

Labor Efficiency and Productivity
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Introduction

In a competitive industry, continual improvements in performance are essential. Benchmarking is one of the comparative analysis tools that can be used to assess improvements in performance. The steps involved in benchmarking are as follows: determine what to benchmark, form a benchmarking team, identify benchmarking targets, collect and analyze information and data, and take action. Though these steps seem relatively straightforward, the benchmarking process can be complicated by the sheer number of items that can be benchmarked, the different methods used to compute benchmarks, and changes in production levels due to fluctuations in rainfall and temperature over time.

Using Kansas Farm Management Association (KFMA) data, this paper examines differences in labor efficiency and productivity among farms. Farms are categorized using the overall efficiency index.

Methods

An overall efficiency index was computed for each farm using linear programming (Fare et al., 1985; Coelli et al., 2005). Overall efficiency indices measure differences in cost per unit of output among farms and range from zero to one. Farms with an overall efficiency index of one are producing at the lowest cost per unit of output. Farms with an index below one could lower per unit cost by improving efficiency. Thus, farms with a relatively lower index are inefficient. Two outputs (crop and livestock) and

six inputs (labor, livestock, seed, fertilizer, herbicide and insecticide, and capital) were used to compute the overall efficiency index for each farm. Labor expense included hired and unpaid operator labor. Livestock expense included feed, dairy expense, breeding charges, and veterinarian expenses. Capital expense included fuel, utilities, custom hire expense, repairs, interest, depreciation, insurance, and miscellaneous expenses.

The overall efficiency indices were used along with farm type information to categorize farms. Farm types analyzed included non-irrigated farms in the eastern, central, and western portions of the state; irrigated farms; crop/dairy farms; and crop/beef cow farms. Labor standards were used to identify farm types.

Variables compared among farms included the following: gross farm income, value of farm production, net farm income, value of farm production per worker, labor efficiency index, total acres, crop acres, crop intensity index, less tillage index, crop machinery investment per acre, percent of income derived from specific crop and livestock enterprises, expense ratios, operating profit margin ratio, asset turnover ratio, and overall efficiency index. Value of farm production per worker represents a labor productivity benchmark. The number of workers included hired labor and operator labor. A more productive farm would have a higher value for this variable. The labor efficiency index was computed by dividing total labor expense (hired and unpaid labor expense) by value of farm production. A more efficient farm would have a lower value for this variable.

The crop intensity index was used to examine differences in double cropping among farms. This variable was computed by dividing total harvested acres by total crop

acres. A farm with an index above one would be double cropping to at least some extent. The less tillage index was used to examine differences in tillage practices among farms. This variable is computed by dividing herbicide and insecticide expense by crop machinery cost (fuel, repairs, interest, depreciation, and custom hire expense). Farms that have adopted reduced tillage systems would have a higher index. The percentage of income variables were computed by dividing the enterprise income (e.g., feed grain income) by gross farm income. The expense ratios were computed by dividing the expense for each input by gross farm income. The operating profit margin and asset turnover ratios represent commonly used financial ratio benchmarks.¹

Data

Table 1 presents summary statistics for the sample of farms. For a farm to be included in the analysis, it had to have continuous whole-farm data from 2003 to 2007. Data were available for 781 KFMA farms.

Value of farm production and total acres are commonly used to measure farm size. The average farm included in the analysis had a value of farm production of \$330,272 and 1,907 total acres which included crop, pasture, and farmstead acres.

The average value of farm production per worker was \$217,786. The average labor efficiency index was 0.1814. The average labor efficiency index indicated that approximately 18% of value of farm production was used to cover hired and unpaid labor expense.

Results

Results are summarized below for non-irrigated crop farms, irrigated crop farms, crop/dairy farms, and crop/beef cow farms. There were 249 non-irrigated crop farms in

¹ Additional information pertaining to financial ratios can be found in Langemeier (2007).

eastern Kansas, 234 non-irrigated crop farms in central Kansas, and 41 non-irrigated crop farms in western Kansas. The other farms types were summarized for the entire state.

There were 15 irrigated farms, 18 crop/dairy farms, and 37 crop/beef cow farms.

