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MEASURING LOWER TRACTOR COSTS FROM REDUCED TILLAGE IN COTTON: PRELIMINARY RESULTS

John R.C. Robinson
Texas A&M Research and Extension Center
Weslaco, TX
Shelley U. Underbrink and Lawrence L. Falconer
Texas A&M Research and Ext. Center
Corpus Christi, TX
Jason L. Johnson
Texas A&M Research and Extension Center
San Angelo, TX
Bill J. Thompson
Texas A&M Research and Ext. Center
Ft. Stockton, TX

Abstract

The paper presents preliminary results from a recent survey of Texas cotton growers to collect and correlate information about reduced tillage adoption and the age, size, and cost of their tractor fleet. Linear and nonlinear regression was used to test the hypothesis that reduced tillage adoption is associated with longer lived tractors with fewer repairs, smaller horsepower requirements, and overall lower costs. The preliminary results indicate that nonlinear relationships were a better fit. OLS regressions of tractor costs on reduced tillage adoption and other regressors had a very low R-square statistic.

Introduction

Alternative tillage systems have been and continue to be the focus of economic analysis for potential improvements in economic efficiency. These studies range from comparisons of enterprise budgets (Cooke et al, 2003) to whole farm mathematical programming approaches (Robinson and Falconer, 2003). Partial budgeting is adequate to assess the tradeoffs between changes in productivity and input costs. However, budgeting approaches fail to show how the most profitable choice of crop/tillage system might vary with increasing scale. The optimal crop mix is also influenced by the pattern of acquisition of lumpy resources like full-time labor and equipment (Robinson and Falconer, 2003). Crop mix and resource investment/disinvestment requires a whole farm, mixed integer programming approach.

In addition to the aforementioned sources of benefits, anecdotal evidence from farmers suggests that a major benefit of reduced tillage systems is enabling them to use smaller tractors for longer periods of time, and with fewer repairs. Besides lower repair costs, smaller horsepower and longer lived tractors also imply lower total tractor cost per hour, and thus lower production costs. No known studies have ever attempted to measure this benefit. Therefore the purpose of this study was to a) collect primary data about reduced tillage adoption and tractor fleet, b) statistically estimating the relationship between various tractor cost variables (age, horsepower, repair cost, total cost per hour) and the adoption of reduced tillage, and c) testing the hypothesis that lower tractor costs, longer lived tractors, and lower repair costs are associated with adoption of reduced tillage.

Methods

Survey Instrument

A survey instrument was developed with the explicit goal of brevity and ease of completion on the part of the respondent. The survey was formatted as a one-page folded postcard. The questions were intended to be answered by the respondent "off the top of his head", i.e., without having to reference detailed information on file. The survey asked respondents to rate their level of tillage on a simple five point scale where 1= conventional tillage (with examples of typical implements), 2-4 were progressively reduced tillage, and 5=no tillage. Respondents were also asked how many years they had operated with this tillage system. The survey also solicited the following information about the respondents' tractors: acres farmed, tractor make/model, own/lease status, expected life, annual hours of use, and implements used with that tractor.

Mail Survey

The population being sampled was the population of cotton farmers in West and South Texas (excluding the High Plains and Rolling Plains). Official county extension cotton farmer mailing lists were obtained from county extension agents in these regions. As such, the sample for this study was not strictly random. However, we argue that the sample was representative of the total population of cotton farmers in these areas because 1) the lists were extensive and in some cases represented the total population of cotton farmers, and 2) we do not expect any systematic differences between the population of all cotton farmers and the subset of cotton farmers who receive extension mailings. In most cases, we expect them to closely overlap.

Self addressed, stamped survey postcards were mailed to 3,838 farmers in the West/South Texas study area. Of these, 383 surveys were returned for a ten percent response rate.

Data Development

The survey data were coded into a Microsoft Excel database. Observations with missing values for useful life, remaining life, tillage system, and tractor model/make were excluded, as were several notable outliers. Given the multiple tractor observations for each of the 383 returned surveys (i.e., one survey per farming operation), the resulting usable dataset had 1,132 observations of tractor information with an associated tillage rating. For each tractor observation, the reported tractor model/make, horsepower, and tractor age were used to obtain corresponding current market value and current list price using a tractor blue book. All of these variables were inputted into an Excel-based machinery cost estimator template called MACHCOST (McGrann, 2003) to calculate variable, fixed and total costs per hour for each tractor observation. In addition, the variable cost calculations were broken down into fuel/lube and repairs/maintenance.

