IMPACT OF TILLAGE SYSTEM ON INPUT DEMANDS FOR FARMS

Elizabeth A. Yeager, Michael R. Langemeier, and Tian Xia

August 2011
Staff Paper No. 12-01

The authors are graduate research assistant, professor, and associate professor in the Department of Agricultural Economics, Kansas State University, Manhattan, KS 66506-4011.

Contribution no. 12-082-D from the Kansas Agricultural Experiment Station.

Kansas State University,
Manhattan, KS 66506-4011

Impact of Tillage System on Input Demands for Farms

Elizabeth A. Yeager, Michael R. Langemeier, and Tian Xia

August 2011
Staff Paper No. 12-01

The authors are graduate research assistant, professor, and associate professor in the Department of Agricultural Economics, Kansas State University, Manhattan, KS 66506-4011.

Impact of Tillage System on Input Demands for Farms

Abstract

This study used 10 years of continuous data for 218 farms in central Kansas to estimate input demands for labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital. Additional variables of interest were tillage method, percent of labor devoted to crop production, and average total assets. The farms denoted as no-till had an increased demand for seed and chemicals. The farms with a greater percentage of labor devoted to crop production had an increased demand for seed, fertilizer, chemicals, repairs, fuel, and capital. Larger farms in terms of average total assets had an increased demand for labor and capital.

Key words: input demands

JEL Classifications: Q11, Q12

Impact of Tillage System on Input Demands for Farms

Introduction

Few studies have identified the factor demands of inputs for agricultural production and the relationship between the demand for inputs and the use of conventional or mixed tillage methods and no-till. Previous studies on demand for agricultural inputs are dated and primarily focus on energy inputs. Recent studies have begun to look at the profitability differences in mixed-tillage or no-till practices as compared to conventional tillage practices, but they have not identified the changes in demand for agricultural inputs as a result of the tillage decision.

In the late 1970s and during the 1980s, there was a lot of interest in energy prices and their impact on agricultural production. Burton and Kline (1978) were concerned with how farms may adjust their energy consumption if an energy crisis occurred. They used models of farms designed to represent a typical dairy farm in Virginia. They found that compared to conventional tillage, no-till corn production techniques used more energy inputs. They required less engine fuel per acre, but they used more energy inputs in the form of nitrogen fertilizer and pesticides.

Kliebenstein and McCamley (1983) estimated linear, quadratic, and cubic energy demand functions for inputs that supply energy directly (i.e., diesel fuel) and inputs that can be substituted for energy-supplying inputs (i.e., herbicides) for risk averse producers using a model of a typical Missouri crop farm. They found that energy consumption elasticities were more responsive to changes in crop prices than changes in energy prices.

Shumway and Alexander (1988) estimated demand equations for the following agricultural inputs: material, hired labor, machinery, and energy input groups for ten regions of the United States comprising the contiguous 48 states. They also estimated output supply equations. Results indicated that there was considerable regional variation; the price elasticities varied more across regions than across the input and output categories.

A study by Parsch et al. (2001) examined the profitability differences between conventional tillage and conservation tillage for six years in eastern Arkansas using test plot data. Their study confirmed a common finding that conservation tillage results in higher variable input costs and lower equipment costs. They found that on average, net revenue minus total costs was higher for conventional tillage versus conservation tillage for every cropping system except continuous cotton.

No-till production practices are growing in popularity. A benefit of no-till systems is that they allow for a shorter cropping cycle due to the reduced time spent preparing the fields. This may allow for double-cropping not previously used due to time constraints (FAO 2001). The United States saw an increase in no-till adoption from 16 million acres to 52 million acres between 1990 and 2000 (Fawcett and Caruana 2001). The North Central Kansas Farm Management Association experienced an increase in the number of farms listed as no-till from 7 farms in 1996 to 76 farms in 2008. Langemeier (2010a) examined the efficiency and profitability of no-till and mixed tillage for farms in the South Central and North Central Kansas Farm Management Association. The no-till farms were on average larger, produced relatively less wheat and more feed grains and oilseeds, were more cost efficient, and had higher profit margin and asset turnover ratios.

This study adds to the previous literature by using farm-level data for a sample of Kansas farms. Many previous studies have instead used simulated data or aggregate data. This may be of concern due to issues with aggregation bias and applicability to farms in other regions (Theil 1954; Lee, Pearson, Pierse 1990).