Though not discussed below, inefficient farms tended to over-utilize both labor and capital.² Thus, the reader should focus on these two expense ratios when examining the results presented in Tables 2-7.

Non-Irrigated Crop Farms

Summary statistics for the non-irrigated crop farms in eastern, central, and western Kansas are summarized in Table 2. Several of the variable averages differ across regions of the state. Because of this, the overall efficiency categories for each region are summarized separately in Tables 3-5.

Table 3 presents summary statistics for non-irrigated crop farms in eastern Kansas in the top overall efficiency category and the bottom overall efficiency category. Table 4 and Table 5 present similar information for central and western Kansas, respectively. The top and bottom categories for eastern and central Kansas represent quartiles. The top and bottom categories for western Kansas represent averages for farms in the bottom one-half and top one-half in terms of the overall efficiency index.

Farms in the top overall efficiency category had a value of farm production per worker that was 85 percent higher in eastern Kansas, 126 percent higher in central Kansas, and 50 percent higher in western Kansas than value of farm production per worker for farms in the bottom overall efficiency category. Consistent with these results, the labor efficiency index or total labor expense as a percent of value of farm production was substantially lower for farms in the top overall efficiency category. Farms in the top

² Overall efficiency was more sensitive to changes in capital than to changes in labor.

category had a labor efficiency index of 0.1361 in eastern Kansas, 0.1602 in central Kansas, and 0.1453 in western Kansas.

In addition to having improved labor efficiency and productivity, farms in the top overall efficiency category tend to be larger, have a higher crop intensity index, have a higher less tillage index, a lower crop machinery investment per acre, generate more income from feed grain production, generate less income from wheat, have significantly lower labor expense and capital expense ratios, and substantially better operating profit margin and asset turnover ratios. Farms in the bottom quartile had a negative operating profit margin in eastern and central Kansas and operating profit margin of only 0.0162 in western Kansas. In contrast, the operating profit margin for farms in the top overall efficiency category ranged from 0.1807 in central Kansas to 0.2320 in eastern Kansas. The average asset turnover ratio for farms in the top overall efficiency category was more than double that of the value for farms in the bottom overall efficiency category in each region of the state.

Irrigated Crop Farms

Table 6 contains information for irrigated crop farms in Kansas. There were not enough irrigated crop farms in the sample to further categorize these farms into top and bottom categories. On average, the irrigated crop farms had a value of farm production per worker of \$367,065 and a labor efficiency index of 0.1140. Both labor efficiency and productivity is substantially above that of the average farm in the sample (see Table 1).

Crop/Dairy Farms

Information for crop/dairy farms can also be found in Table 6. There were not enough crop/dairy farms in the sample to further categorize these farms into top and

bottom categories. On average, crop/dairy farms had a value of farm production per worker of \$118,984 and a labor efficiency index of 0.2850. Given the labor intensive nature of this farm type, it is not surprising to find that labor efficiency and productivity measures for this farm type are substantially worse than that of the average farm in the sample (see Table 1). It is interesting to note that the average overall efficiency index for the crop/dairy farms was 0.8289 or 0.2459 above the index for the average farm.

Crop/Beef Cow

Summary statistics for the crop/beef cow farms can be found in Table 6. Summary statistics for crop/beef cow farms in the bottom and top one-half overall efficiency categories can be found in Table 7. Value of farm production per worker for farms in the top overall efficiency category was 68 percent higher than that of farms in the bottom overall efficiency category. The average labor efficiency index, as well as the labor and capital expense ratios, were substantially higher for farms in the bottom overall efficiency category. Thus, controlling labor and capital expenses was quite difficult for some of the crop/beef cow farms.

In addition to improved labor efficiency and productivity, farms in the top overall efficiency category tended to be larger, generated less income from beef production, and had substantially better operating profit margin and asset turnover ratios. Though the percent of income derived from beef production was lower for the farms in the top category, this group actually had more beef cows. The average number of beef cows was 104 for farms in the bottom category and 118 for farms in the top category.

Summary and Conclusions

This paper examined differences in labor efficiency and productivity among KFMA farms. Farms were categorized using the overall efficiency index. This index accounts for all cash and opportunity costs. Farms in the top overall efficiency category had significantly higher labor productivity, measured using value of farm production per worker, and significantly lower labor expense as a percentage of value of farm production. In addition, farms in the top category tended to be larger, had higher operating profit margins, and higher asset turnover ratios.

