Labor and Management Components in Economies of Farm Size Studies

Roger G. Johnson and Steven C. Hvinden

Data from North Dakota farmers are used to develop regression equations estimating seasonal use of farm operator labor and management time by farm size. Management time has a large fixed component and increases linearly with farm size. Annual labor supervision time per man-month supervised increases when more than 15 man-months of hired or family labor are used.

Economies of farm size continue to be an important question facing agricultural economists. Farmers need to know the extent of size economies in planning profitable sized units. Consumers are interested from the standpoint of efficiency of food production. Rural communities are concerned when the results of farm size economies reduce the population of both farm people and those providing services to farmers. Policymakers also use economies of size information in evaluating effects of public policies on structural changes in farming.

Economies of farm size studies usually involve either use of data from a sample of actual firms or construction of synthetic firms — also called the economic-engineering approach. One problem when using data from actual farm firms is that managerial quality tends to increase with farm size, thereby confounding management effects with pure economies of farm size. The synthetic firm approach enables one to measure pure size economies since the quality of management can be held constant by specifying uniform production practices and yields [Madden, p. 29]. To hold management quality constant, however, requires knowledge of the management time requirements of farms of different sizes. Unfortunately, little research has addressed changes in management time requirements associated with increases in farm size.

With the notable exception of a study by Hughes and Stanton of New York dairy farms, the authors were unable to find empirical verification of how management time requirements as farm size increases could be a critical determinant of economies of farm size. sumed a fixed per acre management time requirement [Krause and Kyle, Faris and Armstrong] but gave no empirical support for their estimates. Other studies [Davis and Madden, Van Arsdall and Elder] based their estimates of management time on the number of workers. The source of their data was interviews with professional farm managers or progressive farmers. However, no evidence of the reliability of these estimates was given. Increased management time requirements as farm size increases could be a critical determinant of economies of farm size.

The purposes of this paper are three. First, to show for one type of farming the relationship between farm size and the hours which farm operators spend per day on labor and on management activities. Second, to indicate how farmers allocate their management time among activities. Third, to present evidence that diseconomies of size exist in the management time used to coordinate and supervise labor. The uses and implications of these data in economies of size studies will be indicated.

Farm Survey

Farmers in eight counties in central North

Roger G. Johnson is Professor and Steven C. Hvinden is Research Assistant in agricultural economics, North Dakota State University.

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Dakota were interviewed in 1975 concerning the amount of time spent on labor and management activities [Hvinden]. Information was obtained from 97 small grain producers randomly selected from four farm size groups (Table 1). The farms ranged in size from 850 to 5,600 acres with an average of 89 percent of the acres used as cropland. The sample was limited to farmers receiving two-thirds or more of their income from grain production.

Each farmer was given a description of management and labor activities to help assure uniformity of responses. Management activities were defined as purchasing inputs, acquisition of land, keeping and using records, information gathering and consultation, marketing of products, supervising labor, and planning. Labor activities involved a large proportion of physical labor, such as livestock chores, driving a tractor, and repairing machinery. This labor-management classification has two advantages. First, it was easily understood by the farmers interviewed. Second, the classification restricts labor time to jobs which are directly used by an enterprise, leaving farm overhead tasks in the management category. However, this division of activities into labor or management is arbitrary since labor and management are not necessarily mutually exclusive events. Hence, the distinction between them is difficult to define in terms of specific activities [Johnson]. Some activities classified as management, such as record keeping or purchasing of inputs, also involve some physical labor.

The farm operator was asked to indicate the number of hours spent on labor activities and also the hours spent on management activities in a typical day during each season of the year. When labor and management tasks were being performed simultaneously, such as planning while driving the tractor, the time was counted only in the labor category. Time estimates for labor and management were obtained from the farmers for "typical" spring fieldwork, spring nonfieldwork, summer, harvest, wet harvest, postharvest, and winter days. "Typical" days were examined throughout the year since the time spent on labor and management varies by season. The labor or management time could occur in the evening or night as well as during the day. For partnerships, the daily management time included the contributions of all partners. This was done to charge partnerships with total management time similar to sole proprietorships. After estimating the time spent in management-type activities, the farmer was asked to indicate the percent of management time spent on the three or four most important management activities.

