ECONOMIES OF SIZE OF ILLINOIS CASH-GRAIN & HOG FARMS

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ECONOMIES OF SIZE OF ILLINOIS CASH-GRAIN AND HOG FARMS

BY ROY N. VAN ARSDALL AND WILLIAM A. ELDER

THE PROFITABILITY OF MIDWESTERN CASH-GRAIN AND hog farming is influenced by a wide variety of forces. During the past decade major changes have occurred in demand and supply relationships, production technology, and institutional constraints. These changes have resulted in greater capital requirements, higher cost of production, increased productive capacity of labor, more specialization, shifts in enterprise combinations, and a moderation of the risk associated with farming.

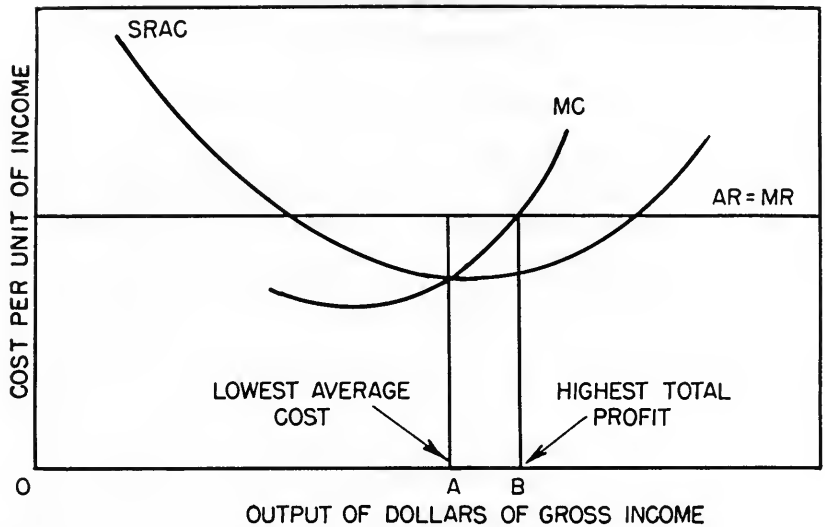
Most farms in the Midwest are still operated as family farm units on which the operator and members of his family supply most of the labor and management. Farm numbers, however, have been declining rapidly and the size of farms is increasing. Investments, fixed costs, and cash costs per farm are all higher. Improved production practices, more mechanization, and larger machines have increased the productive capacity per man substantially.

A major question rising from these developments is the relation between the size of management unit and the efficiency and profitability of production. Farmers, suppliers of inputs and services, marketing firms, investors, farm leaders, and society in general will benefit from information that will aid in the development and servicing of farms of optimal size.

Objectives

The general objective of this study is to examine the costs and returns of cash-grain and hog farming in Illinois as related to size of farm when capacity of management, size of field machinery, and size of the labor force are the chief factors restricting the size of the farming operation.

Specific objectives concerning these two types of farming operations are: (a) to determine the size, enterprise organization, and resource use of farms that are planned to make the most efficient use of resources; (b) to estimate the operating, intermediate, and long-term capital requirements for optimally organized farms; (c) to compare family with larger-than-family farms with respect to efficiency in the use of resources; (d) to calculate the complement of field machinery necessary to perform timely operations; (e) to determine the total and seasonal pattern of labor use; (f) to appraise the influence on optimal farm organization of participation versus nonparticipation in the feed grain and wheat programs; and (g) to determine the farm organization required to maximize profit instead of minimize cost, given both the labor force and acres of land.



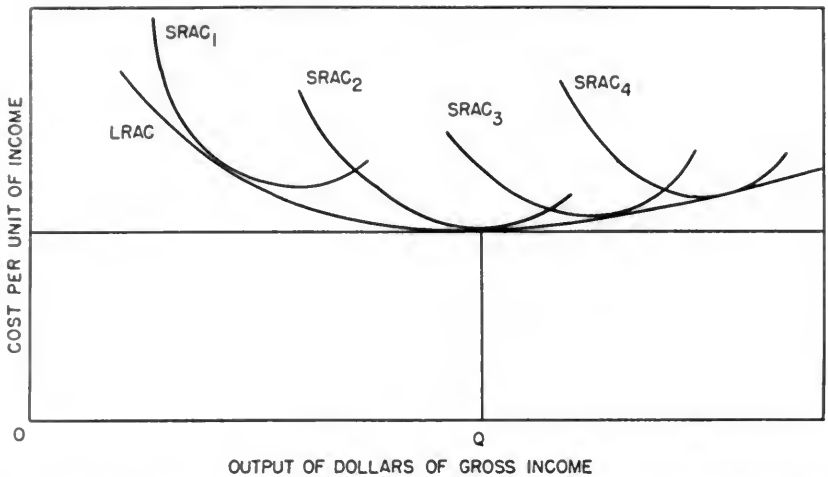
Theoretical illustration of short-run average cost and optimal size of firm for least cost and maximum profit when pure profit exists. (Fig. 1)

