-term viability of the farm, the age and experience of the farmer, the debt level of the farm, the availability and ease of obtaining information on conservation tillage practices, and the availability of support for conservation tillage systems. These may be important factors for some farmers; however, for this population of farmers, they may be necessary but not sufficient for adoption. For example, the level of support for conservation tillage is most likely checked by farmers, but the deciding factors are farm size, how important erosion is on their farm, recent major investments, their management skills, how well it fits with their production goals and farms' setting, and whether or not another producer recommended trying this new technology.

Table 1. Survey and Conservation Tillage Response Rate by County

	County	
	Scott	Le Sueur
Surveys:		
Not usable	336	450
Usable	290	398
Total	626	848
Conservation tillage response:		
No response	6	3
Know nothing of it	46	48
Know of it but rejected	50	56
Tried and rejected	22	39
Currently using	166	252
Total	290	398

Table 2.   Description of Variables Used in Analysis

Variable	Description	Measure
COUNTY[f]	county in which farm located	Le Sueur=0 Scott=1
ACRES[f]	acres of cropland (not pasture) in 1996	numerical
FTEMPLOY[f]	at least one full-time employee	no/yes
EROSION[f]	soil erosion on farm (non-issue - important issue)	10-50
MAJINVST[f]	major investment to expand farm in last five years	no/yes
FARMDEBT[f]	farm debt level exceeds 40% total farm value	no/yes
VIABLTY[f]	actions affecting farm's long-term viability (other's - my own)	10-50
FARMEXP[p]	years of farming experience	numerical
ESTNFIN[p]	estimate next year's farm finances	no/yes
FAMCONT[p]	family will continue farming the farm	no/yes
FARMERS[p]	other farmers as primary source of conservation tillage information	no/yes
QNTINFO[a]	quantity of information (none - all needed)	10-50
OBTINFO[a]	obtaining information (difficult - easy)	10-50
COMPLXT[a]	complexity of information (complex - simple)	10-50
COSTSCT[a]	cost of practices (costly - economical)	10-50
LABOREQ[a]	labor requirements (labor-intensive - labor-saving)	10-50
PLANHZN[a]	farmer's planning horizon (short - long)	10-50
SUPPORT[a]	support resources (limited - widely-available)	10-50
MNGMSKL[a]	farmer's conservation tillage management skills (inadequate - sufficient)	10-50
CONTROL[a]	control over adoption decision (no control - complete)	10-50
QUALINF[w]	quality of information (inconsistent - consistent)	10-50
RELEVNC[w]	relevance of information (not relevant - relevant)	10-50
PRDGOAL[w]	production goals and conservation tillage (do not fit - completely fit)	10-50
PHYSICL[w]	farm's physical setting and conservation tillage (inappropriate - appropriate)	10-50
NEGRISK[w]	risk of negative outcomes with conservation tillage (increases - decreases)	10-50

[f] These are factors associated with the FARM.

[p] These are factors associated with the PRODUCER.

[a] Nowak describes these as influencing producer's ABILITY to adopt conservation tillage.

[w] Nowak describes these as influencing producer's WILLINGNESS to adopt conservation tillage.

Table 3. Producer Characteristics by Tillage Type and County

Characteristics	Conservation Tillage		County	
	User	Non-User	Scott	Le Sueur
ACRES *#	384.2	165.8	245.4	374.6
FTEMPLOY *	0.2	0.1	0.2	0.2
EROSION *	36.6	26.1	34.0	33.3
MAJINVST *#	1.4	1.3	1.3	1.4
FARMDEBT	1.2	1.2	1.2	1.2
VIABLTY	38.4	38.5	38.2	38.5
FARMEXP	26.7	27.1	25.9	27.4
ESTNFIN *#	1.5	1.3	1.3	1.5
FAMCONT *#	0.7	0.6	0.6	0.7
FARMERS *#	0.3	0.1	0.2	0.3
QNTINFO	38.8	37.8	39.0	38.1
OBTINFO #	39.2	39.1	40.1	38.5
COMPLXT *#	34.0	32.3	35.5	32.2
COSTSCT *#	32.5	26.1	32.9	29.1
LABOREQ *	39.0	36.5	38.7	38.0
PLANHZN *#	36.6	33.4	34.6	36.4
SUPPORT	34.9	33.5	35.2	34.0
MNGMSKL *	38.1	33.2	37.1	36.5
CONTROL #	38.4	38.9	39.7	37.7
QUALINF *#	35.8	34.2	36.2	34.8
RELEVNC *	33.7	26.8	32.2	31.4
PRDGOAL *	34.6	21.8	31.3	30.8
PHYSICL *	38.1	25.5	35.0	34.3
NEGRISK *	30.3	24.1	29.5	28.0