Daily Labor and Management Equations

The farm survey data were used to develop two regression equations for each season. Linear equations were used based upon visual inspection of scatter diagrams of the data. One equation relates hours spent per day by the farm operator in labor activities to size of farm measured in man-months of labor needing supervision. The other equation relates hours spent per day in management activities to the same measure of farm size. The results for each season of the year are presented in Table 2. The spring and harvest seasons have been divided into those

TABLE 1. Farm Size Groups by Cropland Acres and Number of Farmers Interviewed, Central North Dakota Grain Farms, 1975.

Farm Size Group	Cropland Acres	Farmers Interviewed
Small	800-1,399	22
Medium	1,400-1,999	26
Large	2,000-2,599	23
Very Large	2,600-5,600	26
TOTAL		97

TABLE 2. Seasonal Bivariate Regression Equations Relating Daily Operator Labor and Management Time With the Annual Amount of Labor Needing Supervision (Man-Months), Central North Dakota Grain Farms, 1975.

Season	Equation[a]	r^2	Level of Significance
Spring Fieldwork	L = 13.9−.073X	.07	1%
	M = .9+.090X	.09	1%
Spring Nonfieldwork	L = 8.4−.105X	.10	1%
	M = 1.8+.145X	.22	1%
Summer	L = 10.5−.188X	.26	1%
	M = .8+.207X	.40	1%
Harvest	L = 13.9−.074X	.04	10%
	M = .4+.098X	.19	1%
Wet Harvest	L = 8.4−.118X	.11	1%
	M = 1.4+.144X	.29	1%
Postharvest	L = 10.3−.086X	.07	1%
	M = 1.0+.085X	.20	1%
Winter	L = 3.9−.058X	.04	5%
	M = 2.2+.061X	.08	1%

[a]L = Hours spent per day in labor activities by the farm operator.
M = Hours spent per day in management activities by the farm operator.
X = Man-months of labor needing supervision.

days when fieldwork is possible and those when it is not possible due to adverse field conditions.

The measure of farm size chosen was the annual man-months of labor needing supervision.[1] This measure of farm size was selected over alternatives such as acres or gross income for two reasons. First, a labor measure is needed for farm size studies using the economic-engineering approach. Typically, these studies use linear programming techniques to develop short-run cost curves for plants of increasing size. The fixed resources (plant) for a crop or crop-livestock farm usually are defined by the number of workers and size of machinery complement. Both acres and gross income are allowed to vary in developing the short-run cost curves; therefore, these size measures would not give a constant basis upon which to determine the labor contribution of the farm operator. Second, the amount of labor needing supervision in nearly all seasons was the measure of size that best explained the daily operator labor and management time as indicated by the r^2 values.[2]

The signs of the b values indicate that the time allocated to labor activities by the operator decreases with size of farm while management time increases. The decrease in labor time with increases in farm size is not exactly offset by increased management time since the total time spent per day increased slightly with size of farm. During the two most critical labor periods, spring fieldwork and harvest, long hours are worked per day with most of the time devoted to labor; while in less pressing periods, hours worked per day decline and a larger portion is devoted to management.

The coefficients of determination indicate that from 4 to 40 percent of the variance in daily labor and management time is explained by size of farm. However, all but two of the regression coefficients are significantly different from zero at the 1 percent level. The wide confidence interval implied by the r^2 values indicates that it would be unwise to use the equations beyond the range of the sample data. The number of man-months of

[1]Labor needing supervision includes hired labor and family labor other than the farm operator or his partner.

[2]Crop acres as a size measure gave higher r^2 values than man-months of labor needing supervision only for daily operator labor and management time in the winter and daily operator management time for spring fieldwork.

labor supervised on the survey farms ranged from 0 to 50.