Regression Analysis

Regression analysis was applied to test the following prior hypotheses: 1) tractor total cost per hour is a decreasing function of tillage index (where the latter is one for conventional tillage and five for no tillage); 2) repair/maintenance cost is a decreasing function of tillage index; 3) tractor age is an increasing function of tillage index; and 4) tractor horsepower is negatively correlated to tillage index. Ordinary least squares was used to estimate several multivariate specifications of these four dependent variables. Besides tillage index, the other regressors included tenure (i.e., the years in which a reported tillage system had been used), acres, and dummy variables for specific regions.

Results and Discussion

Descriptive Statistics

Table 1 shows average, minimum and maximum values for observed or calculated tractor variables. This data summary shows that the average tractor in use is old (average is 17 years) used in a large operation (average = 2,330 acres) employing a tillage system that involves either annual or alternate year plowing (i.e., average tillage index = 1.8). By far the most common tillage index rating in the survey data was a "1" indicated conventional tillage with annual moldboard or chisel operations.

Ordinary Least Squares

This paper presents OLS regression results of total costs. The estimated equation was

[1] tcost = tillage tenure acres own age annhrs bbook hp, where

tcost	is total tractor cost per hour,
tillage	is index of current tillage system where 1= conventional and 5 = no till
tenure	is number of years of operation in the current tillage system
acres	is number of acres farmed
own	is indicator variable of own/lease
age	is tractor age, in year
annhrs	is annual hours of operation
bbook	is current blue book market value
hp	is tractor horsepower.

The regression used 1,131 observations. The resulting adjusted R^2 value was 0.7944 indicating that a considerable portion of the variability in tractor cost was explained by the independent variables. The regression parameter estimates and associated statistics are of the expected sign, with the notable exception of tillage, which was not significant. In general, farms with more acreage and older tractors were associated with lower tractor costs, probably because of lower fixed costs. Higher value tractors, larger horsepower ratings, and more annual hours were all associated with higher tractor costs per hour, which is also not a surprising result. What is surprising is that the tillage index was not significant at all. In similar regressions of R&M cost (results not shown), tillage index had an expected sign of –0.11 but was borderline significant (P=0.11). This implies that for each unit change in tillage index towards no till (on a scale from one to five), the predicted change in tractor R&M costs is $0.11/hour.

OLS regression might not be the best approach since the univariate relationship between tillage index and either tractor total cost, tractor R&M cost, and tractor age all appeared nonlinear (see Figures 1 through 3). Therefore further analysis with nonlinear regression is warranted. The data development for this study is still in the preliminary stage and will eventually include additional information on specific implements reportedly used with each tractor. The relationship between tractor costs and their use with specific implements (data not shown) could be a substitute approach to using the tractor index as a regressor. One potential confounding issue is that adopters of reduced tillage may not have disinvested themselves of their larger tractors, or been able to take advantage of owning a tractor for a longer period of time than could have been done using conventional tillage. It may take another five to ten years to show a stronger relationship between current tractor age or size (and hence costs) and tillage rating.

Acknowledgements

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Table 1. OLS Regression Results.

Variable Name	Estimated Coefficient	Standard Error	T-Ratio 1122 df	P-value
TILLAGE	0.32888 E-02	0.1421	0.2314E-01	0.982
TENURE	-0.11363 E-01	0.1156 E-01	-0.9827	0.326
ACRES	-0.25868 E-03	0.6845 E-04	-3.779	0.000
OWN	-0.93575	1.068	-0.8760	0.381
AGE	-0.59127 E-01	0.1951 E-01	-3.031	0.002
ANNHRS	0.17484 E-02	0.1017 E-03	17.18	0.000
BBOOK	0.64555 E-04	0.1293 E-04	4.992	0.000
HP	0.12353	0.3973 E-02	31.09	0.000
CONSTANT	14.771	1.326	11.14	0.000

Table 2. Descriptive Statistics of Selected Surveyed Variables.

Variable	Mean	Minimum	Maximum
Tillage Index (1=conv., 5=Notill)	1.8	1	5
Years of Operation with This Tillage System	20.9	1	60
Size of Operation (acres)	2,331	3	10,700
Tractor Age (years)	17	1	60
Tractor Hours of Annual Use	751	10	16,000
Calculated Tractor Repair and Maintenance Cost ($/hr)	$7.04	$0.03	$39.66
Calculated Tractor Fuel and Lube Cost ($/hr)	$9.25	$1.12	$22.68
Calculated Tractor Fixed Cost ($/hr)	$5.41	$0.14	$55.30
Calculated Tractor Total Cost ($/hr)	$33.80	$14.16	$88.76.