*An asterisks indicates the means of user and non-user were significantly different (p<0.1).
#A pound sign indicates the means of the two counties were significantly different (p<0.1).

Table 4. Results of the Logistic Analysis*

Variable	Base	Economic	Nowak	A Priori	Final
INTERCEPT	-6.806* (1.469)	-3.130* (0.748)	-3.747* (0.987)	-6.682* (1.206)	-6.054* (1.114)
COUNTY	0.076 (0.296)			-0.021 (0.265)	
ACRES	0.003* (0.001)	0.004* (0.001)		0.003* (0.001)	0.003* (0.001)
FTEMPLOY	0.042 (0.430)			0.068 (0.392)	
EROSION	0.043* (0.013)			0.034* (0.011)	0.038* (0.012)
MAJINVST	0.567* (0.343)			0.567* (0.304)	0.515* (0.315)
FARMDEBT	-0.053 (0.408)	0.368 (0.314)		-0.064 (0.368)	
VIABLTY	0.012 (0.015)			-0.005 (0.012)	
FARMEXP	0.004 (0.012)			0.013 (0.011)	
ESTNFIN	0.288 (0.308)			0.248 (0.279)	
FAMCONT	-0.413 (0.301)			-0.201 (0.282)	
FARMERS	0.743* (0.350)			1.066* (0.321)	0.726* (0.334)
QNTINFO	0.004 (0.021)		0.010 (0.019)		
OBTINFO	-0.026 (0.022)		-0.030 (0.021)		-0.031* (0.017)
COMPLXT	-0.010 (0.017)		-0.016 (0.015)		
COSTSCT	0.021 (0.014)	0.035* (0.010)	0.004 (0.013)	0.030* (0.012)	0.018 (0.013)
LABOREQ	0.029* (0.017)	0.010 (0.013)	0.025 (0.017)	0.006 (0.015)	0.023 (0.016)
PLANHZN	0.002 (0.015)		0.018 (0.014)		
SUPPORT	-0.012 (0.019)		-0.005 (0.017)		
MNGMSKL	0.057* (0.016)		0.050* (0.015)		0.051* (0.015)
CONTROL	-0.057* (0.016)		-0.047* (0.014)		-0.056* (0.015)
QUALINF	-0.007 (0.020)		-0.013 (0.018)		
RELEVNC	-0.020 (0.017)		-0.005 (0.015)		
PRDGOAL	0.096* (0.019)		0.107* (0.018)		0.093* (0.017)
PHYSICL	0.055* (0.017)		0.063* (0.015)	0.074* (0.014)	0.053* (0.016)
NEGRISK	0.016 (0.016)	0.055* (0.012)	0.004 (0.015)	0.037* (0.014)	
LR	241.86	95.64	185.89	186.58	234.90

*Parameter estimates are presented with standard errors in parens below and an asterisks if significant ($p < 0.1$). The log-likelihood ratio (LR) (a test of joint significance of all model covariates) is significant for all models ($p = 0.0001$).

Table 5 . Example of Predictive Ability of Final Model

Variable	User	Non-User
INTERCEPT	1.0	1.0
ACRES	384.2	165.8
EROSION	36.6	26.1
MAJINVST	1.4	1.3
FARMERS	0.3	0.1
OBTINFO	39.2	39.1
COSTSCT	32.5	26.1
LABOREQ	39.0	36.5
MNGMSKL	38.1	33.2
CONTROL	38.4	38.9
PRDGOAL	34.6	21.8
PHYSICL	38.1	25.5
Logit (p)	2.72	-0.83
Probability	0.94	0.30

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APPENDIX A

Sample Cover Letter and Survey Instrument

August 1996

Dear Operator:

We are interested in your opinions about conservation tillage. Specifically, we want to know why some farmers choose to use conservation tillage and why others do not. The enclosed survey is designed to help us answer these questions.

