Conventional Tillage versus No-till: Characteristics of Producers and Farms

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Abstract

A survey of Oklahoma farmers was conducted to determine characteristics of farms across three tillage categories: conventional tillage exclusively; no-till exclusively; other (combination of systems). The seven percent that use no-till exclusively crop more acres, rent more acres, and use more crop rotations than farms that use conventional tillage exclusively.

Introduction

Based on data reported by the Conservation Technology Information Center (CTIC), the use of no-till (NT) for crop production in Oklahoma is low compared to the national average. In 2004, NT was used on less than six percent of the acres cropped in the Southern Plains of Texas and Oklahoma. This is less than one-quarter of the national average of 22.6 percent (CTIC 2004). This is somewhat disconcerting since the heart of the 1933-35 Dust Bowl that ravaged the nation was in the Southern Plains and NT is the most soil conserving production system.

In 1933, Oklahoma farmers planted more than 15.7 million acres to annual crops (including 4.4 million acres of wheat, 4.1 million acres of cotton, 3.3 million acres of corn, and 1.1 million acres of oats) (USDA-NASS 2008). By 2000, acres planted to annual crops in the state, plus acres in the Conservation Reserve Program (CRP), decreased to 9.1 million (USDA-NASS 2008). More than 40 percent of land cropped in 1933 has been converted to other uses, mostly improved pasture used for beef production. It can be assumed that the vast majority of the 6.6 million acres that were cropped in 1933 that are no longer planted to annual crops are seldom tilled. By this measure, Oklahoma could well lead the nation in the proportion of "cropland" under NT. However, the CTIC data do not account for transitions from cropland to pasture or

transitions from pasture to cropland. Most (75 percent) of the Oklahoma cropland not in pasture and not in CRP is seeded to continuous winter wheat (USDA-NASS 2008).

Several studies of continuous wheat production in the region have found that when wheat is grown year after year in the same field, grain yield is reduced when a substantial quantity of wheat residue from the previous wheat crop is retained on the surface (Daniel et al. 1956; Zingg and Whitfield 1957; Harper 1960; Davidson and Santelmann 1973; Heer and Krenzer 1989; Epplin et al. 1994; Epplin and Al-Sakkaf 1995; Decker et al. 2009). For continuously cropped winter wheat in the region yields from NT are significantly less than yields from CT. The predominance of continuous cropping to wheat may explain the low rate of NT use for the region.

Additional studies have found that the economics of NT for continuous wheat production in the region depends on farm size (Epplin and Tice 1986; Epplin et al. 2005; Decker et al. 2009). In part because of the investment required in NT drills and seeders, conventional tillage (CT) is relatively more economical for small sized continuous wheat farms.

When prices of grains and oil seeds increase relative to the price of beef cattle, interest in converting cropland pasture to crop production is expected to increase. A conversion from pasture to annual crops with NT rather than CT would be more desirable from a soil conservation perspective. Information regarding the characteristics of farms in the region that currently use NT relative to those that don't, could be used by extension educators to aid in explaining the relative economics of conversion of perennial grass pastures to annual crops. The objective of the research reported in this paper is to determine the proportion of Oklahoma farmers that use CT exclusively, the proportion that use NT exclusively, and the proportion that do not use either CT or NT exclusively (other tillage (OT)). An additional objective is to determine characteristics

of farms and farmers that fall into each of the three (NT exclusively, CT exclusively, OT) categories.

Data

A survey was mailed to 9,500 Oklahoma farmers. The producers were randomly selected from the Oklahoma Agricultural Statistics Service (OASS) database by OASS personnel. To reduce the number of hobby and lifestyle farmers, the sample was limited to respondents with at least 80 acres of cultivated land. Responses from farmers and ranchers that produce only livestock were also removed from the sample. A total of 1,703 usable surveys were evaluated.

Producers were asked background information regarding their age, education, experience with current tillage practices, and off farm employment. They were asked to report the number of hours worked off farm per week as well as the share of income earned from off-farm employment. They were also asked to list their: tillage practices; acres farmed; acres rented; crop rotation; wheat production practices; crop and livestock sales; split of farm income between crop and livestock sales; machines owned; perceived benefits of conservation tillage; perceived problems of conservation tillage; and perceived knowledge of conservation tillage.