Theoretical Framework

A farm operator viewing his business in the short run finds certain of his resources fixed and others variable. He can reduce his average cost per unit of output by expanding production and making more complete use of his fixed resources. Continued expansion, however, will eventually result in increasing average cost of production. Such a situation is illustrated by the SRAC (short-run average cost) curve (Fig. 1).[1]

The optimal size of business for the farm, for which costs are illustrated in Figure 1, depends upon the objectives of the farm planner. If profit maximization is the goal, then output should be expanded to OB where the added return (MR or marginal revenue) equals the added cost (MC or marginal cost) by producing the last unit of output. If the objective is to minimize average cost of production, then output should be OA. In this example, pure profit, or profit plus return to inputs not included in the costs, exists as long as average returns (AR) are greater than average costs. Such profits occur at both the profit maximization and cost minimization output levels. In a time period long enough for prices and costs to change, firms to enter (or exit), and other adjustments to occur, pure profits (or

[1] For a detailed discussion of the theory and concepts of economies of size of business, see J. P. Madden, Economies of Size in Farming, Agricultural Economic Report 107, pp. 2-28, Economic Research Service, U.S. Department of Agriculture, February, 1967.



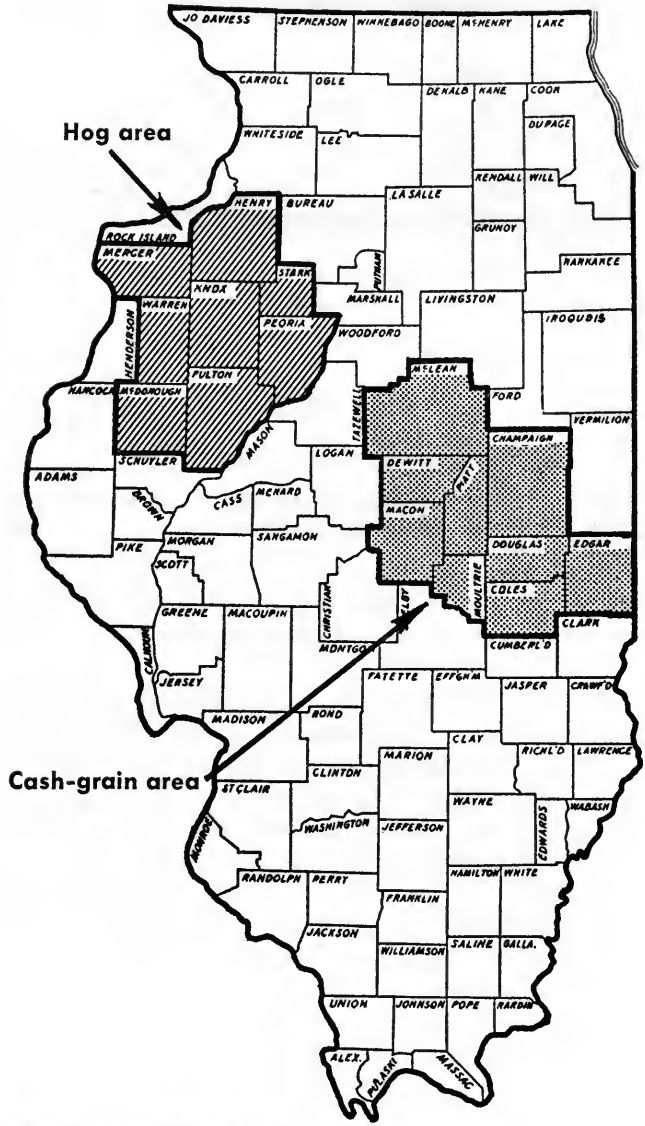
Theoretical illustration of short-run average cost curves and an envelope or long-run average cost curve in an equilibrium situation. (Fig. 2)

losses) disappear. In this case the objectives of profit maximization and cost minimization become compatible and are achieved at the same volume of operation.