We will use the results to help improve our understanding of farmers' concerns and how farmers make decisions. Your answers will also help us improve educational programs and policy proposals.

For this survey, let's use the Natural Resources Conservation Service's (NRCS, formerly SCS) definition of conservation tillage. They define conservation tillage as “a tillage system that leaves enough crop residue to adequately protect the soil from erosion throughout the year. The percent of cover required varies by field according to soil type, slope, crop rotation, winter cover crops used and other factors.”

We are cooperating with the Minnesota Agricultural Statistics Service for this survey. They are using their mailing lists and will be compiling your answers. We will receive only a computerized set of data without any names or addresses. We will keep all individual responses confidential and report only statistical information at the group level. The results will be made available through local papers and other local sources.

Please answer the questions for your operation. We think it will take only 15-25 minutes.

Thank you for your help.

Kent Olson
Associate Professor

Dave Resch
Extension Educator

TILLAGE SURVEY

Please answer the questions for your operation. When answering questions, please think of conservation tillage as including, but not limited to: no-till, ridge till, reduced tillage, or mulch tillage. ***All individual responses will be kept strictly confidential.*** Only group information and summarizations will be released.

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101. At any time in the past, have you ever used conservation tillage?
_______ no, I do not know much about conservation tillage
_______ no, I looked into conservation tillage, but decided against it
102. _______ yes, I tried it but quit after _______ years
103. _______ yes, I tried it and still use it after _______ years

104. How many acres of land are you cultivating for crops this year (excluding permanent pasture)?
_______ acres of cropland for 1996

105. Of your cropland, what percentage is under conservation tillage now?
_______ percent of cropland under conservation tillage

106. When you started conservation tillage, did you:
_______rent equipment
_______ custom hire services
_______ purchase equipment without ever having used it first
_______ I never started conservation tillage

107. For conservation tillage on your cropland now, do you:
_______ rent equipment
_______ custom hire services
_______ use your own purchased equipment
_______ I do not use conservation tillage now

For Questions 108-123, please place an X anywhere along the line to indicate what you think about the topic compared to the two extremes at either end of the line.

108. Quantity of information available on conservation tillage practices:

no information available [---------|---------|---------|---------] all the information I need I can get

109. Obtaining information on conservation tillage is:

difficult [---------|---------|---------|---------] easy

110. Complexity of conservation tillage practices or systems:

complex [---------|---------|---------|---------] simple

111. Cost of conservation tillage practices or systems:

costly [---------|---------|---------|---------] economical

112. Labor requirements of conservation tillage practices:

labor-intensive [---------|---------|---------|---------] labor-saving

113. My planning horizon with respect to the general farming operation:

short-term (next week) [---------|---------|---------|---------] long-term (next decade)

114. Availability of support resources for conservation tillage systems:

very limited [---------|---------|---------|---------] widely available

115. My management skills with respect to conservation tillage:

inadequate [---------|---------|---------|---------] sufficient

116. My control over the decision to adopt conservation tillage:

no control [---------|---------|---------|---------] complete

117. My farming operation's long-term viability is influenced by:

other's actions [---------|---------|---------|---------] my own actions

118. Quality of information about conservation tillage:

inconsistent and unreliable [---------|---------|---------|---------] reliable and consistent

119. The relevance of information about conservation tillage to my farm:

not relevant [---------|---------|---------|---------] totally relevant

120. Conservation tillage practices and my current production goals:

do not fit [---------|---------|---------|---------] completely fit

121. To my farm's physical setting, conservation tillage is:

inappropriate [---------|---------|---------|---------] appropriate

122. With conservation tillage, the risk of many negative outcomes:

increases [---------|---------|---------|---------] decreases

123. On my farm, soil erosion is:

not an issue [---------|---------|---------|---------] important issue

If you are currently using conservation tillage, please answer the following questions; if not, please continue with Question 131. For Questions 124 - 130, please try to recall how you felt about the issues *at the time you were thinking about changing to conservation tillage*.