Results of this study have important implications for those interested in computing and interpreting benchmarks. In addition to using whole-farm financial ratios such as the operating profit margin ratio and the asset turnover ratio, it is important to benchmark specific expenses including labor. It is important to note that labor benchmarks vary by farm type. For example, crop/livestock farms have higher labor efficiency indices. Thus, it is important to consider farm type when comparing labor benchmarks.

References

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Fare, R., S. Grosskopf, and C.A.K. Lovell. *The Measurement of Efficiency of Production*. Boston: Kluwer-Nijhoff, 1985.

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Table 1. Summary Statistics for Sample of 781 KFMA Farms.^a

Item	Average
<u>Farm Characteristics</u>	
Gross Farm Income (\$)	357,488
Value of Farm Production (\$)	330,272
Net Farm Income (\$)	76,951
Value of Farm Production per Worker (\$)	217,786
Labor Efficiency Index	0.1814
Total Acres	1,907
Crop Acres	1,332
Crop Intensity Index	0.990
Less Tillage Index	0.106
Crop Machinery Investment per Acre (\$)	140.46
<u>Income Shares</u>	
Percent of Income from Feed Grains	22.47%
Percent of Income from Wheat	14.69%
Percent of Income from Oilseeds	16.87%
Percent of Income from Hay and Forage	3.04%
Percent of Income from Beef	18.50%
Percent of Income from Dairy	3.98%
<u>Cost Shares</u>	
Labor Expense Ratio	0.1676
Livestock Expense Ratio	0.0977
Seed Expense Ratio	0.0692
Fertilizer Expense Ratio	0.1040
Herbicide and Insecticide Expense Ratio	0.0554
Capital Expense Ratio	0.5924
<u>Efficiency and Profitability</u>	
Operating Profit Margin Ratio	0.1439
Asset Turnover Ratio	0.3030
Overall Efficiency Index	0.5830

^a Source: Kansas Farm Management Association Databank.

Table 2. Characteristics of Non-Irrigated Crop Farms.^a

Item	Eastern Kansas	Central Kansas	Western Kansas
Number of Farms	249	234	41
<u>Farm Characteristics</u>			
Gross Farm Income (\$)	351,911	291,100	300,350
Value of Farm Production (\$)	344,579	283,323	288,522
Net Farm Income (\$)	85,363	56,642	61,306
Value of Farm Production per Worker (\$)	243,416	208,127	224,461
Labor Efficiency Index	0.1628	0.1953	0.1894
Total Acres	1,731	1,773	2,573
Crop Acres	1,342	1,463	2,172
Crop Intensity Index	1.089	0.989	0.679
Less Tillage Index	0.101	0.117	0.134
Crop Machinery Investment per Acre (\$)	157.18	122.97	75.05
<u>Income Shares</u>			
Percent of Income from Feed Grains	31.38%	22.31%	25.01%
Percent of Income from Wheat	9.44%	28.79%	30.17%
Percent of Income from Oilseeds	31.60%	12.18%	4.11%
Percent of Income from Hay and Forage	2.01%	4.76%	3.43%
<u>Cost Shares</u>			
Labor Expense Ratio	0.1594	0.1901	0.1819
Livestock Expense Ratio	0.0295	0.0359	0.0476
Seed Expense Ratio	0.1013	0.0668	0.0474
Fertilizer Expense Ratio	0.1210	0.1345	0.0850
Herbicide and Insecticide Expense Ratio	0.0604	0.0722	0.0725
Capital Expense Ratio	0.5932	0.6136	0.6742
<u>Efficiency and Profitability</u>			
Operating Profit Margin Ratio	0.1641	0.0931	0.1212
Asset Turnover Ratio	0.3140	0.3429	0.3163
Overall Efficiency Index	0.5571	0.5640	0.5999

^a Source: Kansas Farm Management Association Databank.