The use of the data in Table 2 for an economic-engineering study of the economies of farm size can be demonstrated by an example. Suppose a researcher wanted to construct short-run cost curves for one-man, two-man, and three-man farms, each with an appropriate machinery complement. Assuming the operator represents the first man, each additional man would be 12 man-months of labor needing supervision. The labor available for spring fieldwork by the operator could be determined by substitution in the appropriate equation. For example, with a two-man farm, the operator could contribute 13 hours per day [13.9 − .073(12) = 13.0]. Using 21 spring fieldwork days, the operator could contribute 273 hours of labor during this period.[3]

Allocation of Management Time

The farmers' allocation of management time among management activities is presented in Table 3. The farmers also indicated which tasks were most important to the success of their businesses (Table 3).

[3]In the study area, the average farmer estimated that he needed 21 fieldwork days in the 60-day spring period and 22 harvest days in the 45-day fall harvest period.

Planning and labor supervision were the two most time consuming management tasks, taking approximately 40 percent of the farmers' management time. Following in order of management time usage were marketing products, purchasing inputs, record keeping, information gathering, and land acquisition. Marketing products was selected as the most important management task, since with widely fluctuating markets the correct timing of grain sales has a great effect on farm income. Although a substantial percentage of the farmers' management time was spent supervising labor, this task was ranked second from last in importance. Record keeping was ranked third in importance, although this task did not require a large percentage of management time. The low importance attributed to acquisition of land was due to the fact that many of the farmers interviewed were not currently interested in acquiring additional land. Farm size had little effect on the allocation of management time, except that operators of larger farms allocated more time to labor supervision.

Economies of Size in Management Time

The large fixed component and the linear nature of the equations presented in Table 2 indicate that there are long-run economies of size in the use of total management time. This is expected since many management ac-

TABLE 3. Percentage of Management Time Spent on Management Activities and Relative Importance of the Management Activities.

Management Activity	Percent of Management Time Required[a]	Rank of Importance
Planning	25	2
Labor Supervision	16	6
Marketing of Products	13	1
Purchasing Inputs	11	4
Record Keeping	10	3
Information Gathering	8	5
Acquisition of Land	2	7

[a]Column does not total 100 percent, since the farmers did not have to allocate all of their management time.

tivities, such as marketing, record keeping, and planning, must be performed irregardless of farm size. When farm size was measured in gross sales rather than man-months of labor supervised, total management time per dollar of gross sales also declined with farm size.

Economists attribute long-run diseconomies of firm size to problems of coordination. It has been suggested that coordination problems are particularly difficult in farming because of the lack of uniformity among resources, spatial dispersion of operation, and the unpredictable behavior of resources, environment, and the market [Madden, p. 11]. The present study provides evidence that diseconomies of size exist in the part of total management time that farm operators devote to supervision and coordination of labor.

The time spent annually by the farm operator in coordination and supervision of labor was calculated from the survey data. That portion of daily management time used for labor supervision each season was multiplied by the length of the season and summed for all seasons. Several regression equations relating time spent in labor coordination and supervision to size of farm measured in man-months of labor supervised were tried. The best fitting equation with a coefficient of determination (r^2) of .52 was: $S = 77 + .34X^2$, where S = annual hours spent in labor supervision and coordination and X = man-months of labor supervised.

Dividing the above equation by X gives the equation for annual hours spent per man-month supervised ($S/X = 77X^{-1} + .34X$). The average annual time spent in coordination and supervision of labor for varying number of man-months of labor supervised is illustrated in Figure 1.

The minimum average operator time is spent for supervising 15 man-months of labor. The decreasing portion of the curve may be due to the time needed to direct

