Short communication

Perceptions on the use of no-till farming in production agriculture in the United States: an analysis of survey results

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Abstract

A number of economic and environmental benefits are associated with the use of no-till in production agriculture in the United States. There are lower labor, energy, and machinery costs associated with no-till farming relative to conventional tillage systems and other types of conservation tillage. Reduced erosion and runoff associated with no-till also lead to a number of environmental benefits, including a reduction in water quality impairment. The objective of this study is to assess farmers’ perception of their actual use of no-till. An analysis of the Agricultural Resource Management Study survey data for 1996 shows that for soybean (Glycine max L. Merr.), winter wheat (Triticum aestivum L.), spring wheat, and durum wheat, farmers’ perceptions are consistent with reality. In the case of corn (Zea mays L.), however, nearly 18% of corn farmers believe they are using no-till, while in actuality, only slightly more than 12% are using this tillage system. In order to properly associate the benefits of no-till with its use, it is important that farmers’ perception of what constitutes no-till and their actual use of no-till be consistent. ©2000 Published by Elsevier Science B.V.

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1. Introduction

No-till is an agricultural production practice where the soil is left undisturbed from harvest to seeding and from seeding to harvest. The only ‘tillage’ is the soil disturbance in a narrow slot created by coulters, disk or runner seed furrow openers, or hoe openers attached to a planter or drill. No-till planters must be able to cut residue and penetrate undisturbed soil. Weed control relies on herbicides applied preplant, pre-emerge or post-emerge. The type and timing of herbicide application depends on the weed pressures and climatic conditions. Strictly speaking, no-till does not allow operations that disturb the soil, other than the planting operation (Conservation Technology Information Center, 1997).

The objectives of this study are (1) to provide a brief overview of no-till farming systems in the US, and (2) to examine farmers’ perceptions of what constitutes no-till.

2. Potential benefits of no-till in U.S. agriculture

There are a number of significant economic and environmental benefits associated with the use of no-till...
in production agriculture in the US. The use of no-till may affect the cost of labor, fertilizers, pesticides, and machinery relative to conventional tillage (Zero Tillage Farmers Association, 1997). A reduction in the intensity and number of tillage operations lowers costs for labor and machinery, especially if the machinery is used optimally (Siemans and Doster, 1992).

The benefit from no-till of reduced labor needs is greater than just the labor cost savings per hectare. There is the associated opportunity cost of the labor and time saved. That is, if less hired labor is needed, there will be direct savings. Saving the farmer’s, or other family labor, may permit him to engage in off-farm activities. Lower labor requirements for tillage lead to additional returns from the expansion of existing enterprises or allow time for new activities to improve profitability for the whole farm operation.

Machinery operating costs may not be lower for no-tillage. Lower fuel and maintenance costs associated with no-till may be overshadowed by the higher cost of new no-till implements. Lower fuel costs are a consequence of the fewer trips across a field with no-till. Maintenance costs will be lower because the equipment will be used less (Hunt, 1984).

No-till serves to reduce soil erosion. A reduction in soil erosion associated with no-till will mitigate many off-site erosion-related problems, including water-use impairment. Three related causes of water-use impairment are sedimentation, eutrophication, and pesticide contamination. When soil particles and agricultural chemicals wash off a field, they may be carried in runoff until discharged into a water body or stream. Not all agricultural constituents that are transported from a field reach water systems, but a significant portion does, especially dissolved chemicals and the more chemically active, finer soil particles. Once agricultural pollutants enter a water system, they lower water quality and can impose economic losses on water users. These off-site impacts can be substantial. The off-site impacts of erosion are potentially greater than the on-site productivity effects in the aggregate (Foster and Dabney, 1995). Therefore, society may have a larger incentive for reducing erosion than farmers have.

