ABSTRACT

The ability of operators and managers to benchmark farm performance with those in their region is a great starting point for cost management. This study expands on the traditional one-tier stratification of farm-level data and uses a two-tier approach using farm income and expense allocation as categories of performance. Farm managers, consultants, and landowners can utilize this framework to provide more insights and management opportunities for their self or their clientele. More specifically, they can identify expenditure characteristics and the capital allocation of the top managers for benchmarking against their own operations.

A Two-Tiered Benchmarking Analysis for Cost Management

By Jordan M. Shockley, William A. Osborne, Carl R. Dillon, and Jerry S. Pierce

Introduction

Recent crop price levels have placed an emphasis on the need for effective control of farm business expenses. Historically, high commodity prices over the earlier part of this decade have likely heightened pressure on farmers to increase yields further. As prices have pushed higher, the marginal revenue on each additional crop unit produced increases and entices farmers to produce more units. Under these conditions, producers are motivated to increase input costs that are thought to increase production. Increased costs are likely to be incurred until the point where the marginal cost equals marginal revenue and all potential profit has been realized.




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Shifting focus on increasing crop revenue can potentially sway attention placed on resource management and cost control. Several studies have emphasized the importance of controlling farm costs as an important component for improving farm income (Dhuyvetter and Kastens, 2005; Mishra, et al., 1999; Sonka, et al., 1989; Wood, et al.; 1987). As the historically high crop price enjoyed by farmers have tapered recently, farmers will likely become increasingly cost conscious into the future as uncertainty regarding the duration of high grain prices and the potential for input and output price volatility is anticipated.

The ability of operators and managers to benchmark farm performance with those in their region is a great starting point for cost management. To provide a regional baseline for comparison, a common technique for analyzing and presenting farm-level data is through the lens of stratification. This method has the advantage of testing information in defined categories of performance which can make data analysis and comparison between groups convenient and usable in practical applications. Typically, farm-level data is categorized in a one-tier approach (e.g. high, medium, and low income levels) and is used in extension publications for producers to benchmark their own farm against those aggregated within income levels across a state or region.

This study expands on the one-tier stratification of farm income and includes an additional level ("two-tier") for expenditures. This allows us to answer a question such as, "What percent of top managers (high income) are also in the lower one-third in machinery expenditures." Consultants and farm managers can utilize this for a more detailed benchmarking option for their clientele or own operations. By identifying expenditure characteristics and the capital allocation of the top managers, inferences can help lower performing managers make expenditure adjustments to aid in improving profitability. Landowners can also benefit by benchmarking a tenants performance and adjust leasing arrangements accordingly, especially those using a cost share lease. Utilizing Kentucky grain farmers as the example, the specific objectives are to:

1.) Utilize a two-tier framework of income and expenditures for benchmarking;
2.) Analyze income and expenditures patterns for significant relationships; and
3.) Provide interpretation and recommendations for practical application.

Data and Methods

To accomplish the above objectives, the Kentucky Farm Business Management Program (KFBM) at the University of Kentucky is used as the sole source for certified farm-level data for this analysis. This study employs selected data available through KFBM for years 2006 through 2011 which were dedicated as "grain farms". In Kentucky, it is not uncommon to have both grain and cattle enterprises. Farms that generated 25 percent or more of their gross revenue from livestock above feed costs were excluded from the study (Kaase, et al., 2003).

Net farm income (NFI) is used as the performance measure in this study and selected for its documented use as a measure of farm success (Haden and Johnson, 1989; Melichar, 1979; Mishra, et al., 1999; Seger and Lins, 1986). Net farm income is defined as gross farm returns less total non-feed costs, including gain/loss on the sale of machinery and buildings. Net farm income can also be thought of as the return to the operator's

opportunity cost of equity capital, management, and labor. Aggregating net farm income and expenditures into tiers can be a useful tool for benchmarking farm operations.