The respondents were classified into three categories: CT, the group that reported using conventional tillage exclusively; NT, respondents that reported using no-till exclusively; and OT, respondents that reported that they did not use either CT or NT exclusively. Some of the OT respondents reported that they use CT in some circumstances and NT for other conditions. Some of the acres in the OT category may have been farmed using NT practices. Respondents in the OT category may adjust tillage to conditions and use CT for a particular crop on a field in one year and NT for the same crop in the same field in a subsequent year. Cross-tabulation was used to classify characteristics of respondents by tillage category.

Findings

Five hundred and eighty-two (34 percent) of the 1,703 respondents reported that they use CT exclusively (with a primary tillage tool such as a moldboard plow, chisel plow, or offset disk) (Table 1). Seven percent (117) reported using NT exclusively and the remaining 1,004 (58 percent) reported using OT. The average number of acres planted to annual crops for farms that use CT exclusively is 598. This does not include acres used for perennial crops such as alfalfa and acres used for cropland pasture and rangeland. The average number of acres planted by the exclusive CT farms is significantly less ($P < 0.0001$) than the average number of acres planted by the OT farms (971 acres) which was also significantly less ($P < 0.05$) than the average number of acres planted by the exclusive NT farms (1,220 acres).

Farms that use CT exclusively farmed 24 percent of the total acres planted to annual crops as reported in the survey. Ten percent of the acres were in the NT exclusive group. This does not mean that only ten percent of the acres were planted with NT practices since NT may have been used on some of the OT acres. However, the finding is reasonably consistent with the CTIC that reported that 10.1 percent of the state's crop acres were planted NT in 2004 (CTIC 2004).

Of the respondents that reported using CT exclusively, only seven percent crop more than 1,500 acres. However, the NT exclusive farms are significantly larger and 30 percent crop more than 1,500 acres. This finding is consistent with prior research in that most studies of differences across farms that employ different tillage systems have found that the number of acres planted to annual crops is one of the most significant factors (Ervin and Ervin, 1982; Rahm and Huffman, 1984; Belknap and Saupe, 1988; Gould, Saupe and Klemme, 1989).

Table 2 includes the average number of acres planted to selected crops by tillage system. Wheat is the primary annual crop grown in the state and it is the predominant crop in each category. Respondents that reported using CT exclusively, plant an average of 555 acres to wheat. Most of these farms plant only wheat. The percentages of acres planted to wheat are 92.5, 66.8, and 79.9 for CT, NT, and OT, respectively. The NT farms have the most diverse cropping systems and the CT farms have the least diverse systems.

On average, farms that used CT exclusively, rented 297 acres for production of annual crops (Table 3). The average number of acres rented by the exclusive CT farms (297) is significantly less ($P < 0.0001$) than the average number of acres (550) rented by the OT farms which was also significantly less ($P < 0.05$) than the average number of acres (751) rented by the exclusive NT farms.

Forty percent of farms that used CT exclusively did not rent any land for production of annual crops. They planted annual crops only on land owned. Half of the farms that used CT exclusively and that rented land to produce annual crops rented less than 250 acres. Almost three quarters (74 percent) of the NT farms rented cropland and 35 percent of the 74 percent rented more than 1,000 acres.

Wheat Production System

In the Southern Plains, winter wheat can be grown for either grain-only, forage-only, or for both fall-winter forage plus grain (dual-purpose) (Hossain et al. 2004; Redmon et al. 1995; Redmon et al. 1996; True et al. 2001). Based on the results reported in Table 4, seven percent of the acres are planted for forage-only, 68 percent for dual-purpose, and 24 percent for grain only. These results are consistent with those reported by prior studies. Surveys conducted by True et al. (2001) and Hossain et al. (2004) found that between 9-20 percent of the wheat area planted in

Oklahoma was intended for forage-only; 49-66 percent was intended for dual-purpose; and 25-31 percent for grain-only.

Of the total wheat acres planted on farms that used CT exclusively, 21 percent was for grain-only and 71 percent is mono-cropped. The 71 percent mono-cropped by the CT exclusive farms is significantly greater than the 52 percent ($p < 0.1$) mono-cropped by the OT farmers and significantly greater ($p < 0.001$) than the 31 per cent mono-cropped by the NT farms.