The objective of this study is to determine the input demands for labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital using a system of equations; and explore the differences in input demands for conventional tillage versus no-till farms, for farms with a higher percent of labor devoted to crops, and the impact of farm size. Elasticity values will also be calculated and interpreted for own-price, cross-price, and expenditure elasticities.

Methods

In order to estimate the factor input demands, the AIDS (Almost Ideal Demand System) model developed by Deaton and Muellbauer (1980) was used. The AIDS model was chosen because it has many desirable properties. It provides a first order approximation to the general unknown relationship among the budget shares, the log of the expenditures, and log of prices. It is also very flexible and allows for additional explanatory variables to be included in the model. The following linear approximation of the AIDs model was estimated:

(1) $$w_i = a_i + b_i \ln\left(X/P\right) + \sum_{j=1}^{8} c_{ij} \ln p_j + d_i nt + e_i \%labor + f_i aasset + u_i,$$

where w_i is the share of total expenditure allocated to input *i* (=1, 2, …, 8), *i* indexes the eight input categories, labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital; p_j is price for item *j*; $X = \sum_{i=1}^{8} p_i q_i$ is total expenditure; P denotes Stone's geometric price index ($\ln P = \sum_{i=1}^{8} w_i \ln p_i$); nt is a dummy variable denoting 1 for farms categorized as no-till; *%labor* is percent of labor devoted to crop production; *aasset* is total average assets; a_i through f_i are the parameters to be estimated and u_i is the error term for input *i*. This system is estimated with the implicit assumption that farm inputs are a weakly separable group.

The no-till variable was included to determine if the budget share spent on the inputs differed based on the decision to use conventional or mixed tillage practices or only no-till. Wheat acreage has been decreasing over the last few decades while feed grains and oilseeds acreage has increased (Langemier 2009). Wheat acres as a percentage of total crop acres was considered as a variable to capture this trend, but it was not included in the model because of the significant negative correlation between no-till and wheat acres.

The percent of labor devoted to crop production was included to capture the differences in the farms in terms of whether they were predominately crop or livestock production. Total average assets were included as an indicator of farm size. Previous research has used a variety of measures for farm size including number of employees, acres, livestock numbers, and total assets. Each measure has issues with its use, but average total assets seems to be the least problematic. This is especially true when considering farms that include both crop and livestock enterprises.

It is expected that the conventional tillage farms will allocate their budget across inputs differently than no-till farms. The conventional tillage farms are expected to have a larger share of their costs going to machinery repair, fuel and utilities, and labor than the no-till farms. The no-till farms are expected to have a larger share of their costs being allocated to chemicals.

Data

A panel data set comprised of 10-years of data for 218 farms from central Kansas was used in this study. To be included in the study, the farms must have been continuous members of the Kansas Farm Management Association (KFMA) over the 10-year period from 1999-2008. Central Kansas farms were chosen because data is available on whether they used conventional tillage or no-till practices. Farms that used conventional tillage for some cropping enterprises and no-till for other cropping enterprises were considered as a conventional tillage farm. In order to be considered no-till, the farm had to utilize a no-till production system for all of their crops. Due to data limitations, each farm was denoted as conventional tillage or no-till for all ten years based on their classification in 2008. For more information on the variables available in the KFMA databank and their definitions see Langemeier (2010b).

Labor input price was calculated by taking the labor cost and dividing by the number of workers on the farm (i.e., the labor input). The number of workers on each farm was computed using labor months for part-time and full-time workers, and included hired and unpaid family and operator labor. An opportunity charge per operator was used to account for the unpaid family and operator labor (in 2008 this charge was $47,500 per operator). All other prices were from USDA Agricultural Prices using 2008 as the base year for the price indices. Implicit quantities of the inputs other than labor were determined by taking the input cost for the farm and dividing by the appropriate price index. The livestock input included feed, veterinary, dairy, and livestock marketing and breeding. The chemical input included both herbicides and insecticides. The repair input included those on machinery, irrigation equipment, and buildings. The fuel input included fuel and oil, automotive, irrigation energy, crop storage and marketing, and utilities. The capital input included machine hire, conservation, interest, cash farm rent, depreciation, opportunity interest charge, fees, real estate taxes, personal property taxes, general farm insurance, and crop insurance.