Several studies are available that evaluate the improvements in water quality associated with the use of no-till. Richards and Baker (1998) reported on the effort to reduce eutrophication in Lake Erie that began in the early 1970s. Between 1975 and 1995, implementation of no-till increased from less than 5% to more than 50% of planted acreage. The adoption of no-till, in conjunction with reduced fertilizer application rates, led to a reduction in total phosphorous loadings of 24%, a reduction in suspended sediments of 19%, and a reduction in total Kjeldahl nitrogen of 10%.

Fawcett et al. (1994) surveyed the effects of various best management practices, including no-till, on pesticide runoff into surface water and leaching into groundwater. Average herbicide runoff in no-tillage systems, for example, was 30% of the conventional tillage runoff. With regard to leaching, however, no-till does not fare as well. Increases in infiltration accompanying the use of no-till may result in a greater threat to groundwater from pesticides or nitrate. Preferential flow of water through macropores, which may be more prevalent with no-tillage, can allow water and dissolved solutes or suspended sediment to bypass upper layers of soil. This may transfer pesticides to shallow groundwater or to depths in the soil where biological degradation is slower. It is important, however, to keep this in perspective. Even though there in an increase in the potential leaching risks of certain pesticides associated with no-till, the relative concentrations of pesticides found in surface water are typically greater than those found in groundwater.

3. Perceptions versus reality

3.1. Overview of the problem

It is clear that no-till has a number of economic and environmental benefits. This realization has been used to promote the adoption of no-till in the US (Zero Tillage Farmers Association, 1997). Between 1989 and 1997, the use of no-till has increased from 5.1 to 15.6% of total planted hectarage in production agriculture in the US (Conservation Technology Information Center, 1997).

One of the current problems with promoting the use of no-till is the disparity in farmers’ perception of precisely what constitutes no-till. There are others types of conservation tillage, however, including mulch till and ridge till. With mulch tillage, the soil is disturbed prior to planting. Tillage tools, such as chisels, field
cultivators, disks, sweeps, and blades, are used. Weed control is accomplished with herbicides and/or cultivation. With ridge tillage, the soil is left undisturbed from harvest to planting except for nutrient injection. Planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are rebuilt during cultivation.

The economic and environmental benefits accruing to no-till do not, for the most part, carry over to other types of conservation tillage. If they do, however, the realized benefits are substantially less (Dickey et al., 1992; Fawcett et al., 1994; University of Illinois Agricultural Extension Service, 1997).

The extent of this misperception in what constitutes no-till is the subject of what follows. It is based on an analysis of survey data.

3.2. Survey data on use of no-till

In 1996, the U.S. Department of Agriculture conducted the first Agricultural Resources Management Study (ARMS) survey. The survey was a combination of the former Cropping Practices Survey and the Farm Costs and Returns Survey. The Cropping Practices survey collected field level data. The Farm Costs and Returns Survey collected whole farm data. Both of these surveys had long histories. They were based on stratified random samples of all farms in the US. The stratification was a function of the crops grown, the farm size, and the region of the country. The ARMS survey emulates this sampling approach.

Annual data were collected on fertilizer and pesticide use, tillage systems employed, cropping sequences, whether the cropland is designated as highly erodible, and information on the use of other inputs and production practices from individual farms in the US. The survey covered corn, cotton (Gossypium spp.); soybean; wheat (winter, spring and durum), and potatoes (Solanum tuberosum L.). Highly trained enumerators visited farms to collect the randomly selected site-specific information. Since no-till is not a viable production practice for potatoes, and it is not yet extensively used on cotton, these crops were omitted from consideration. Only farms in selected states were surveyed, but about 80% of the total planted hectare