The "rotation" results reported in Table 4 may seem to be inconsistent with the results reported in Table 2. For example, in Table 2 it is reported that only 7.5 percent of the CT exclusive group is planted to crops other than wheat. However, in Table 4 it is reported that 29 percent of the wheat acres are rotated. The combined information suggests that the crop rotations include several years of wheat. For example, for the NT group a rotation may include two years of wheat followed by one year of an alternative crop.

Table 5 includes the percentage of farms that use each of the three alternative wheat production systems and the percentage that use crop rotations by tillage group. Table 5 differs from Table 4 in that the data in Table 4 are based on acres rather than farms. Based on the means, the NT farms are more than 2.5 times more likely to use crop rotations than the CT farms.

Tractors, Machines, Implements

Table 6 includes information regarding tractor and machine use. The survey question used to obtain these responses was intended to determine the types of tractors and machines used on the farms. Thirty-two percent of the respondents reported that they use at least one tractor with more than 225 horsepower. A third of 32 percent, are in the CT group, six percent are in the NT group, and 61 percent are in the OT group. These percentages are very similar to the

percentage of farms in each of the three categories: 34 percent CT; 7 percent NT; 58 percent OT. The percentages for all implements used in tillage operations are also similar to the percentages of farms in each of the groups. These finding suggest that the farms that use NT exclusively have retained tillage implements. It is not clear how they "use" tillage tools in their exclusively NT operations.

The findings reported in Table 6 also show that the chisel plow is the most commonly used primary tillage tool. For example, 77 percent indicated that they use a chisel plow. This compares with 57 percent for an offset disk, 43 percent for a moldboard plow, and 42 percent for a sweep plow. The most frequently used seeding implement is a double disk drill (61 percent) followed by a single disk drill (34 percent), row crop planter (23 percent), air seeder (11 percent), and hoe drill (9 percent).

Sales and Off-farm Income

Fifty-four percent of the surveyed farms reported less than $100,000 of annual crop and livestock sales (Table 7). Sixty-five percent of the farms that used CT exclusively had less than $100,000 in annual crop and livestock sales. Fourteen percent of the farms indicated that their farm income was derived exclusively from crop sales. In other words, 86 percent have receipts from sale of livestock. Farms in the NT group were more likely to report crop sales exclusively (23 percent).

On average the farms in the NT group are larger and report more sales. For example, 28 percent of the farms in the NT group reported annual crop and livestock sales in excess of $250,000. Only 12 percent of the CT group reported annual crop and livestock sales in excess of $250,000 (Table 7).

A positive linear association was found between acres planted and gross farm sales (Table 7). The coefficients of correlation (ρ) between acres planted and gross farm sales were significantly different from zero ($P<0.0001$) for each group (CT, $\rho = 0.51$; NT, $\rho = 0.55$; OT, $\rho = 0.57$).

The majority of the survey respondents (57%) reported that they have off farm income. However, the source of off farm income was not defined. Since 38 percent (Table 8) indicated that they are over 65 years of age, it could be that social security is an important source of off farm income. However, this information was not obtained. In the CT group, 21 percent reported earning over 75% of their income from off farm activities (Table 7).

Seventy percent of the respondents indicated that they were more than 55 years of age (Table 8). The data show that farmers in the NT group are younger. Only 59 percent of the NT group are more than 55 years of age.

Fifty percent of the respondents reported a high school education level (9 to 12 years of school). Only two percent reported less than nine years (grade school) of education. The remaining 48 percent indicated that they attended college.

About 63 percent of the respondents indicated that they do not have off-farm employment. The highest proportions of producers who do not have an off farm job is under NT. Among the CT group, 17 percent indicated that they work over 40 hours per week off farm. However, only 11 percent of the NT group reported a similar off-farm work load.

A distinct pattern appears in the number of years farmers reported using their current tillage practice. This variable does not necessarily measure the farmer experience; it is an indication of the current farming tillage experience. Seven-six percent of farmers had been practicing their current tillage for more than four years, 11 percent for less than two years and the

rest (13 percent) had between three and four years of experience with current tillage practices (Table 8). Of the farmers who reported using CT exclusively, 96 percent have used CT for more than four years. In the NT group, 52 percent reported using NT for more than four years, and 48 percent for less than four years. CT farmers have more experience with their tillage method compared to NT farmers.