Table 1 provides summary statistics for the variables used in the estimation. The average total expenditure on farm inputs was $329,287. The largest budget share was for capital, accounting for approximately 40.67 percent of expenditures. The smallest budget share was for seed with approximately 4.93 percent of expenditures. The average percent of labor devoted to crop production was 82.96 indicating that, on average, the farms in this sample used more of their labor for crop production than for livestock production. The percent of labor devoted to crop production varied across farms with a range of 3 percent to 100 percent. Most of the farms had both crops and livestock enterprises, however, the importance of livestock in terms of total expenditures varied greatly. Seven of the farms had no livestock inputs during the ten year period while others had no livestock expenditures for several of the years. All other inputs were utilized by every farm to at least some extent.

A total of 57 farms, 570 observations, were denoted as no-till. The average total assets were approximately $832,840, however, average total assets ranged from $82,724 to $5,687,197, indicating that the range in terms of size of farms where size is measured in total assets is quite large.

Results

The LA/AIDS model was estimated using the PROC SYSLIN iterative seemingly unrelated regression (ITSUR) procedure in SAS 9.1. No restrictions were initially placed on the model. The adding-up conditions are automatically met in the AIDS model. Therefore, only seven equations are necessary to estimate the system. The seed equation was dropped during estimation and its parameters were calculated afterward using the adding-up restrictions. The symmetry and homogeneity restrictions were tested and imposed after the tests indicated that we fail to reject the corresponding null hypothesis at the five and one percent significance level, respectively.

The parameter estimates are presented in table 2. Three of the eight own-price coefficients were significant at the five percent level or less. Eleven of the twenty-eight cross price coefficients were significant at the 10 percent or 5 percent levels. The coefficients were significant for expenditure, percent of labor devoted to crop production, and total average assets for every equation. The dummy variable for no-till was significant in most of the equations.

This indicates that the size of the farm, the time devoted to crop production, and tillage decision did impact the budget share allocated to each input.

Based on the estimation results, the farms denoted as no-till had no difference in the demand for labor; had an increased demand for seed and chemicals; and had a decreased demand for livestock, fertilizer, repairs, fuel, and capital.[1] By devoting a larger percentage of time to crop production, a farm had an increased demand for seed, fertilizer, chemicals, repairs, fuel, and capital; and a decreased demand for labor and livestock. Larger farms in terms of average total assets had an increase in quantity demanded of labor and capital and a decrease in quantity demanded of livestock, seed, fertilizer, chemicals, repairs, and fuel.

As mentioned previously, it was expected that no-till farms would have a different demand for inputs that conventional tillage farms. One unexpected result was the insignificant difference in the demand for labor. No-till systems are often assumed to be labor saving. These results indicate that may not be the case. This could be due to the changes in crop rotations and the potential for double cropping (FAO 2001). The increased demand for seed is likely attributed to the switch from wheat to feed grains, particularly corn, associated with the adoption of a no-till system (Langemeier 2010a). The decreased demand for repairs, fuel, and capital is as expected due to the shorter time spent preparing seed beds (FAO 2001; Parsch et al. 2001). It was initially expected that there should be no difference in the demand for livestock between conventional and no-till cropping systems. However, the no-till farms in this sample were found to have a decreased demand for livestock. This is likely attributed largely to the fact that the percent of labor devoted to crop production was higher for the no-till farms, approximately 87 percent, compared to conventional tillage farms, approximately 82 percent. The decreased demand for fertilizer by no-till farms was also unexpected because no-till farms typically produce more feed grains which require more fertilizer. However, this coefficient was not significantly different from zero. The fact that an increased demand for fertilizer was not observed may be due to the higher cost efficiency observed by no-till farms (Langemeier 2010a).

The results with respect to the percent of labor devoted to crop production variable were not surprising. Livestock operations, particularly beef cow, dairy cow, and swine operations, tend to be more labor intensive. Therefore, the budget share allocated to both labor and livestock would decline as the percent of labor devoted to crop production increases. The larger farms experienced an increased budget share for labor and capital compared to the smaller farms. They had a lower budget share allocated to the other inputs than the smaller farms. The large farms are likely using the additional labor and capital to economize on the other inputs.

Expenditure, own-price (compensated and uncompensated), and cross-price (compensated) elasticities were computed and are presented in table 3 (Zheng and Kaiser 2008). The formulas used are as follows:

(2) $E_i = 1 + {}^{b_i}/_{w_i}$ (expenditure elasticity)

(3) $E_{ii}^C = -1 + {}^{c_{ii}}/_{w_i} + w_i$ (compensated own-price elasticity)

(4) $E_{ij}^C = {}^{c_{ij}}/_{w_i} + w_j$ (compensated cross-price elasticity)

(5) $E_{ii}^U = -1 + {}^{c_{ii}}/_{w_i} - b_i$ (uncompensated own-price elasticity)

The budget shares are the averages over the 10-year sample period. The parameter estimates are as previously defined.

