Impact of the Adoption of Less Tillage Practices
on Overall Efficiency

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Abstract

This paper evaluated the impact of the adoption of less tillage practices on the overall efficiency of a sample of farms in Kansas. The paper also explored the relationship between overall efficiency, farm size, and less tillage. Farms that have adopted less tillage practices were relatively more efficient.

Introduction

Over the past decade, there has been a noticeable decrease in the number of tillage operations performed in the production of crops in Kansas and surrounding states. For instance, in 1990, less than 1% of wheat acres and approximately 4% of full season corn, grain sorghum, and soybeans acres in Kansas were produced using no-till practices (CTIC). By 2004, approximately 9% of the wheat acres and 33% of the full season corn, grain sorghum, and soybeans in Kansas were produced using no-till practices (CTIC). An additional 12% of the wheat acres, and 15% of the full season corn, grain sorghum, and soybean acres were produced using mulch till and ridge till practices in 2004 (CTIC).

Despite the trend in the reduction of tillage operations, there are still quite a few farms that have not drastically reduced the number of tillage operations employed. Information on the benefits and costs associated with the reduction in tillage operations would be useful to those that have not materially changed their tillage practices.

Previous research has focused on the adoption of no-till practices. While it is interesting to study no-till adoption, there are numerous farms that have reduced tillage operations, but have not adopted no-till. By examining the reduction in tillage in general, this paper will address a broader topic than the investigation of the adoption of no-till practices and should be of interest to a wider audience.

The primary objective of this paper was to evaluate the impact of the adoption of less tillage practices on the overall efficiency of a sample of Kansas farms. The paper also examined the impact of farm size on efficiency, and compared the characteristics of farms by less tillage category.

Methods

Overall efficiency for each farm was computed using the economic total expense ratio. Under perfect competition, the economic total expense ratio would be equivalent to overall efficiency computed using Data Envelope Analysis (DEA). The economic total expense ratio was computed by dividing economic cost by gross farm income.

Overall efficiency for each farm was related to farm size and a less tillage index using the following relationship:

(1)   ETEXPR = f(GFI, LTI)

where ETEXPR is the economic total expense ratio, GFI is gross farm income, and LTI is a less tillage index. The less tillage index is computed by dividing herbicide and insecticide cost by total crop machinery cost. A farm that has reduced tillage would have relatively higher chemical costs, relatively lower machinery costs, and a higher less tillage index. The less tillage index has been used by Nivens, Kastens, and Dhuyvetter (2002) to examine the adoption of reduced tillage practices. The relationship in equation (1) was explored using Ordinary Least Squares regression.

Due to the importance of economies of size, the relationship between the economic total expense ratio and gross farm income is expected to be negative. Given the trend in the reduction of tillage operations, a negative relationship is also expected between the economic total expense ratio and the less tillage index.

Because of changes in rainfall and soil quality across Kansas, the relationship between the economic total expense ratio and the less tillage index may vary by region. To account for this possibility, equation (1) was estimated for eastern, central, and western Kansas, as well as for the entire state.

In addition to exploring the relationship between overall efficiency, farm size, and a less tillage index, financial and production characteristics are compared across less tillage categories. The less tillage categories were developed by sorting the farms by the less tillage index and grouping the farms into three categories: bottom one-third, middle one-third, and top one-third. The top one-third category would have the highest levels of the less tillage index.

Data

Table 1 contains summary information for a sample of 681 Kansas farms. All of the sample farms were members of the Kansas Farm Management Association and had continuous data for the 1999-2003 period. To be included in the sample, each farm had to have used over two-thirds of its labor to produce dryland crops. On average, the sample farms received approximately 80% of their gross farm income from crop production. The other 20% of gross farm income was obtained from livestock production, custom work, and patronage dividends.

The economic total expense ratio for each farm was computed using total economic cost and gross farm income information. Total economic cost was computed by summing labor costs, purchased input costs, and capital costs. Labor costs included unpaid operator and family labor, and hired labor. Average family living expenses were multiplied by the number of operators on the farm to obtain an opportunity charge for unpaid operator and family labor. Purchased input costs included purchased feed, seed, fertilizer, organization fees, veterinarian expenses, marketing expenses, herbicide and insecticide, and crop insurance. Capital costs included depreciation, repairs, fuel and utilities, machine hire, taxes, general insurance, and an opportunity charge on assets. The

opportunity charge on assets included opportunity charges for purchased inputs, current crop and livestock inventories, breeding livestock, machinery and equipment, buildings, and land.

The economic total expense ratio averaged 1.2684 over the study period. Capital costs accounted for approximately 52% of total economic costs. Labor and purchased input costs accounted for approximately 21% and 27% of total economic costs, respectively. Average farm size, as measured using gross farm income, was $221,942. On average, the less tillage index was 0.2661 indicating that herbicide and insecticide costs were on average approximately 27% of total crop machinery costs.

Results

Table 2 contains a summary of financial and production characteristics by less tillage category. Individual farms were categorized into the low one-third, middle one-third, and high one-third categories with respect to their less tillage index. Farms in the low one-third group till the soil more intensively and have a relatively higher economic total expense ratio. Specifically, this group had an economic total expense ratio of 1.43. In contrast, the high one-third group had an economic total expense ratio of 1.17. This result suggests that farms that have not adopted less tillage practices have higher per-unit costs. Farms in the top one-third category also tended to be larger, had relatively higher purchased input costs in proportion to total economic costs, and relatively lower labor and capital costs in proportion to total economic costs.