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sample size</th>
<th>Indicated</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (maize)</td>
<td>3403</td>
<td>0.1799 (0.0065)</td>
<td>0.1220 (0.0056)</td>
</tr>
<tr>
<td>Soybean</td>
<td>2688</td>
<td>0.3146 (0.0089)</td>
<td>0.3227 (0.0090)</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>898</td>
<td>0.0294 (0.0056)</td>
<td>0.0335 (0.0060)</td>
</tr>
<tr>
<td>Spring wheat</td>
<td>252</td>
<td>0.0230 (0.0094)</td>
<td>0.0380 (0.0121)</td>
</tr>
<tr>
<td>Durum wheat</td>
<td>98</td>
<td>0.0515 (0.0224)</td>
<td>0.0655 (0.0251)</td>
</tr>
</tbody>
</table>

a The number of farms surveyed.
b The value is the proportion of farmers who indicated they used no-till.
c The value is the proportion of farmers who actually used no-till farming. The determination of actual used is described in the text.
d Standard errors of the estimates in parentheses.

for the respective crops was covered. Five tillage systems, including conventional tillage with moldboard plow, conventional tillage without moldboard plow, mulch tillage, ridge tillage, and no-till, were defined, based on the use of specific tillage implements and their residue incorporation rates (Bull, 1993). For the purpose of classification of the survey results, no-till was defined as a system that has no-tillage operation before planting. This does allow field passes of implements, such as corn stalk choppers, which do not incorporate any residue. Respondents (farmers) were also asked on the survey if they used no-till.

3.3. Survey results

Focusing on five survey crops, namely, corn, soybean, winter wheat, spring wheat, and durum wheat, a comparison of farmers’ perception that they used no-till and whether they de facto used no-till is presented in Table 1. For the production of soybean, winter wheat, spring wheat, and durum wheat, there was no statistically significant difference at the 95% level between farmers’ perception that they used no-till and their actual use of no-till. Thus, the economic and environmental benefits that result from the use of no-till in the production of these commodities can be fully claimed by farmers producing soybean, winter wheat, spring wheat, and durum wheat.

The use of no-till in the production of corn was different. There was a statistically significant difference at the 95% level in farmers’ perception and reality. Nearly 18% of corn farmers perceived that they used
no-till, while in fact only slightly more than 12% used no-till. A disaggregated analysis of the data showed that, of the nearly 18% of farmers who perceived they used no-till, 3.4 (0.5)% actually used mulch tillage and 2.4 (0.4)% used ridge tillage (Standard errors of the estimates are in parentheses.). None of these farmers, however, used conventional tillage. While the percentage of farmers using a tillage system different than no-till while believing they were using no-till was relatively small, the fact that 32 174 740 ha of corn were planted in 1996 translates into a substantial number of acres on which farmers perceptions with regard to tillage system used were inconsistent with the actual tillage system used (U.S. Department of Agriculture, 1998). This has important implications because the production of corn in the US is concentrated in the regions that are most susceptible to sheet and rill erosion (Conservation Technology Information Center, 1997). It is these regions where the environmental benefits associated with the use of no-till are greatest (Uri, 1999).

It is interesting to speculate on why the perceived use of no-till differed from its actual use for corn, but not for the other commodities. The survey did not provide a definition of what constitutes no-till. Thus, corn farmers might have mistaken no-till for other types of conservation tillage if the soil was not tilled immediately prior to planting. Alternatively, there is a possibility that farmers were actually using no-till, but the classification was inaccurate. There is no reason, however, to believe that this was the situation.

4. Conclusion

A number of economic and environmental benefits are associated with the use of no-till in production agriculture in the US. There are lower labor, energy, and machinery costs associated with no-till farming relative to conventional tillage systems and other types of conservation tillage. The reduced erosion associated with no-till also leads to a number of environmental benefits, including a reduction in water quality impairment.

In order to encourage no-till and its benefits, it is important that farmers’ perception of what constitutes no-till and their actual use of no-till be consistent. An analysis of Agricultural Resource Management Study survey data for 1996 showed that for soybean, winter wheat, spring wheat, and durum wheat, farmers’ perceptions were consistent with reality. In the case of corn, however, nearly 18% of corn farmers surveyed believed they were using no-till, while, in actuality, only slightly more than 12% were using this tillage system.

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References