The own-price elasticities for every input were negative as expected in a demand system. This means that as own-price increases demand for the input will decrease. The expenditure elasticities are interpreted holding all other demand factors constant. A 1 percent increase in input expenditures increased demand for labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital by 0.69 percent, 1.37 percent, 1.22 percent, 1.16 percent, 1.20 percent, 1.08 percent, 1.02 percent, and 0.98 percent, respectively. The differences in the magnitude of the elasticities were quite large. The input that is most responsive to a change in expenditure is livestock while the least responsive is labor.

The cross-price elasticities measure the percentage change in demand for input *i* with respect to a one percent price change in input *j* while holding all else constant. The cross-price elasticities will be positive for substitutes and negative for complements. For example, a 1 percent increase in the price of seed decreased demand for chemicals by 0.58 percent holding other demand factors constant. All signs were consistent for the cross-price elasticities, however, the magnitudes did vary. For example, a 1 percent increase in the price of capital increased demand for fuel by 0.38 percent, while a 1 percent increase in the price of fuel increased demand for capital by 0.06 percent.

Conclusion

The objective of this study was to estimate a system of input demand equations for eight major agricultural inputs: labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital while including three other explanatory variables, a no-till dummy variable, the percent of labor devoted to crop production, and average total assets. The AIDS model allows for a rather unique approach to examine the input demands for the farms in this study. The AIDS model was a better choice than the cost function approach for this study because the authors were not concerned with the profit function or output supply of the farms, rather the interest was entirely in the inputs used by the farms viewed as consumers. The AIDS model provides a very flexible functional form to estimate demand, and it allows the constraints implied by economic theory to be imposed or tested. The desirable properties and ease of interpretation were chosen over the standard cost function approach.

It was found that on average, farms that were denoted as no-till did have significant differences in their demand for almost all agricultural inputs. They had an increased demand for seed and chemicals and a decreased demand for livestock, fertilizer, repairs, fuel, and capital. These results are consistent with those found in agronomy studies that variable input costs will increase while those related to machinery will typically be less (Parsch et al. 2001).

Farms that spent a larger percentage of labor on crop production had an increased demand for seed, fertilizer, chemicals, repairs, fuel, and capital; and a decreased demand for labor and livestock. Larger farms in terms of average total assets had an increase in quantity demanded of labor and capital and a decrease in quantity demanded of livestock, seed, fertilizer, chemicals, repairs, and fuel.

Labor and capital inputs had the two largest expenditure shares. An increase in expenditure would result in the quantity demanded of each input increasing, holding all else constant, but it would increase the quantity demanded of livestock inputs the most and labor inputs the least. A 1 percent increase in input expenditures increased demand for labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital by 0.69 percent, 1.37 percent, 1.22 percent, 1.16 percent, 1.20 percent, 1.08 percent, 1.02 percent, and 0.98 percent, respectively.

Additional research in this area is warranted. Changes in relative crop prices impact crop mix decisions. Also, it is important to note that feed grains and oilseeds are more conducive to reduced tillage or no-till practices. If the adoption of no-till continues in the future, the results of this study will be of importance to both producers considering changing their tillage methods and policy makers who work to initiate conservation tillage practices.

Footnotes

[1] The sign of the coefficient, d_i, of the no-till dummy indicates the difference between no-till and conventional tillage farms in not only the budget share of input *i*, but also the quantity demanded for input *i*, *ceteris paribus*, because the budget share and the quantity demanded for an input will change in the same direction when the input price and total expenditure remain unchanged. For example, a positive estimated value of d_i implies that no-till farms have both a larger budget share and a higher level of quantity demanded for input *i* than conventional tillage farms. Similar interpretations apply to the coefficients, e_i and f_i, which accounts for inputs associated with the percent of labor devoted to crop production and total average assets.

References

Burton, R., and R.G. Kline. "Adjustments in a Farm Business in Response to an Energy Crisis." *American Journal of Agricultural Economics* 60(May 1978):254-258.

Fawcett, R., and S. Caruana. "Better Soil Better Yields." Conservation Tillage Information Center 2001. Internet site: http://ctic.paqinteractive.com/media/pdf/Better%20Soil%20Better%20Yields.pdf (Accessed July 2010).

Deaton, A., and J. Muellbauer. "An Almost Ideal Demand System." *American Economic Review* 70(June 1980):312-326.