As a farm business expands by adding to the resources that are fixed in the short run (for example, by increasing the regular labor force or by changing to a larger size of field machinery), a new set of costs is created. Production can then be increased until the new set of resources is fully utilized. Successive increases in fixed inputs result in a series of short-run average cost curves such as illustrated by $SRAC_1$, $SRAC_2$, $SRAC_3$, and $SRAC_4$ in Figure 2. The larger businesses may result in economies so that the cost curves will reach successively lower levels until eventually some diseconomies to size begin to cause higher costs. This situation is illustrated in Figure 2 where least cost is reached by $SRAC_2$.

A curve tangent to this series of short-run cost curves approximates a long-run average cost curve, the lowest point of which indicates the size of business that will result in most productive use of resources. This curve is LRAC in Figure 2.

Optimal farm size in this study is that which results in least cost per unit of output, both in the short-run time period when some resources are fixed and in the long run when farm operators are free to change all resources and to shift from one size of farm to another, except when maximization of profit is specified.



Counties included in the study. (Fig. 3)

Sources of Data

Input-output data used in this study were synthesized from the farm records of efficient commercial farmers, results of production experiments, and physical performance standards. A high level of managerial efficiency was assumed.

Price and cost relationships were based largely on 1954-1963 averages projected to expected 1970 conditions. Land-quality and production restrictions were those existing in the areas under study.

Analytical Technique

Linear programming models were used to solve for cost minimizing farm plans. Least cost per dollar of gross income, given specific sets of resources and a gross income objective, was the primary goal.[2]

The procedure involved establishing several sets of full-time laborers equipped with basic field machinery. All other resources were made available without limit, and minimum cost solutions were programmed for successively higher levels of gross income until the maximum attainable level of gross income was reached. The results produced an average cost curve for each size of farm business considered.

Successively larger farms, in terms of regular labor force and complement of equipment, were subjected to the same analysis. The resulting series of cost curves formed an approximation of a long-run cost curve.

Characteristics of Study Areas

Two areas of Illinois were studied. A nine-county area in east central Illinois was selected as typical of cash-grain farming and is referred to as the "cash-grain area" (Fig. 3) in this report. An eight-county area in western Illinois was selected to represent grain-livestock production. This area is referred to as the "hog area." The average land mix in each area in 1959 was used in specifying the land resources available.

Ninety percent of all land in the cash-grain area is used as cropland or rotation pasture (Table 1). Corn and soybeans dominate the cropping pattern, accounting for 74 percent of cropland use in both 1959 and 1964. Livestock are important on some farms, but in 1964 sales amounted to only 245 hogs and 44 grain-fed cattle and calves per 1,000 acres of cropland.

The tillable land in the hog area is highly productive, but cropland and rotation pasture account for only 76 percent of the total land area (Table 1). Corn accounted for 50 percent of cropland used in both 1959 and 1964. Soybeans and small grains were of lesser significance.

Livestock production is of major importance to the farm economy of the hog area. Sales of hogs averaged 991 head per 1,000 acres of cropland in 1964, or over four times the concentration in the cash-grain area. Sales of grain-fed cattle and calves average 138 head per 1,000 acres of cropland. Dairy and poultry were of minor importance, falling well below state average concentrations in both areas.

[2] *Ibid.*, pp. 29-34.