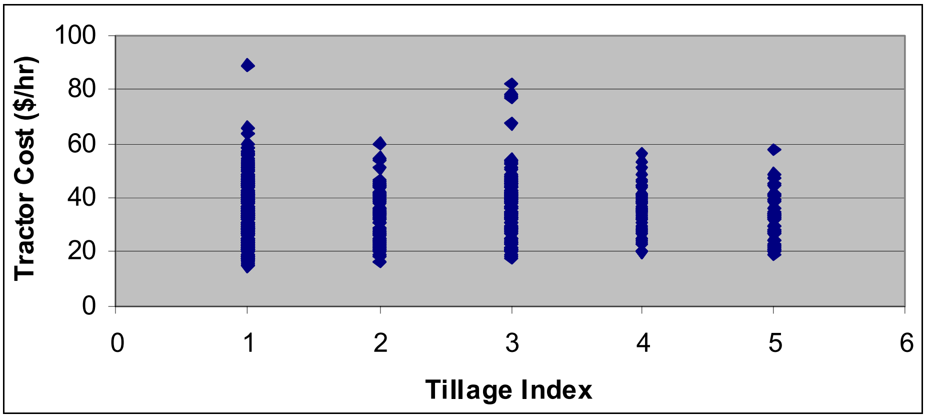

Figure 1. Tractor Cost per Hour by Tillage Adoption Index.

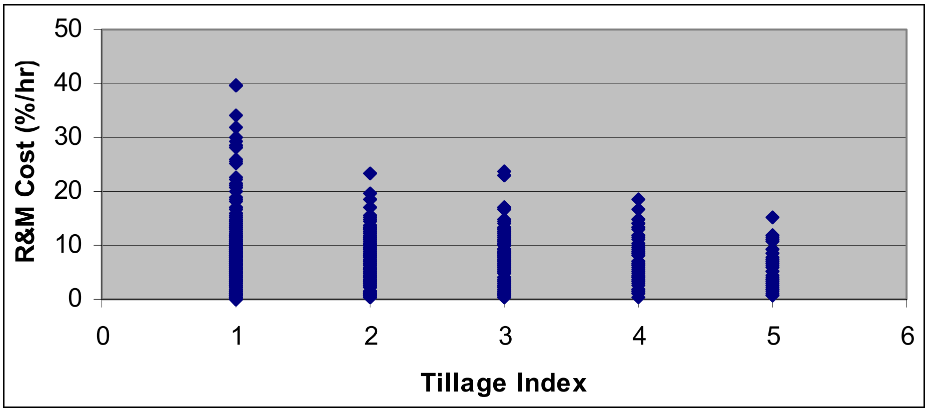

Figure 2. Repair and Maintenance Costs by Tillage Index.

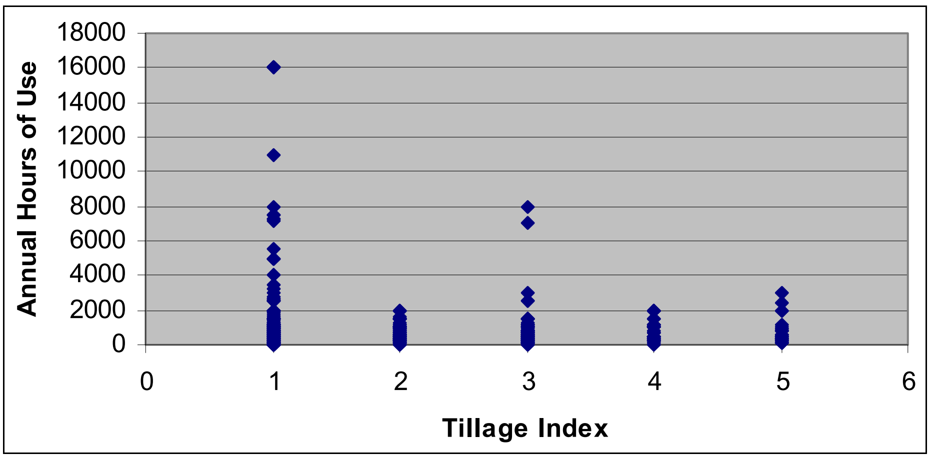

Figure 3. Annual Hours of Use by Tillage Index.