FAO. "The Economics of Conservation Agriculture." FAO Corporate Document Repository 2001. Internet site: http://www.fao.org/DOCREP/004/Y2781E/y2781e04.htm#P0_0 (Accessed June 2010).

Kliebenstein, J.B., and F.P. McCamley. "Energy-Related Input Demand by Crop Producers." *Southern Journal of Agricultural Economics* 15(December 1983):63-70.

Langemeier, M. "Relative Efficiency of Kansas Wheat Farms." Paper presented at the Risk and Profit Conference, Manhattan, Kansas, August 20-21, 2009.

Langemeier, M. "Relative Technical and Cost Efficiency of No-Till Farms." *Journal of International Farm Management* 5(April 2010a).

Langemeier, M.R. "Kansas Farm Management SAS Data Bank Documentation." Department of Agricultural Economics, Staff Paper No. 11-01, August 2010b.

Lee, K.C., M.H. Pesaran, and R.G. Pierse. "Testing for Aggregation Bias in Linear Models." *The Economic Journal* 100, No. 400, Conference Papers (1990):137-150.

Parsch, L.D., T.C. Keisling, P.A. Sauer, L.R. Oliver, and N.S. Crabtree. "Economic Analysis of Conservation and Conventional Tillage Cropping Systems on Clayey Soil in Eastern Arkansas." *Agronomy Journal* 93(2001):1296-1304.

SAS Institute. *SAS/STAT User's Guide, Version 9.1*. Cary, NC: SAS Institute, 2005.

Shumway C.R., and W.P. Alexander. "Agricultural Product Supplies and Input Demands: Regional Comparisons." *American Journal of Agricultural Economics* 70(February 1988):153-161.

Thiel, H. *Linear Aggregation of Economic Relations*. Amsterdam: North-Holland, 1954.

United States Department of Agriculture, National Agricultural Statistics Service. *Agricultural Prices*, various issues.

Zheng, Y., and H.M. Kaiser. "Advertising and U.S. Nonalcoholic Beverage Demand." *Agricultural and Resource Economics Review* 37(October 2008):147-159.

Table 1. Variable Definitions and Summary Statistics, 1999-2008

Variable	Definition	Mean	Standard Deviation	Minimum	Maximum
q_1	Labor input (number of workers)	1.44	0.78	0.20	7.00
q_2	Livestock input	35,621	68,962	0.00	708,789
q_3	Seed input	27,865	28,695	105	272,576
q_4	Fertilizer input	86,367	74,515	280	646,625
q_5	Chemical input	21,798	20,851	33	207,423
q_6	Repair input	27,508	22,216	587	195,852
q_7	Fuel input	44,326	35,271	4,101	369,452
q_8	Capital input	161,464	107,072	21,758	782,224
p_1	Labor input price	39,132	11,218	15,308	144,411
p_2	Livestock input price (2008 base year)	0.6402	0.1375	0.5155	1.0000
p_3	Seed input price (2008 base year)	0.6351	0.1543	0.4710	1.0000
p_4	Fertilizer input price (2008 base year)	0.4230	0.2107	0.2679	1.0000
p_5	Chemical input price (2008 base year)	0.8935	0.0422	0.8561	1.0000
p_6	Repair input price (2008 base year)	0.8708	0.0768	0.7662	1.0000
p_7	Fuel input price (2008 base year)	0.5311	0.2218	0.2733	1.0000
p_8	Capital input price (2008 base year)	0.8190	0.1102	0.6796	1.0068
w_1	Budget share for labor	0.1867	0.0664	0.0444	0.4821
w_2	Budget share for livestock	0.0587	0.0840	0.0000	0.5724
w_3	Budget share for seed	0.0493	0.0310	0.0007	0.1894
w_4	Budget share for fertilizer	0.1000	0.0484	0.0007	0.3039
w_5	Budget share for chemicals	0.0573	0.0368	0.0001	0.2407
w_6	Budget share for repairs	0.0736	0.0334	0.0043	0.2331
w_7	Budget share for fuel	0.0677	0.0269	0.0108	0.2086
w_8	Budget share for capital	0.4067	0.0886	0.1288	0.7197
x	Total expenditure	329,287	218,675	57,010	1,857,937
nt	Dummy Variable=1 for no-till	57 farms (26%) were no-till			
%labor	Percent of labor devoted to crops	0.8296	0.1831	0.03	1.00
aassets	Total average assets	832,840	608,720	82,724	5,687,197