124. I started to consider conservation tillage because:

forced to by government policy [---------|---------|---------|---------] observed erosion was a problem

125. When I began conservation tillage, I expected net farm income to:

decrease [---------|---------|---------|---------] increase

126. For conservation tillage equipment, I was willing to invest:

nothing [---------|---------|---------|---------] anything which was profitable

127. If conservation tillage needed it, I would increase my workload:

not at all [---------|---------|---------|---------] large increase

128. At the time of the change, how important was it to continue farming?

not at all, I was thinking of quitting [---------|---------|---------|---------] very important, I had to continue

129. When you started using conservation tillage, did you make a numerical estimate of the additional investment needed in machinery and equipment?

_______ no
_______ yes

130. Did you make an estimate of how your operating costs would change?

_______ no
_______ yes

131. Do you currently make an annual, quantified estimate of next year's farm income and costs (more than just using last year's figures)?

_______ no
_______ yes

132. In what year were you born?

_______ year

133. In what year did you begin farming?

_______ year

134. What is your sex?

_______ female
_______ male

135. Do you have any family members willing to continue farming your farm?

_______ no
_______ yes
_______ maybe

136. What is the highest level of education you have completed?

_______ grade school
_______ high school or equivalent
_______ trade or technical school
_______ college (bachelor's degree)
_______ graduate or professional school
_______ other (please specify) ____

137. What percentage of your farmland do you rent from others?

_______ percent farmland rented from others

138. In the last five years, have you made major investments to expand your farming operation for farming purposes (not for development potential)?

_______ no
_______ yes

139. Do you estimate your farm debt level to be more than 40% of the total estimated value of your farm business?

_______ no
_______ yes

140. How many employees do you have?

_______ employees

Where do you obtain information to use in your farm decisions? Please check only the TOP 3 sources of information for (1) your entire farm and (2) conservation tillage (check only if you used or considered conservation tillage).

		Entire farm		Conservation tillage
Other farmers	141.	_____	153.	_____
Personal discussion with extension staff	142.	_____	154.	_____
Personal discussion with staff from government agencies such as NRCS, SWCD, DNR	143.	_____	155.	_____
Organized group discussions (such as a ridge till club)	144.	_____	156.	_____
Extension meetings	145.	_____	157.	_____
Custom operators (for conservation tillage)	146.	_____	158.	_____
Private, paid consultants	147.	_____	159.	_____
Equipment dealers or their representatives	148.	_____	160.	_____
Company representatives or sales-force	149.	_____	161.	_____
Promotional literature	150.	_____	162.	_____
Newspapers, magazines, or trade journals	151.	_____	163.	_____
Radio or television	152.	_____	164.	_____

APPENDIX B

The two tables in this appendix present some descriptive statistics of the survey responses. In Table B1, each row represents a particular response to a question of the survey (indicated by the first column). For example, in the first row and the first column (under the column heading "number") is "v101-1" which represents the first response of question or variable 101 of the survey. In the cell to its right is the name "KNOWNOT" which is a mnemonic device to represent that particular response to the question -- in this case the producer who checks the first response to question 101 "knows nothing about conservation tillage." Looking across this row we see the breakdown of producers responding to this question by county (Scott and Le Sueur), conservation tillage category (User, Nonuser, and Other), and all (which is the total of all conservation tillage categories, not county). Note not all producers responded to all questions. Additionally, note that not all questions of the survey are represented in Table B1. Most questions in which the response categories were continuous, such as farm size (acres), are presented in Table B2.

Table B2 has a format similar to that of Table B1 in that the first two columns contain the question (variable) number and name for the row to which they pertain. In Table B2, however, the items in the columns to the right of the variable name contain the mean, standard deviation, and number of observations for each variable, by county, conservation tillage category, and all. Unlike Table B1, the individual possible responses to each question are not presented (i.e., response 1 to question 101, response 2 to question 101, etc.). Instead, all possible responses for each question are used to calculate the mean and standard deviation. As with Table B1, Table B2 does not contain all variables. For example, it would make little sense to present the mean and standard deviation for the question asking for respondent's gender (v134). Finally, there are no data for questions v124 to v130 for non-users and others because they were asked to not answer these questions when completing the survey.