Various studies and data outlets aggregate farm expenses into varying categories, with some more granular than others (Huffman and Evenson, 1989; Schnitkey, 2001; Schnitkey and Lattz, 2003; Albright, 2002). The selected farm expenses of interest for this study include those essential for commercial production: land, machinery, crop inputs, and labor expenses. The aggregate land expense category reflects the per acre cost of land utilization regardless of which method or combination of methods for access is used. Those methods include ownership (including interest/opportunity costs and taxes), share leasing, and cash rents.

In addition to land, eight expenditure components are used to estimate the yearly machinery expense for farms: interest/opportunity costs of ownership; insurance; housing; gain or loss in sales; depreciation; repairs and maintenance; fuel and oil; and custom work. These components were chosen based on available information and the work of previous research (ASABE, 2006; Beaton, et al., 2005; Gustafson, et al., 1988; Hadrich, et al., 2012; Kastens, 1997; Lazarus and Selley, 2002). These components help measure machinery expenses regardless of machinery acquisition strategy.

Crop expenditures per acre measures outflows of operating capital used on inputs related to crop production performance and quality. Seed, fertilizer, and chemical (herbicides, pesticides, etc.) inputs are traditionally included when calculating total farm costs. In addition, the crop expenditure variable includes costs associated with drying grain, utilities, and grain storage. These expenditures are included to reflect the out-of-field costs of grain production and marketing.

The last category used for farm expenditures is labor which accounts for hired labor, and opportunity costs of operator and family labor. While these opportunity costs are not direct cash expenses for the operation, it is crucial to reflect the value of unpaid labor. Failing to do so would likely vastly underestimate the cost of labor for most operations.

Utilizing the income and expense categories above, 1,080 grain farm observations from KFBM are first sorted by their net farm income per acre earnings. The top third, middle third, and bottom third are designated high-, middle- and low-income farms, respectively. This, of course, represents a commonly used tier for benchmarking farm performance. Herein, the addition of a second tier based on level of expenditure also is used. Thus, a similar sorting and assigning procedure is used for each of the four per acre expense categories. Therefore, again based on thirds, farmers are identified as low, middle, or high spenders. These designations, while simple, will provide valuable insight into spending habits of the designated income classes.

Two separate statistical analyses are performed to analyze the differences between income levels within each expense level category. The first analysis utilizes Duncan's multiple range test (Duncan MRT) (Ott, 1984) to measure the significant differences in mean expenditures across income levels for each expense level classification separately. For example, of all the observations that have land expenditures in the lower third, is there a significant difference in the mean value

per acre between high, middle, and lower income levels. The second analysis utilizes a significant test of two proportions (Ott, 1984). This method is used to test if the proportion (%) of each income earner is statistically significant at each expense level. This study focuses on only testing the top managers (high income level) to provide better insights on what expenditure habits are related to farm success. More detailed data description and model framework can be found in Osborne, 2013.

Results

The analysis results are displayed in several tables for simplicity and ease of study. Each table has descriptive information on each farm income level's expenditure level. The mean, standard deviation, coefficient of variation, minimum, and maximum are provided to give some detailed information on the spending practices of farmers. Also, the specific numerical results will give farmers basic points of reference to see where their operation falls within the dataset. Additionally, information is provided on how many farms fell into a specific income line for a variable level section. This same information is also displayed on a percentage basis. Results are based on the participating grain farms in the KFBM program from 2006-2011.

The descriptive statistics for each variable used in this study by income classification and as an "All-Farms" grouping is presented in Table 1 (traditional one-tier approach). Note that high-income earners had the highest average expenditures in all cost categories, but a clear spending pattern is not present in the minimum and maximum expenditures for the study's top performers. Another interesting observation is that the middle-income group has the smallest standard deviation in every cost category. These statistics, among others, provide insight regarding the central tendency and variation of income and expenditures associated with income level and as a complete group.