Table 9 includes a summary of perceptions. The responses as reported in Table 9 conform to expectations. The CT group claims less understanding of no-till than the NT group. The NT group is more likely to agree with statements such as NT reduces labor cost, NT reduces fuel costs, NT reduces equipment costs, and NT reduces soil erosion.

One item in "perceived benefits" section is particularly noticeable. Each of the three groups rated "increases yield" lower than any other "perceived benefit" in the group. The growers may well be aware of the research results that consistently show lower wheat grain yield when wheat is grown continuously with no-till practices.

Table 9 also includes a summary of perceived problems of no-till practices. These responses also conform to expectations. Those in the CT group are more likely to agree with statements that are less favorable for no-till. Furthermore, those in the NT group are more likely to agree with statements that favor no-till.

Discussion

The objective of the research was to determine the proportion of Oklahoma farmers that use CT exclusively, the proportion that use NT exclusively, and the proportion that do not use either CT or NT exclusively (other tillage (OT)). An additional objective was to determine characteristics of farms and farmers that fall into each of the three (NT, CT, OT) categories.

A mail survey of Oklahoma farmers randomly selected from the OASS database was conducted. Responses from farmers and ranchers that produce only livestock were removed from the sample as well as responses from those with less than 80 acres of cultivated land. A total of 1,703 usable surveys were evaluated. Of these, 582 (34 percent) reported that they use CT exclusively (with a primary tillage tool such as a moldboard plow, chisel plow, or offset disk), 117 (seven percent) reported using NT exclusively and the remaining 1,004 (58 percent) reported using OT. Farmers that reported using a combination of systems, for example NT on some acres and CT on other acres, were classified in the OT group.

On average, the NT farmers crop more than twice as many acres as the CT farmers (598 versus 1,220 acres of annual crops). Fifty percent of the NT farms plant more than 1,000 acres to annual crops compared to 16 percent of the CT farms. The NT farms have more diversified cropping operations. The CT farms plant more than 90 percent of their annual crop acres to wheat. The NT farms plant only 67 percent of their crop acres to wheat.

The NT farms rent more land for production of annual crops than the CT farms (751 versus 297 acres). Fifty-five percent of the NT farms rent more than 500 acres compared to 25 percent of the CT farms that rent more than 500 acres. Forty percent of the CT farms do not rent any land for production of annual crops.

The use of wheat acres planted differs across the farms. For example, 73 percent of the wheat acres on CT farms are planted for dual-purpose (fall-winter forage plus grain), while only 54 percent of the wheat acres on the NT farms are planted for dual-purpose. The proportion planted for grain-only is 21 percent for the CT farms and 37 percent for the NT farms. The remaining six percent (nine percent) is planted for forage-only on the CT (NT) farms.

The NT farms report that they use crop rotations on 69 percent of their acres. The CT group reported using crop rotations on 29 percent of their acres. Evidently these rotations on CT farms include several years of wheat since the CT group reported that 92.5 percent of their acres are seeded to wheat.

The survey did not detect major differences in the type of machines used on the farms across tillage group. For example, 32 percent of the farms reported that they use at least one tractor with more than 225 horsepower; of this 32 percent, 33 percent were in the CT group (34 percent of the farmers) and six percent were in the NT group (seven percent of the farmers). The survey did not include any questions to attempt to determine differences in hours of use per year for the machines.

Twenty-eight percent of the NT group reported annual crop and livestock sales in excess of $250,000. Only 12 percent of the CT group reported annual crop and livestock sales of $250,000. Twenty-three percent of the NT group reported zero income from livestock compared to only 13 percent of the CT group.

On average the CT farmers are older. Forty-two percent of the CT group are over 65, compared to 28 percent of the NT group. Members of the CT group are more likely to work off the farm. Thirty-one percent of the CT group report that they work more than 20 hours per week off the farm compared to 18 percent of the NT group. This finding is consistent with the findings regarding acres farmed and gross sales. Since the NT group on average farms more acres and has more gross sales from farming activities than the CT group, it is consistent that they would be less likely to work off farm.

Forty-eight percent of the NT group reported that they have been using NT for four years or less. The vast majority (96 percent) of the CT group reported that they have been using CT for more than four years.