Table B1. Number of Respondents for Survey Question by County and Conservation Tillage Category

Variable		County		Conservation Tillage			
Number	Name	Scott	Le Sueur	User	Non-user	Other	All
v101-1	KNOWNOT	52	51	0	0	103	103
v101-2	LOOKEDAT	50	56	0	106	0	106
v101-3	TRIED	22	39	0	61	0	61
v101-4	USER	166	252	418	0	0	418
v106-1	SCTRENT	29	60	79	10	0	89
v106-2	SCTCUST	21	56	59	18	2	79
v106-3	SCTPURCH	125	147	247	25	0	272
v106-4	SCTNEVR	48	51	0	99	83	182
v107-1	CTRENT	7	17	24	0	0	24
v107-2	CTCUST	19	26	43	2	2	47
v107-3	CTPURCH	134	191	312	13	2	327
v107-4	CTNEVR	60	86	2	144	84	230
v129-1	ESTEQPT	109	135	233	11	1	245
v129-2	ESTEQPT	64	125	179	10	1	190
v130-1	ESTCOST	104	114	208	10	5	223
v130-2	ESTCOST	67	147	203	11	1	215
v131-1	ESTNFIN	158	160	211	107	77	395
v131-2	ESTNFIN	73	175	193	55	21	269
v134-1	SEX	3	6	4	5	6	15
v134-2	SEX	234	341	414	161	96	671
v135-1	FAMILY	91	104	124	71	61	256
v135-2	FAMILY	59	95	113	41	16	170
v135-3	FAMILY	86	145	176	55	26	257
v136-1	ED	33	15	30	18	19	67
v136-2	ED	115	187	226	76	41	343
v136-3	ED	50	87	99	38	21	158
v136-4	ED	26	43	41	28	15	84
v136-5	ED	9	5	12	2	4	18
v136-6	ED	2	6	7	1	3	11
v138-1	MAJINVST	158	209	249	118	84	451
v138-2	MAJINVST	75	134	162	47	19	228
v139-1	FARMDEBT	193	268	325	136	84	545
v139-2	FARMDEBT	39	69	83	25	17	125
v140-0	EMPLOYEE	195	287	334	148	92	574
v140-1	EMPLOYEE	28	38	54	12	6	72

v140-2	EMPLOYEE	8	15	19	4	2	25
v140-3+	EMPLOYEE	4	5	7	2	2	11
v141	FMFARMER	79	127	146	60	41	247
v142	FMEXTNS	18	38	42	14	15	71
v143	FMGOVNT	20	36	43	13	17	73
v144	FMGROUP	4	6	9	1	1	11
v145 #	FMEXTMT	7	31	27	11	6	44
v146	FMCUSTM	9	10	15	4	1	20
v147 * #	FMPAIDC	5	22	24	3	2	29
v148 *	FMDEALR	27	45	59	13	7	79
v149	FMCOREP	13	29	30	12	3	45
v150 *	FMPROMO	22	26	29	19	12	60
v151	FMPAPER	79	135	153	61	33	247
v152	FMRADIO	10	15	15	10	10	35
v153 * #	CTFARMER	51	103	129	25	16	170
v154 *	CTEXTNS	16	31	40	7	6	53
v155 *	CTGPVNT	28	51	69	10	8	87
v156	CTGROUP	6	7	11	2	0	13
v157 *	CTEXTMT	11	22	28	5	4	37
v158	CTCUSTM	7	18	20	5	2	27
v159 * #	CTPAIDC	2	9	11	0	0	11
v160 *	CTDEALR	24	48	62	10	2	74
v161 *	CTCOREP	8	20	24	4	1	29
v162 *	CTPROMO	17	20	31	6	9	46
v163 * #	CTPAPER	53	105	131	27	16	174
v164	CTRADIO	5	10	12	3	4	19
county-0	LE SUEUR	0	347	252	95	51	398
county-1	SCOTT	238	0	166	72	52	290
v10123v4-0	NONUSER	72	95	0	167	0	167
v10123v4-1	USER	166	252	418	0	0	418
v10123v4-2	OTHER	52	51	0	0	103	103

*An asterisk indicates there was a significant difference in positive responses to this question between users and non-users ($p<0.1$).