To expand further, a two-tier approach is utilized in Tables 2-5. Each table describes the composition and distribution of the study population by expense variable (Land, Machinery, Crop, and Labor) as well as income level. In this two-tier approach it is possible for the same farm to be represented multiple times within the same income and/or expenditure classification. It is also possible for a farm to fluctuate between the multiple designations due to year to year farm performance variation.

The two-tier approach is first utilized on land expenditures and is presented in Table 2. For the low land expense level, the Duncan MRT test indicates that it does not matter if you have an income level that is high, middle, or low, there is no significant difference in what each spend (at the mean) per acre for land. This is also consistent across all three land expense levels (low, middle, and high). It is important to note that those within the low income and high expenses category experience the greatest variability in land expenditure (a CV of 28.13) and have the maximum land expenditure of $515.66 per acre. These low performing managers should reevaluate their strategies on land expenditures and use farm management decision-making tools to access the marginal economics involved. Utilizing the second test of two proportions, there is a significantly lower percent of good managers (high income) within the low land expense category (26%). In addition, there is also a significantly greater percent of good managers (high income) within the high land expense category (40%). This indicates that a greater proportion of high income earners are willing to pay for land.

In addition to land expenditures, the two-tier approach was also utilized on machinery expenditures (Table 3). For the low machinery expense level, the Duncan MRT test indicates that it does not matter if you have an income level that is high, middle, or low, there is no significant difference in what each spend (at the mean) per acre for machinery. This is also consistent across all three land expense levels (low, middle, and high) except for those with high machinery expenditures with middle income. These producers seem to spend significantly less per acre on machinery than those with high and low income (within the high machinery expense level). On the other hand, low-income farms spend the same on machinery per acre as high income earners, but are not generating nearly the same income. Low performing farms might not be able to spread the cost of machinery profitably over their operation due to the investment scale of machinery. Poor managers could also be investing in machinery that is beyond their needs or are drawn by the prospect of having new machinery. An appeal for a certain brand of machinery, the "new paint" effect, or just another instance of keeping up with the Joneses are all fairly unquantifiable, but likely have some influence on purchasing decisions for most farmers. These managers should focus on profit maximization and critically evaluate their machinery strategy for improved cost-effectiveness. Utilizing the second test of two proportions, there is a significantly lower percent of good managers (high income) within the low machinery expense category (28%). In addition, there is also a significantly greater percent of good managers (high income) within the high machinery expense category (40%). This indicates that a greater proportion of high income earners are willing to pay for machinery.

Further analysis examines crop input expenditures in the two-tier framework and is presented in Table 4. For the low crop input expense level, the Duncan MRT test indicates that it that high and low income levels are significantly difference in what each spend (at the mean) per acre for machinery. Within the low crop expense tier, high income earners spend significantly more per acre on crop inputs and those with low income. Similar to machinery expenses, low-income farms spend the same on crop inputs per acre as high income earners, but are not generating nearly the same income. This evidence could suggest that simply spending money on crop inputs is not enough to generate higher income. Managers need to weigh the numerous factors that should affect when and how they use crop inputs. Forecasted weather, crop condition, and new technology among others are all possible considerations when utilizing crop inputs. Top managers are not only willing to spend more on crop inputs and use them judiciously, but understand how to use them efficiently to seek better returns. Utilizing the second test of two proportions, there is a significantly lower percent of good managers (high income) within the low crop input expense category (23%). In addition, there is also a significantly greater percent of good managers (high income) within the high crop input expense category (42%). This indicates that a greater proportion of high income earners are willing to pay for crop inputs.

Finally, labor expenditures are examined in the two-tier framework and results presented in Table 5. For the low labor expense level, the Duncan MRT test indicates that it does not matter if you have an income level that is high, middle, or low, there is no significant difference in what each spend (at the mean) per acre for labor. This is also consistent for the middle expense level for labor.