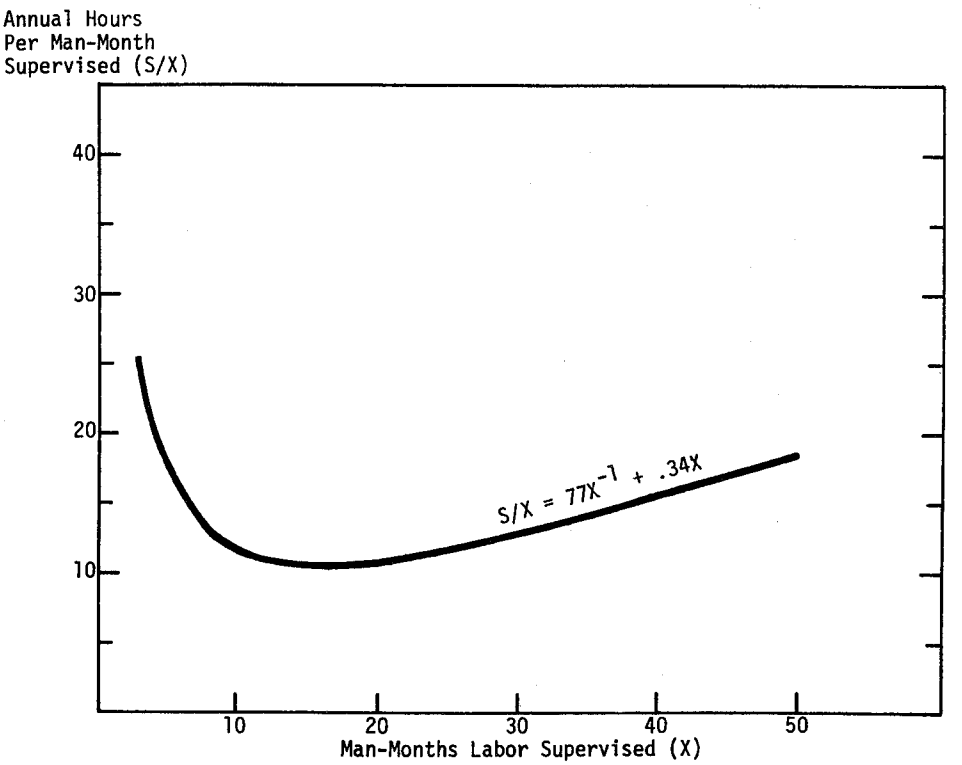

Figure 1. Average annual time spent in coordination and supervision of labor by amount of labor supervised.

part-time seasonal help and younger family members. The increasing labor supervision and coordination begins at just over one full-time hired man. The data support the contention that each additional man supervised uses more than a proportional amount of the farm operator's time. These diseconomies appear for North Dakota grain farms ranging in size up to four workers besides the operator. This result does not imply that diseconomies of size exist in the total farming operation because other economies of size, including total management time, outweigh the diseconomies involved in the coordination and supervision of labor.

Conclusions

Specification of how the farm operator's management time requirements change with size of farm has been a serious data void hampering economies of size studies using the economic-engineering approach. Equations derived in this study provide this information for grain farms in central North Dakota. Planning and labor supervision took the most management time, while the farmers considered marketing the most important management activity. Evidence is also presented to show that one aspect of management, the time needed to coordinate and supervise labor, increases at an increasing rate with the amount of labor needing supervision. Studies of labor and management time allocations are needed in other types of farming areas to further improve the accuracy of economies of size studies.

References

Davis, B., and P. J. Madden. *Theory and Procedures for Studying Economies of Size in Irrigated Cotton Farms of the Texas High Plains.* MP-780, Texas Agricultural Experiment Station, August, 1965.

Faris, E. J., and D. L. Armstrong. *Economies Associated With Size, Kern County Cash-Crop Farms.* Giannini Foundation Research Report No. 269, California Agricultural Experiment Station, December, 1963.

Hughes, E. M. Jr., and B. F. Stanton. *Time Spent on Entrepreneurial and Related Activities.* A. E. Res. 187, Cornell University Agricultural Experiment Station, December, 1965.

Hvinden, S. C. *Use of Labor and Management Time on North Dakota Grain Farms.* Unpublished M.S. Thesis, North Dakota State University, January, 1977.

Johnson, G. L. *Managerial Concepts for Agriculturalists.* Bulletin 619, Kentucky Agricultural Experiment Station, July, 1954.

Krause, K. R., and L. R. Kyle. *Midwestern Corn Farms: Economic Status and the Potential for Large and Family-Sized Units.* USDA, ERS, Agricultural Economic Report No. 216, November, 1971.

Madden, P. J. *Economies of Size in Farming.* USDA, ERS, Agricultural Economic Report No. 107, February, 1967.

Van Arsdall, R. N., and W. A. Elder. *Economies of Size of Illinois Cash-Grain and Hog Farms.* Bulletin 733, Agricultural Experiment Station, University of Illinois, February, 1969.