A pound sign indicates there was a significant difference in positive responses to this question between the two counties ($p<0.1$).

Table B2. Descriptive Statistics of Selected Variables from Survey, by County and Conservation Tillage Category

Variable		County						Conservation Tillage											
		Le Sueur			Scott			User			Non-user			Other			All		
Number	Name	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd
v102	YRSQUIT	33	3.0	3.0	19	3.4	3.9	0			52	3.2	3.3	1	5.0	0.0	53	3.2	3.3
v103	YRSUSED	237	9.6	8.0	160	9.3	7.6	397	9.5	7.9	0			0			397	9.5	7.9
v104	ACRES *#	343	374.6	434.3	236	245.4	354.2	414	384.2	454.5	165	165.8	180.8	103	76.4	108.0	682	284.9	388.5
v105	PCTCONT	339	51.3	40.8	233	47.6	40.5	409	68.3	32.4	163	3.4	13.2	96	2.1	14.4	668	42.9	41.6
v108	QNTINFO	338	38.1	9.0	235	39.0	9.5	411	38.8	9.0	162	37.8	9.6	93	33.9	10.7	666	37.8	9.5
v109	OBTINFO #	342	38.5	8.9	236	40.1	9.4	414	39.2	9.1	164	39.1	9.3	91	34.9	11.4	669	38.6	9.6
v110	COMPLXT *#	338	32.2	10.1	238	35.5	10.3	414	34.0	9.9	162	32.3	11.3	88	31.0	10.1	664	33.2	10.3
v111	COSTSCT *#	339	29.1	11.4	237	32.9	12.7	415	32.5	11.3	161	26.1	12.8	87	26.1	11.0	663	30.1	12.0
v112	LABORER *	340	38.0	8.8	238	38.7	9.3	417	39.0	8.5	161	36.5	10.1	89	34.9	9.6	667	37.8	9.2
v113	PLANHZN *#	340	36.4	9.3	236	34.6	11.3	412	36.6	9.8	164	33.4	10.9	91	32.7	11.1	667	35.3	10.4
v114	SUPPORT	335	34.0	9.6	233	35.2	10.5	408	34.9	9.8	160	33.5	10.4	89	31.3	10.0	657	64.0	10.1
v115	MNGMSKL *	340	36.5	10.1	236	37.1	10.0	416	38.1	9.0	160	33.2	11.7	91	28.5	11.7	667	35.6	10.7
v116	CONTROL #	341	37.7	11.1	237	39.7	10.5	416	38.4	10.6	162	38.9	11.6	93	36.6	11.6	671	38.3	11.0
v117	VIABLTY	342	38.5	10.1	236	38.2	11.6	414	38.4	10.4	164	38.5	11.5	95	38.5	10.9	673	38.4	10.7
v118	QUALNF *#	338	34.8	9.3	235	36.2	9.7	416	35.8	9.0	157	34.2	10.8	88	32.5	9.6	661	35.0	9.6
v119	RELEVNC *	341	31.4	10.4	236	32.2	11.1	415	33.7	9.8	162	26.8	11.4	93	26.6	12.2	670	31.0	11.0
v120	PRDGOAL *	343	30.8	10.8	237	31.3	11.0	417	34.6	8.8	163	21.8	10.3	92	25.1	11.0	672	30.2	11.1
v121	PHYSICL *	343	34.3	11.7	236	35.0	11.7	416	38.1	9.5	163	25.5	11.7	92	28.7	13.1	671	33.8	12.0
v122	NEGRISK *	337	28.0	10.1	236	29.5	11.6	416	30.3	10.3	157	24.1	10.6	88	28.9	10.4	661	28.7	10.7
v123	EROSION *	345	33.3	12.8	237	34.0	13.7	416	36.6	11.8	166	26.1	13.4	99	27.7	13.6	681	32.7	13.4
v124	STARTCT *	239	32.3	12.3	161	35.3	10.9	400	33.5	11.8	0			0			400	33.5	11.8
v125	EXPTNFI	247	30.7	9.0	162	32.1	8.8	409	31.3	8.9	0			0			409	31.3	8.9
v126	EQPTINV	248	34.3	9.5	163	32.8	9.7	411	33.7	9.6	0			0			411	33.7	9.6
v127	WORKLOD #	245	28.4	8.5	162	26.0	9.5	407	27.4	9	0			0			407	27.4	9.0
v128	CMTFAR,	245	39.9	8.9	161	39.3	10.5	406	39.6	9.6	0			0			406	39.6	9.6