Table 2. Iterative Seemingly Unrelated Regressions Parameter Estimates of Factor Input Demands for Kansas Farms, 1999-2008

	Intercept	Price Coefficients								Expenditure	NT	%labor	aassets
Equations	a_i	c_{i1}	c_{i2}	c_{i3}	c_{i4}	c_{i5}	c_{i6}	c_{i7}	c_{i8}	b_i	d_i	e_i	f_i
Labor	0.747**	0.006**								-0.058**	0.000	-0.015**	1.49E-08**
	(0.025)	(0.002)								(0.001)	(0.001)	(0.003)	(0.000)
Livestock	0.029	0.004	0.027							0.022**	-0.007**	-0.298**	-1.44E-08**
	(0.057)	(0.005)	(0.030)							(0.002)	(0.003)	(0.007)	(0.000)
Seed	-0.186**	0.007**	-0.004	0.011						0.011**	0.008**	0.053**	-8.10E-09**
	(0.032)	(0.003)	(0.019)	(0.022)						(0.001)	(0.001)	(0.003)	(0.000)
Fertilizer	0.046	-0.012**	-0.0124	0.002	0.064**					0.016**	-0.003	0.093**	-1.53E-08**
	(0.031)	(0.003)	(0.013)	(0.009)	(0.008)					(0.001)	(0.002)	(0.005)	(0.000)
Chemical	-0.167**	0.005*	0.005	-0.036**	0.019*	-0.017				0.012**	0.023**	0.067**	-1.93E-08**
	(0.035)	(0.003)	(0.018)	(0.018)	(0.010)	(0.028)				(0.001)	(0.002)	(0.004)	(0.000)
Repair	-0.041	0.003	0.022	0.002	-0.015	0.022	-0.0546			0.006**	-0.011**	0.028**	-1.45E-08**
	(0.036)	(0.003)	(0.018)	(0.022)	(0.012)	(0.032)	(0.041)			(0.001)	(0.002)	(0.004)	(0.000)
Fuel	0.145**	-0.008**	-0.017*	-0.011	0.011**	-0.004	-0.004	0.034**		0.002**	-0.010**	0.025**	-9.52E-09**
	(0.022)	(0.002)	(0.009)	(0.007)	(0.005)	(0.008)	(0.009)	(0.004)		(0.001)	(0.001)	(0.003)	(0.000)
Capital	0.428**	-0.005	-0.024	0.029**	-0.056**	0.005	0.024**	-0.0019	0.029	-0.010**	-0.002	0.047**	6.61E-08**
	(0.058)	(0.005)	(0.015)	(0.010)	(0.057)	(0.011)	(0.011)	(0.006)	(0.019)	(0.002)	(0.004)	(0.010)	(0.000)

Note: *,** denotes that estimates are significant at the 10 percent and 5 percent levels or less, respectively. Standard errors are in parentheses.

Table 3. Input Demand Elasticities for Sample of Farms

	Compensated Price Elasticities								Expenditure Elasticity	Uncompensated Price Elasticities
Quantity of…	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}	E_{i6}	E_{i7}	E_{i8}	E_i	E_{ii}
Labor input	-0.7831**	0.2480	0.3376**	0.0629**	0.2797*	0.2302	0.0693**	0.1747	0.6880**	-0.9116**
Livestock input	0.0780	-0.4845	-0.0253	-0.0652	0.1512	0.3593	-0.1988*	-0.0001	1.3739**	-0.5652
Seed input	0.0891**	-0.0212	-0.7379	0.0707	-0.5802**	0.0787	-0.1092	0.1199**	1.2198**	-1.0108
Fertilizer input	0.0337**	-0.1111	0.1436	-0.2629**	0.4382*	-0.1096	0.2694**	-0.0389**	1.1594**	-0.3789**
Chemical input	0.0859*	0.1477	-0.6753**	0.2512*	-1.2412	0.3512	0.0032	0.0701	1.2026**	-1.3102
Repairs	0.0908	0.4506	0.1177	-0.0807	0.4347	-1.6683	0.0216	0.1338**	1.0825**	-1.7480
Fuel input	0.0251**	-0.2290*	-0.1500	0.1822**	0.0098	0.0199	-0.4342**	0.0630	1.0224**	-0.5034**
Capital input	0.3805	-0.0004	0.9897**	-0.1581**	0.1582	0.7386**	0.3786	-0.5225	0.9762**	-0.9195

Note: **,* denotes that the estimates are significant at the 10 percent and 5 percent levels or less, respectively. Significance based on significance of coefficients in Table 2.