Reponses to questions regarding perceived benefits and perceived problems associated with NT were consistent with expectations. Farmers in the NT group are more likely to agree with statements that shed a favorable light on NT and farmers in the CT group are more likely to agree with statements that shed a favorable light on CT. The lowest average perception score among the CT group was assigned to the "increase yield" question. This suggests that members of the CT group, that crop most of their acres to continuous wheat, are concerned about wheat yield response to NT versus CT. This perception is consistent with results of several long term studies that have found lower grain yields with continuous monoculture wheat from NT relative to CT (Daniel et al. 1956; Zingg and Whitfield 1957; Harper 1960; Davidson and Santelmann 1973; Heer and Krenzer 1989; Epplin et al. 1994; Epplin and Al-Sakkaf 1995; Decker et al. 2009).

Another finding of the survey is that farm size matters. This finding is also consistent with prior research that has found that NT is relatively more economical for farms that crop more acres (Epplin et al. 2005; Decker et al. 2009).

The survey confirms that crop rotations are not common in the state. It is likely that the lack of an economically competitive crop to rotate with winter wheat hinders the use of NT in the state. Alternative winter small grain crops such as oats, barley, and rye are not economically competitive. Summer crops such as corn, soybeans, and grain sorghum do not fit well in a rotation with winter wheat and do not consistently perform well in the climate, which is characterized by hot, dry, windy summers.

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Table 1. Selected Characteristics of Farms that Use Only Conventional Tillage, Only No-Till, and those farms that use Other Tillage Systems (Other Tillage Includes Farms that use a Combination of No-Till and Conventional Tillage)

Item	Tillage system used on farm		
	Conventional tillage exclusively	No-till exclusively	Other
Farms	582[a]	117	1,004
Percent of Farms	34%[b]	7%	58%
Average acres planted to annual crops	598[c]	1,220	971
Percent of acres planted to annual crops	24%[d]	10%	66%
Acres planted to annual crops			
Less than 500	69%[e]	35%	49%
500-1000	15%	15%	20%
1001-1500	9%	20%	12%
Over 1500	7%	30%	19%

[a] Five hundred and eighty-two of the respondents reported that they use conventional tillage exclusively.

[b] Thirty-four percent of the respondents reported that they use conventional tillage exclusively.

[c] The average number of acres planted to annual crops for farms that use conventional tillage exclusively is 598. This does not include acres used for perennial crops such as alfalfa and acres used for cropland pasture and rangeland. The average number of acres planted by the exclusive conventional tillage farms is significantly less ($P < 0.0001$) than the average number of acres planted by the other tillage farms which was also significantly less ($P = 0.0476$) than the average number of acres planted by the exclusive no-till farms.

[d] Farms that use conventional tillage exclusively farmed 24 percent of the total acres planted to annual crops.

[e] Of the respondents that reported using conventional tillage exclusively, 69 percent crop less than 500 acres.

Table 2. Average Number of Acres Planted to Selected Crops by Tillage System

Crop	Tillage system used on farm		
	Conventional tillage exclusively	No-till exclusively	Other
	Acres		
Wheat	555[a]	815	775
Corn	5	104	45
Cotton	3	52	38
Sorghum	13	106	51
Soybeans	3	117	29
Other crops	21	26	32
Proportion Seeded to Wheat	92.5%	66.8%	79.9%
Proportion Seeded to Crops Other than Wheat	7.5%	33.2%	20.1%

[a] Respondents that reported using conventional tillage exclusively, plant an average of 555 acres to wheat. Most of these farms plant only wheat.

Table 3. Characteristics of Land Rented to Produce Annual Crops by Tillage System

Item	Tillage system used on farm		
	Conventional tillage exclusively	No-till exclusively	Other
Average acres Rented for Production of Annual Crops	297 [a]	751	550
Zero Land Rented for Production of Annual Crops	40% [b]	26%	27%
Rented (acres)			
Less than 250	50% [c]	25%	37%
250-500	25%	20%	21%
501-750	8%	10%	12%
751-1000	7%	10%	11%
Over 1000	10%	35%	19%

[a] On average, farms that used conventional tillage exclusively, rented 297 acres for production of annual crops. The average number of acres rented by the exclusive conventional tillage farms is significantly less ($P < 0.0001$) than the average number of acres rented by the other tillage farms which was also significantly less ($P = 0.0271$) than the average number of acres rented by the exclusive no-till farms.

[b] Forty percent of farms that used conventional tillage exclusively did not rent any land for production of annual crops. They planted annual crops only on land owned.