Conversely, for the high labor expense level, higher income earners spend significantly more per acre on labor than both the middle and low income earners. It is possible that these expenditures are not only focused on increasing the farm's quantity of labor, but increasing quality of labor. Crop consultants, agronomists, farm managers, and college educated children are all examples of investment in higher quality labor and human capital. Top managers seemingly are willing to pay for quality labor because of the perceived benefits of their skill and experience on farm income. These specialized services are able to supplement and expand the knowledge of farmers and can translate into better management decisions. Willingness to pay for this qualified advice is likely a trait of top farm managers. As with the other expenditures, the test of two proportions indicates that there is a significantly lower percent of good managers (high income) within the low labor expense category (26%) and a significantly greater percent of good managers (high income) within the high labor expense category (41%). This indicates that a greater proportion of high income earners are willing to pay for labor.

Summary and Conclusion

A two-tier framework for benchmarking is used to analyze Kentucky grain producers. Through this approach, farm expenditures based on expense levels has provided insight on the spending behaviors of high, middle, and low income producers otherwise missed if benchmarking using the traditional one-tier approach. Furthermore, this has exposed significant differences between the average expenditures of performance classes and the apparent gravitation of top managers to spend more than lower performing managers. Consequently, cost control does not imply unwillingness to spend money but rather spending consciously and judiciously with a business mindset of value as a guide. If utilized by consultants, similar results and interpretations can serve as broad benchmarking for which their clientele can establish a baseline of reference to reflect on their own farms particular situation. Several changes in management strategy are possible if producers choose to act on the results. Landowners can also benefit from this type of analysis. Specifically, understanding the spending habits of top managers in the area can be beneficial when working with or negotiating leasing contracts with a tenant.

Analysis of the data revealed that high performance farms were significantly concentrated in the high expenditure section of each expense variable category. A significant majority of the best managers were willing to spend on all four of these expense categories and likely sought to improve returns with their expenditures. Managers that have high expenditures are not necessarily guaranteed sufficient returns on their investments. There are several instances where poor managers are spending more or close to as much as the exceptional managers. These results bolster the arguments that managerial ability is a key to farm success.

Spending sufficiently and judiciously on expenses requires careful thought and implementing the basic principles of agricultural management. It has been seen that top managers are spending significantly more on labor. Labor expenses are used to improve labor quantity and quality which allow managers to focus on the task of managing the farm. Redirecting unskilled tasks from the operator to hired labor liberates the manager to accomplish more management oriented task. Hiring quality labor and investing in human capital also contributes to the decision-making capacity of the farm.

If this two-tiered approach was adopted in other states or regions, more insights and management opportunities can arise. It would also be interesting to benchmark the spending habits of Kentucky grain producers with those in the Corn Belt.

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Table 1. Descriptive statistics of net farm income and expenditures per acre.

Variable	*Income Level*	*Mean*	*Standard Deviation*	*Coefficient of Variation*	*Minimum*	*Maximum*
Net Farm Income Per Acre [1]	High	332.70	113.52	35.18	213.34	1454.86
	Middle	158.55	31.61	19.94	101.95	213.24
	Low	29.57	72.12	243.93	-692.37	101.40
	All Farms	170.28	144.07	84.61	-692.37	1454.86
Land [2]	High	131.09	38.14	29.10	19.83	335.77
	Middle	123.43	35.96	29.14	28.31	378.17
	Low	121.27	41.97	34.61	13.82	515.66
	All Farms	125.26	38.96	31.11	13.82	515.66
Machinery [3]	High	167.00	89.66	53.69	18.52	842.38
	Middle	147.51	62.93	42.66	45.23	781.06
	Low	154.91	71.64	46.25	21.42	614.27
	All Farms	156.47	75.92	48.52	18.52	842.38
Crop [4]	High	220.21	67.46	30.63	67.78	663.09
	Middle	193.17	62.29	32.25	5.93	448.25
	Low	196.29	79.18	40.34	1.89	639.86
	All Farms	203.22	70.97	34.92	1.89	663.09
Labor [5]	High	106.26	132.52	124.71	8.45	1414.23
	Middle	80.63	80.08	99.31	17.91	953.74
	Low	88.09	108.79	123.50	7.00	1442.29
	All Farms	91.66	109.68	119.66	7.00	1442.29

Source: Information represents data collected and published by the Kentucky Farm Business Management Program of Kentucky grain farmers 2006-2011.