Table 3. Overall Efficiency Categories for Non-Irrigated Crop Farms in Eastern Kansas.^a

Item	Bottom Quartile	Top Quartile
<u>Farm Characteristics</u>		
Gross Farm Income (\$)	132,073	585,401
Value of Farm Production (\$)	130,021	570,330
Net Farm Income (\$)	23,576	164,258
Value of Farm Production per Worker (\$)	153,236	283,521
Labor Efficiency Index	0.2841	0.1361
Total Acres	964	2,381
Crop Acres	640	1,924
Crop Intensity Index	1.022	1.124
Less Tillage Index	0.074	0.106
Crop Machinery Investment per Acre (\$)	184.20	153.65
<u>Income Shares</u>		
Percent of Income from Feed Grains	21.78%	33.28%
Percent of Income from Wheat	10.06%	9.22%
Percent of Income from Oilseeds	36.28%	30.50%
Percent of Income from Hay and Forage	6.09%	0.79%
<u>Cost Shares</u>		
Labor Expense Ratio	0.2797	0.1326
Livestock Expense Ratio	0.0210	0.0381
Seed Expense Ratio	0.1036	0.0961
Fertilizer Expense Ratio	0.1201	0.1158
Herbicide and Insecticide Expense Ratio	0.0660	0.0535
Capital Expense Ratio	0.9236	0.4972
<u>Efficiency and Profitability</u>		
Operating Profit Margin Ratio	-0.0359	0.2320
Asset Turnover Ratio	0.1541	0.4339
Overall Efficiency Index	0.4043	0.6788

^a Source: Kansas Farm Management Association Databank.

Table 4. Overall Efficiency Categories for Non-Irrigated Crop Farms in Central Kansas.^a

Item	Bottom Quartile	Top Quartile
<u>Farm Characteristics</u>		
Gross Farm Income (\$)	125,909	450,675
Value of Farm Production (\$)	123,822	435,751
Net Farm Income (\$)	16,957	111,755
Value of Farm Production per Worker (\$)	115,087	260,290
Labor Efficiency Index	0.3565	0.1602
Total Acres	990	2,555
Crop Acres	779	2,091
Crop Intensity Index	0.944	1.011
Less Tillage Index	0.078	0.133
Crop Machinery Investment per Acre (\$)	138.37	108.22
<u>Income Shares</u>		
Percent of Income from Feed Grains	18.11%	23.30%
Percent of Income from Wheat	37.68%	26.05%
Percent of Income from Oilseeds	11.81%	13.22%
Percent of Income from Hay and Forage	3.07%	2.60%
<u>Cost Shares</u>		
Labor Expense Ratio	0.3506	0.1549
Livestock Expense Ratio	0.0242	0.0444
Seed Expense Ratio	0.0752	0.0624
Fertilizer Expense Ratio	0.1481	0.1267
Herbicide and Insecticide Expense Ratio	0.0667	0.0670
Capital Expense Ratio	0.8951	0.5131
<u>Efficiency and Profitability</u>		
Operating Profit Margin Ratio	-0.1421	0.1807
Asset Turnover Ratio	0.1731	0.4791
Overall Efficiency Index	0.4106	0.6955

^a Source: Kansas Farm Management Association Databank.

Table 5. Overall Efficiency Categories for Non-Irrigated Crop Farms in Western Kansas.^a

Item	Bottom Half	Top Half
<u>Farm Characteristics</u>		
Gross Farm Income (\$)	229,338	367,982
Value of Farm Production (\$)	223,801	350,161
Net Farm Income (\$)	35,086	86,278
Value of Farm Production per Worker (\$)	177,902	267,013
Labor Efficiency Index	0.2617	0.1453
Total Acres	2,374	2,762
Crop Acres	1,933	2,401
Crop Intensity Index	0.637	0.709
Less Tillage Index	0.108	0.158
Crop Machinery Investment per Acre (\$)	86.07	66.57
<u>Income Shares</u>		
Percent of Income from Feed Grains	21.49%	27.10%
Percent of Income from Wheat	34.26%	27.74%
Percent of Income from Oilseeds	2.58%	5.02%
Percent of Income from Hay and Forage	4.25%	2.94%
<u>Cost Shares</u>		
Labor Expense Ratio	0.2554	0.1383
Livestock Expense Ratio	0.0343	0.0555
Seed Expense Ratio	0.0335	0.0556
Fertilizer Expense Ratio	0.0844	0.0853
Herbicide and Insecticide Expense Ratio	0.0787	0.0688
Capital Expense Ratio	0.8451	0.5728
<u>Efficiency and Profitability</u>		
Operating Profit Margin Ratio	0.0162	0.1851
Asset Turnover Ratio	0.2092	0.4593
Overall Efficiency Index	0.5087	0.6867

^a Source: Kansas Farm Management Association Databank.