v129	ESTEQPT #	249	1.5	0.5	163	1.4	0.5	412	1.4	0.5	0			0			412	1.4	0.5
v130	ESTCOST #	250	1.6	0.5	161	1.4	0.5	411	1.5	0.5	0			0			411	1.5	0.5
v131	ESTNFIN *#	335	1.5	0.5	231	1.3	0.5	404	1.5	0.5	162	1.3	0.5	98	1.2	0.4	664	1.4	0.5
v132	AGE	339	49.9	12.4	236	50.3	12.7	412	49.7	12.5	163	50.9	12.5	100	54.1	13.7	675	50.6	12.8
v133	FARMEXP	345	27.4	13.3	237	25.9	13.0	417	26.7	13.0	165	27.1	13.6	99	27.3	16.4	681	26.9	13.7
v134	SEX	347	1.0	0.1	237	1.0	0.1	418	1.0	0.1	166	1.0	0.2	102	0.9	0.2	686	1.0	0.1
v135	FAMILY *#	344	2.1	0.8	236	2.0	0.9	413	2.1	0.8	167	1.9	0.9	103	1.7	0.9	683	2.0	0.9
v136	ED	343	2.6	0.9	235	2.4	1.0	415	2.5	1.0	163	2.5	1.0	103	2.5	1.2	681	2.5	1.0
v137	PROPRENT *#	341	30.8	32.8	236	24.1	31.6	411	30.8	33.0	166	21.3	30.1	100	10.1	24.2	677	25.4	32.0
v138	MAJINVST *#	343	1.4	0.5	233	1.3	0.5	411	1.4	0.5	165	1.3	0.5	103	1.2	0.4	679	1.3	0.5
v139	FARMDEBT	337	1.2	0.4	232	1.2	0.4	408	1.2	0.4	161	1.2	0.4	101	1.2	0.4	670	1.2	0.4
v140	EMPLOYEE *	345	0.2	0.6	235	0.2	0.6	414	0.3	0.7	166	0.2	0.5	102	0.2	0.8	682	0.2	0.6
Variables from the database of the Minnesota Agricultural Statistics Service																			
	ALLAND *#	347	400.9	413.6	238	284.8	327.0	418	411.4	425.1	167	209.1	193.2						
	CORN *#	347	154	182.5	238	100.5	143.5	418	157.5	188.8	167	68.9	77.8						
	SOYBEANS *#	347	139.3	194.5	238	68.6	109.4	418	133.3	188.1	167	53.7	82.5						
	ALLWHEAT*	347	8.0	16.6	238	6.0	14.4	418	8.0	16.8	167	5.0	12.5						
	OATS *#	347	7.0	11.4	238	11.0	20.9	418	9.4	17.7	167	6.6	10.7						
	ALLHAY #	347	18.6	29.2	238	30.2	43.0	418	24.6	38.8	167	20.1	26.9						
	ALLCATTL *	347	49.6	136.6	238	50.3	76.2	418	55.1	131.9	167	36.9	57.1						
	MILKCOWS #	347	7.8	21.3	238	17.7	36.9	418	12.2	30.8	167	10.9	24.2						
	HOGS *#	347	123.9	339.1	238	57.2	275.1	418	113.3	326.1	167	55.4	286.4						

* An asterisk indicates the means of users and non-users were significantly different (p<0.1).

A pound sign indicates the means of the two counties were significantly different (p<0.1).