Note: All numbers are in US dollars per acre except for numbers under coefficient of variation.

[1] Net Farm Income Per Acre = (Total Gross Revenue – Total Non-Feed Costs ± Sale of Capital Assets) ÷ Total Operator Acres.

[2] Includes land interest/opportunity costs, property taxes, cash rent, and share leasing costs

[3] Includes interest/opportunity costs, insurance, housing, gain/loss on sales, depreciation, repairs and maintenance, fuel and oil, and custom work.

[4] Includes fertilizer, pesticides, seed, drying costs, utilities, and storage.

Table 2. Land expense statistics per acre by expenditure and income tiers, both separated into upper, middle, and lower thirds.

Expense	*Expense Level*	*Income Level*	*Land Expense Statistics*						
			Mean	*Std Dev*	*CV*	*Min*	*Max*	*N*	*%*
Land [1]	Low	High	88.25 a	18.48	20.94	19.83	109.24	93	26%**
		Middle	88.75 a	17.04	19.20	28.31	109.30	122	34%
		Low	88.70 a	16.90	19.05	13.82	109.10	145	40%
	Middle	High	123.24 a	7.48	6.07	109.63	135.12	122	34%
		Middle	122.41 a	7.43	6.07	109.37	135.30	122	34%
		Low	122.31 a	7.50	6.13	109.31	135.06	116	32%
	High	High	165.17 a	30.93	18.73	135.73	335.77	145	40%**
		Middle	161.11 a	31.01	19.25	135.47	378.17	116	32%
		Low	167.64 a	47.15	28.13	135.56	515.66	99	28%

Source: Information represents data collected and published by the Kentucky Farm Business Management Program of Kentucky grain farmers 2006-2011.

Note: Within an expense level category, ** indicates that the proportion (%) of high, middle, or low income groups in that category is significantly different at the 0.05 level. Example: There is a significantly lower percent (26%) of those with high income who have low land expenditures.

Note: Within an expense level, the same letter indicates that there is no statistical difference between how much land costs per acre between income groups. Example: Within the low expense level for land, there is no significant difference in land expenditures for those with high, medium or low income.

Note: All numbers are in US dollars per acre except for numbers under coefficient of variation, farm observation group size (N), and the farm observation percentage (%).

[1] Includes land interest/opportunity costs, property taxes, cash rent, and share leasing costs.

Table 3. Machinery expense statistics per acre by expenditure and income tiers, both separated into upper, middle, and lower thirds.

Expense	*Expense Level*	*Income Level*	*Machinery Expense Statistics*						
			Mean	*Std Dev*	*CV*	*Min*	*Max*	*N*	*%*
Machinery [1]	Low	High	99.31 a	19.96	20.10	18.52	123.22	102	28%*
		Middle	99.88 a	16.65	16.67	45.23	123.21	128	36%
		Low	97.17 a	21.27	21.89	21.42	122.98	130	36%
	Middle	High	142.79 a	11.38	7.97	123.80	164.56	113	31%
		Middle	141.93 a	12.06	8.50	123.23	166.05	133	37%
		Low	141.88 a	12.36	8.71	123.37	166.17	114	32%
	High	High	233.47 a	107.26	45.94	166.44	842.38	145	40%*
		Middle	216.59 b	78.26	36.13	166.52	781.06	99	28%
		Low	232.42 a	73.27	31.52	166.35	614.27	116	32%

Source: Information represents data collected and published by the Kentucky Farm Business Management Program of Kentucky grain farmers 2006-2011.