Table 3 presents the response of the economic total expense ratio to changes in the less tillage index and gross farm income. Results are presented for eastern, central, and western Kansas, as well as for the entire state. The elasticities reported in table 3

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were computed using variable means and regression coefficients resulting from the estimation of equation (1) for each region and for the entire state. All of the regression coefficients had the expected sign and were significant at the 5% level.

The response of the economic total expense ratio to changes in the less tillage index differs across regions. The economic total expense ratio for farms in western Kansas was relatively more responsive to changes in the less tillage index. In western Kansas, a 10% increase in the less tillage index would result in a 1.07% decrease in the economic total expense ratio while in eastern Kansas a 10% increase in the less tillage index would result in a 0.60% decrease in the economic total expense ratio. Given the difference in rainfall between eastern and western Kansas, the difference in the response to changes in the less tillage index are intuitive. Conserving moisture is considerably more important in western Kansas. Reducing tillage helps conserve moisture.

As expected, there was a negative relationship between the economic total expense ratio and farm size. This result reveals the importance of economies of size and is consistent with other studies (Hallam, 1993; Purdy, Langemeier, and Featherstone, 1997; Cotton, Langemeier, and Featherstone, 1998-99). The response of the economic total expense ratio to changes in farm size varied by region. Farm size changes had a relatively larger impact in eastern and central Kansas than in western Kansas. Using the elasticity for the entire state, a one standard deviation increase in gross farm income would result in a decrease in the economic total expense ratio from 1.27 to 1.10.

Summary

This paper examined the impact of reducing tillage and farm size on overall efficiency. A less tillage index was created using herbicide, insecticide, and crop

machinery costs. Farms that have reduced tillage would have a higher less tillage index.

Results indicated that farms that have reduced tillage were more efficient.

To further explore the differences in production and financial characteristics across farms, the less tillage index was used to categorize farms into three groups: bottom one-third, middle one-third, and top one-third. Farms in the top one-third category, in addition to being more efficient, tended to be larger, had relatively higher purchased input cost in proportion to total economic costs, and relatively lower labor and capital costs in proportion to total economic cost.

The economic total expense ratio was more responsive to changes in the less tillage index in western Kansas than it was in central and eastern Kansas. Reducing tillage operations allows farms in the dryer parts of Kansas to conserve moisture and to more readily plant dryland corn, dryland grain sorghum, and dryland soybeans.

References

Cotton, M.K., M.R. Langemeier, and A.M. Featherstone. "Effects of Weather on Multi-Output Efficiency of Kansas Farms." *Journal of the American Society of Farm Managers and Rural Appraisers*. 62(1998-99):85-91.

CTIC (Conservation Technology Information Center). Crop Residue Management Survey. http://www.ctic.purdue.edu/CTIC/CRM.html

Hallam, A. "Economies of Size: Theory, Measurement, and Related Issues." In *Size, Structure, and the Changing Face of American Agriculture*, edited by A. Hallam. Boulder: Westview Press, 1993.

Nivens, H.D., T.L. Kastens, and K.C. Dhuyvetter. "Payoffs to Farm Management: How Important is Crop Marketing." *Journal of Agricultural and Applied Economics*. 34(2002):193-204.

Purdy, B.M., M.R. Langemeier, and A.M. Featherstone. "Financial Performance, Risk, and Specialization." *Journal of Agricultural and Applied Economics*. 29(July 1997):149-161.

Table 1. Financial and Production Characteristics for a Sample of 681 Kansas Farms.

Variable	Average	Std. Dev.
Labor Cost	45,358	23,637
Purchased Input Cost	73,870	61,877
Capital Cost	131,742	89,408
Gross Farm Income	221,942	169,482
Labor Cost Share	20.85%	7.87%
Purchased Input Cost Share	27.04%	7.93%
Capital Cost Share	52.10%	7.62%
Economic Total Expense Ratio	1.2684	0.4758
Less Tillage Index	0.2661	0.1722
Total Acres	1,782	1,183
Crop Acres	1,404	969
Wheat Acres	464	450
Corn Acres	151	252
Sorghum Acres	213	228
Soybean Acres	286	385
Percent of Farms in Eastern Kansas	43.76%	49.65%
Percent of Farms in Central Kansas	42.29%	49.44%
Percent of Farms in Western Kansas	13.95%	34.67%

Table 2. Financial and Production Characteristics by Less Tillage Index Category.

Variable	Bottom One-Third	Middle One-Third	Top One-Third
Labor Cost	40,332	45,384	50,358
Purchased Input Cost	47,838	75,132	98,640
Capital Cost	114,236	138,274	142,717
Gross Farm Income	169,703	229,674	266,448
Labor Cost Share	23.38%	19.63%	19.55%
Purchased Input Cost Share	21.05%	27.67%	32.41%
Capital Cost Share	55.57%	52.70%	48.04%
Economic Total Expense Ratio	1.4344	1.1971	1.1736
Less Tillage Index	0.1066	0.2401	0.4515
Total Acres	1,556	1,822	1,969
Crop Acres	1,197	1,411	1,604
Wheat Acres	526	463	404
Corn Acres	75	141	236
Sorghum Acres	152	234	252
Soybean Acres	167	285	405
Percent of Farms in Eastern Kansas	32.16%	44.93%	54.19%
Percent of Farms in Central Kansas	51.54%	40.97%	34.36%
Percent of Farms in Western Kansas	16.30%	14.10%	11.45%

Table 3. Relationship Between Economic Total Expense Ratio, Farm Size, and Less Tillage Index.

Region	LTI Elasticity	GFI Elasticity
Kansas	-0.0788	-0.1709
Eastern Kansas	-0.0604	-0.1505
Central Kansas	-0.0828	-0.2284
Western Kansas	-0.1072	-0.1035

Note:

LTI = less tillage index
GFI = gross farm income