[c] Half of the farms that used conventional tillage exclusively and that rented land to produce annual crops, rented less than 250 acres.

Table 4. Wheat Production System and Use of Crop Rotations by Tillage System (% of acres)

		Tillage system used on farm			
		Conventional tillage exclusively	No-till exclusively	Other	Total Percent
Wheat Production System	Grain Only	21%[a]	37%	24%	24%[c]
	Forage Only	6%	9%	8%	7%
	Dual-purpose	73%	54%	68%	68%
Cropping System	Mono-crop	71%[b]	31%	52%	55%[d]
	Rotated	29%	69%	48%	45%

[a] Of the total wheat acres planted on farms that used conventional tillage exclusively, 21 percent was for grain-only.

[b] Of the total wheat acres planted on farms that used conventional tillage exclusively, 71 percent is mono-cropped. The 71 percent monocropped by the conventional tillage exclusive farms is significantly greater than the 52 percent ($p < 0.1$) monocropped by the other tillage farms and significantly greater ($p < 0.001$) than the 31 per cent monocropped by the exclusive no-till farms.

[c] Twenty-four percent of wheat acres was planted for grain-only.

[d] Fifty-five percent of total wheat acres are not rotated with other crops.

Table 5. Wheat Production System and Use of Crop Rotations by Tillage System (% of farms)

		Tillage system used on farm			
		Conventional tillage exclusively	No-till exclusively	Other	Total Percent
Wheat Production System	Grain Only	24%[a]	38%	23%	23%[c]
	Forage Only	14%	14%	15%	15%
	Dual-purpose	62%	49%	64%	62%
Cropping System	Mono-crop	74%[b]	33%	59%	62%[d]
	Rotated	26%	67%	41%	38%

[a] For those farms that use conventional tillage exclusively and produce wheat, 24 percent plant wheat for grain-only. The dual-purpose category includes those farms that used more than one wheat production system.

[b] For those farms that use conventional tillage exclusively, 74% do not rotate crops.

[c] Twenty-three percent of farms planted wheat for grain only.

[d] Sixty-two percent of farms did not rotate crops.

Table 6. Percent of farms that reported ownership of tractors of various sizes, and ownership of tillage, planting, and other implements.

Item	Tillage system used on farm: Conventional tillage exclusively	No-till exclusively	Other	Proportion that Indicated Item Owned[a]
Percent of Farms	34%	7%	58%	
		Tractors Owned		
125 HP or less	34%[b]	6%	60%	70%
126-175 HP	35%	7%	58%	65%
176-225 HP	33%	7%	60%	27%
over 225 HP	33%	6%	61%	32%
		Tillage Implements		
Tandem Disk	33%	6%	61%	52%
Offset Disk	37%	5%	58%	57%
Chisel Plow	36%	5%	59%	77%
Sweep Plow	36%	6%	58%	42%
Moldboard plow	38%	6%	56%	43%
Field Cultivator	36%	5%	59%	59%
Strip-till unit	35%	7%	58%	4%
Vertical till	34%	8%	58%	4%
Other tillage implements	32%	9%	59%	11%
		Planting and Seeding Implements		
Air Seeder	11%	19%	70%	11%
Row Crop Planter	19%	12%	69%	23%
Double Disk Drill	36%	5%	59%	61%
Single Disk Drill	38%	4%	58%	34%
Hoe Drill	39%	3%	58%	9%
		Other Machine Items		
Anhydrous Applicator	36%	5%	59%	26%
Combine	34%	7%	59%	63%
Sprayer	31%	8%	61%	63%
Fertilizer Spreader (dry)	35%	6%	59%	34%
Fertilizer Spreader (wet)	34%	6%	60%	17%

[a] The percentage of farmers surveyed that answered the corresponding item.

[b] Seventy percent of the respondents checked that they owned a tractor with 125 horsepower or less. Of the 70 percent that checked this category, 34 percent were in the conventional tillage group, 6 per cent in the no-till group and 60 percent in the other tillage group.