Note: Within an expense level category, * indicates that the proportion (%) of high, middle, or low income groups in that category is significantly different at the 0.1 level. Example: There is a significantly lower percent (28%) of those with high income who have low machinery expenditures.

Note: Within an expense level, the same letter indicates that there is no statistical difference between how much machinery costs per acre between income groups. Example: Within the low expense level for land, there is no significant difference in machinery expenditures for those with high, medium or low income.

[1] Includes interest/opportunity costs, insurance, housing, gain/loss on sales, depreciation, repairs and maintenance, fuel and oil, and custom work

Table 4. Crop expense statistics per acre by expenditure and income tiers, both separated into upper, middle, and lower thirds.

Expense	*Expense Level*	*Income Level*	*Crop Expense Statistics*						
			Mean	*Std Dev*	*CV*	*Min*	*Max*	*N*	*%*
Crop [1]	Low	High	144.35 a	21.61	14.97	67.78	171.30	81	23%***
		Middle	134.14 ab	31.11	23.19	5.93	171.01	142	39%
		Low	126.53 b	39.35	31.10	1.89	170.85	137	38%
	Middle	High	196.65 a	14.65	7.45	171.59	224.24	127	35%
		Middle	198.60 a	15.58	7.84	171.89	224.71	112	31%
		Low	196.65 a	15.43	7.85	171.78	224.66	121	34%
	High	High	277.42 ab	60.60	21.84	224.81	663.09	152	42%***
		Middle	266.51 b	39.18	14.70	224.88	448.25	106	29%
		Low	289.55 a	67.31	23.25	226.04	639.86	102	28%

Source: Information represents data collected and published by the Kentucky Farm Business Management Program of Kentucky grain farmers 2006-2011.

Note: Within an expense level category, *** indicates that the proportion (%) of high, middle, or low income groups in that category is significantly different at the 0.01 level. Example: There is a significantly lower percent (23%) of those with high income who have low crop input expenditures.

Note: Within an expense level, the same letter indicates that there is no statistical difference between how much crop inputs costs per acre between income groups. Example: Within the middle expense level for crop inputs, there is no significant difference in crop input expenditures for those with high, medium or low income.

[1] Includes fertilizer, pesticides, seed, drying costs, utilities, and storage.

Table 5. Labor expense statistics per acre by expenditure and income tiers, both separated into upper, middle, and lower thirds.

Expense	*Expense Level*	*Income Level*	*Labor Expense Statistics*						
			Mean	*Std Dev*	*CV*	*Min*	*Max*	*N*	*%*
Labor [1]	Low	High	39.57 a	9.69	24.49	8.45	51.90	95	26%**
		Middle	40.05 a	8.13	20.30	17.91	52.00	142	39%
		Low	38.92 a	8.80	22.61	7.00	51.88	123	34%
	Middle	High	63.56 a	8.27	13.01	52.13	84.04	116	32%
		Middle	63.79 a	8.50	13.32	52.21	83.37	118	33%
		Low	65.68 a	8.54	13.00	52.00	83.08	126	35%
	High	High	182.03 a	180.06	98.92	84.19	1414.23	149	41%**
		Middle	158.12 b	119.62	75.65	84.36	953.74	100	28%
		Low	168.01 b	169.51	100.89	84.44	1442.29	111	31%

Source: Information represents data collected and published by the Kentucky Farm Business Management Program of Kentucky grain farmers 2006-2011.

Note: Within an expense level category, ** indicates that the proportion (%) of high, middle, or low income groups in that category is significantly different at the 0.05 level. Example: There is a significantly lower percent (26%) of those with high income who have low labor expenditures.

Note: Within an expense level, the same letter indicates that there is no statistical difference between how much labor costs per acre between income groups. Example: Within the low expense level for labor, there is no significant difference in labor expenditures for those with high, medium or low income.

[1] Includes hired labor, unpaid operator labor, and unpaid family labor.