Table 6. Characteristics of Irrigated Crop and Crop/Livestock Farms.^a

Item	Irrigated	Crop Dairy	Crop Beef Cow
Number of Farms	15	18	37
<u>Farm Characteristics</u>			
Gross Farm Income (\$)	630,177	458,471	179,328
Value of Farm Production (\$)	626,469	337,652	166,273
Net Farm Income (\$)	96,182	82,461	41,369
Value of Farm Production per Worker (\$)	367,065	118,984	140,267
Labor Efficiency Index	0.1140	0.2850	0.2954
Total Acres	1,958	738	1,872
Crop Acres	1,603	509	730
Crop Intensity Index	1.110	1.022	0.916
Less Tillage Index	0.105	0.077	0.090
Crop Machinery Investment per Acre (\$)	231.60	185.06	128.19
<u>Income Shares</u>			
Percent of Income from Feed Grains	50.59%	2.64%	10.96%
Percent of Income from Wheat	12.32%	2.22%	13.72%
Percent of Income from Oilseeds	7.48%	3.92%	12.05%
Percent of Income from Hay and Forage	6.19%	1.45%	3.60%
Percent Income from Beef	1.56%	1.66%	43.34%
Percent Income from Dairy	0.42%	83.54%	5.06%
<u>Cost Shares</u>			
Labor Expense Ratio	0.1134	0.2099	0.2739
Livestock Expense Ratio	0.0074	0.3732	0.1021
Seed Expense Ratio	0.0818	0.0222	0.0464
Fertilizer Expense Ratio	0.1033	0.0375	0.0974
Herbicide and Insecticide Expense Ratio	0.0622	0.0158	0.0471
Capital Expense Ratio	0.6454	0.4121	0.8034
<u>Efficiency and Profitability</u>			
Operating Profit Margin Ratio	0.1413	0.1052	0.0177
Asset Turnover Ratio	0.4638	0.3664	0.1766
Overall Efficiency Index	0.6064	0.8289	0.5148

^a Source: Kansas Farm Management Association Databank.

Table 7. Overall Efficiency Categories for Crop/Beef Cow Farms.^a

Item	Bottom Half	Top Half
<u>Farm Characteristics</u>		
Gross Farm Income (\$)	131,520	224,619
Value of Farm Production (\$)	123,938	206,380
Net Farm Income (\$)	26,362	55,585
Value of Farm Production per Worker (\$)	104,053	174,898
Labor Efficiency Index	0.4025	0.2345
Total Acres	1,689	2,045
Crop Acres	601	853
Crop Intensity Index	0.915	0.917
Less Tillage Index	0.052	0.129
Crop Machinery Investment per Acre (\$)	160.12	106.76
<u>Income Shares</u>		
Percent of Income from Feed Grains	9.14%	11.97%
Percent of Income from Wheat	10.83%	15.32%
Percent of Income from Oilseeds	11.60%	12.29%
Percent of Income from Hay and Forage	4.07%	3.34%
Percent Income from Beef	55.15%	36.79%
Percent Income from Dairy	0.01%	7.87%
<u>Cost Shares</u>		
Labor Expense Ratio	0.3793	0.2155
Livestock Expense Ratio	0.0787	0.1151
Seed Expense Ratio	0.0486	0.0452
Fertilizer Expense Ratio	0.1041	0.0937
Herbicide and Insecticide Expense Ratio	0.0378	0.0522
Capital Expense Ratio	1.1000	0.6389
<u>Efficiency and Profitability</u>		
Operating Profit Margin Ratio	-0.1323	0.1030
Asset Turnover Ratio	0.1124	0.2618
Overall Efficiency Index	0.4116	0.6126

^a Source: Kansas Farm Management Association Databank.