Table 7. Characteristics of Respondents by Tillage System

Item	Tillage system used on farm: Conventional tillage exclusively	No-till exclusively	Other	Total
Crop and livestock sales($,000)				
< 100	65%[a]	39%	49%	54%[b]
100-250	23%	33%	29%	27%
250-500	8%	16%	11%	10%
500-1,000	3%	9%	7%	6%
>1,000	1%	3%	4%	3%
Shares (on-farm gross sales split between crop and livestock)				
Crop exclusively	13%[b]	23%	13%	14%[c]
50%-99 % Crop	52%	55%	52%	52%
>50 % Livestock	35%	22%	35%	34%
Off-farm Income				
Zero	40%[c]	50%	44%	43%[d]
1%-25%	8%	6%	11%	10%
26%-50%	11%	7%	14%	13%
51%-75%	19%	20%	15%	16%
>75%	21%	17%	16%	18%

[a] Sixty-five percent of the farms that used conventional tillage exclusively had less than $100,000 in annual crop and livestock sales.

[b] Fifty-four percent of the farms had less than $100,000 of crop and livestock sales.

[c] Fourteen percent did not have livestock sales.

[d] Forty-three percent reported zero off-farm income.

Table 8. Characteristics of Respondents by Tillage System

Item	Tillage system used on farm: Conventional tillage exclusively	No-till exclusively	Other	Total
Age (years)				
18-34	2%[a]	4%	3%	3%
35-54	24%	37%	29%	27%
55-65	32%	31%	32%	32%
>65	42%	28%	37%	38%
Formal Education (years)				
Grade School	2%[b]	5%	2%	2%
High School	55%	44%	48%	50%
Bachelor's	34%	44%	39%	37%
Master's	8%	5%	9%	8%
Doctorate	2%	2%	3%	2%
Off-farm employment				
Zero	60%[c]	70%	65%	63%
1-20 hrs/week	9%	12%	10%	10%
21-40 hrs/week	14%	7%	12%	12%
> 40 hrs/week	17%	11%	13%	14%
Number of years using the current tillage practice				
0-2 years	3%	25%[d]	14%	11%
3-4 years	1%	23%	19%	13%
> 4years	96%	52%	67%	76%

[a] Two percent of the respondents who use conventional tillage exclusively were between 18 and 34 years of age.

[b] Two percent of the respondents who used conventional tillage exclusively attended formal education for less than nine years.

[c] Of those who reported using conventional tillage exclusively, 60 percent did not work off-farm.

[d] Forty-eight percent of those reporting using no-till exclusively reported that they have using no-till for four or fewer years.

Table 9. Perceived knowledge of no-till, perceived benefits of no-till, and perceived problems of no-till

Item	Tillage system used on farm: Convention tillage exclusively	No-till exclusively	Other	Proportion that Answered [a]
Perceived knowledge of no-till practices (0-10; 0 = no knowledge; 10 = very knowledgeable)				
	5 [b]	8	7	97%
Perceived benefits of no-till practices (1-8; 1 = strongly disagree; 8 strongly agree)				
Reduces labor costs	6	8 [c]	7	92%
Reduces fuel costs	7	8	7	94%
Reduces equipment costs	5	7	6	92%
Reduces soil erosion	6	8	7	93%
Increases yield	3	5	4	83%
Generates greater profits	4	6	5	89%
Conserves soil moisture	6	7	6	91%
Reduces soil compaction	5	7	5	90%
Improves ecological diversity	5	7	6	86%
Perceived problems of no-till practices (1-8; 1 = strongly disagree; 8 strongly agree)				
Lack of state/local research	5	6	5	83%
Increases weed pressure	6	4	6	89%
Soil fertility issues	5	4	5	85%
Increases insect pressure	6	4	6	86%
Residue management	6	4	5	87%
Equipment costs	6	5	6	89%
Increased management skills	5	6	6	86%
Poor economic returns	5	3	5	86%
Difficulty in getting a stand	5	3	5	87%
Inappropriate soil type	5	3	5	84%
Grazing concerns	6	4	5	87%
Reduces yields	5	3	5	86%
Uncooperative landlord	4	4	4	77%
Increases soil compaction	5	3	4	85%
Lack of rental equipment	5	4	5	81%
Increases soil and plant disease	6	4	5	85%
Lack of knowledge of no-till	5	6	5	88%

[a] The percentage of farmers surveyed that answered the corresponding item.

[b] On a scale from zero to ten, the mean reported knowledge of no-till practices by farmers in the conventional tillage group is five.

[c] Farmers in the no-till group of respondents strongly agree that no-till reduces labor cost.