Table 1. — Land Use in the Cash-Grain and Hog-Farming Areas, Illinois, 1959[a]

Land use	Cash-grain farming area[b]		Hog-farming area[c]	
	Acres	Proportion[d]	Acres	Proportion[d]
	(1,000)	(percent)	(1,000)	(percent)
Cropland[e]	2,781	85	1,976	69
Rotation pasture	143	5	207	7
Permanent pasture	207	6	546	19
Woodland	34	1	58	2
Other[f]	107	3	77	3
Total land in farms	3,272	100	2,864	100

[a] All data except "other" land are from 1959 Illinois Census of Agriculture.
[b] Counties: DeWitt, McLean, Macon, Champaign, Piatt, Coles, Douglas, Edgar, and Moultrie.
[c] Counties: Henry, Mercer, Fulton, Knox, McDonough, Warren, Peoria, and Stark.
[d] These land mixes were used in developing optimal farm plans for the respective areas.
[e] The dominant soils are Drummer-Flanagan in the cash-grain area and Tama-Muscatine in the hog area.
[f] Acres of "other" land were estimated from land-use data reported in Soil and Water Conservation Needs Inventory, Univ. Ill., 1962.

Soils

Drummer and Flanagan soils dominate the cash-grain area.[3] They are highly productive, adapted to intensive row-crop production, and present few management problems.

Tama and Muscatine soils are most important in the hog area. They also have high-yield potentials, but rotations including grasses and legumes are needed to maintain productivity and prevent erosion.

Changes in Size and Number of Farms

The cash-grain area included over 19,000 farms in 1945; the hog area nearly 18,000 farms. By 1964 the numbers of farms had dropped about one-third in each area. Declines occurred, both in absolute and relative terms, in all size groups with fewer than 260 acres per farm. The very small farms disappeared most rapidly. Their decline accelerated after 1954 (Appendix Tables 1 and 2).

Farms of 220 to 259 acres declined in number in both areas, but remained about the same percentage of the total throughout the 1945-1964 period. Farms with larger acreages increased both in number and in relative importance. The most rapid growth occurred in farms of 500 or more acres. The number of these farms more than doubled while their relative importance increased more than threefold.

Characteristics of Progressive Farms

Farms operated by the better managers are substantially above area averages in size, investment, and productivity per man. Farmers in the

[3] E. L. Washer, J. B. Fehrenbacher, R. T. Odell, and P. T. Veale. Illinois Soil Type Descriptions, AG-1443. Dept. Agron., Univ. Ill. 1950.

Table 2. — Farm Organization, Investments, and Gross Value of Production on One- and Two-Man, Cash-Grain and Hog Farms, Illinois, 1964[a]

	Cash-grain farms		Hog farms	
	1 man[b]	2 men[b]	1 man[b]	2 men[b]
Number of farms	121	56	60	18
Total acres[c]	301	816	223	618
Tillable acres	281	749	205	517
Crop production, percent of tillable land				
Corn and corn silage	47.2	44.5	57.0	61.0
Soybeans	26.6	32.4	13.0	9.6
Wheat	6.5	7.7	1.8	2.8
Other small grain	4.1	2.3	10.4	8.3
Diverted acres	6.2	6.8	2.2	4.5
Hay and pasture	8.5	4.8	14.8	12.7
Other crops	0.9	1.5	0.8	1.1
Livestock production				
Number of hens	31	4	50	28
Number of dairy cows	0.5	0.1	0.5	0.9
Pounds of beef	8,300	26,500	20,800	56,100
Pounds of pork	22,100	47,900	146,100	248,700
Investments				
Land	$146,815	$381,882	$105,537	$265,810
Machinery[d]	8,073	18,327	7,411	16,998
Buildings and fences[d]	15,037	28,129	15,591	36,353
Livestock inventory[e]	4,459	14,291	14,788	31,270
Grain inventory[e]	16,053	40,193	11,843	27,536
Other	982	1,580	1,008	1,087
Total	$191,419	$484,402	$156,178	$379,054
Labor, months[b]	14.5	30.6	16.6	30.3
Gross production[f]	$ 28,986	$ 75,990	$ 25,717	$ 60,900

[a] A. G. Mueller and D. F. Wilken. Fortieth Annual Summary of Illinois Farm Business Records, Ill. Cir. 915. Univ. Ill., August, 1965.

[b] Farm account keepers record labor in months. Seasonal variations in labor requirements are such that 14 to 15 months are necessary to provide the 2,500 hours of labor alloted to a one-man farm in this study. Full-time operators on grain farms work about 2,000 hours per year. See R. A. Hinton and A. G. Mueller, Detailed Cost Report for Central Illinois, 1959-60, AERR-48, p. 24, Dept. Agr. Econ., Univ. Ill., December, 1961.

[c] The soils on these farms have a high productivity rating similar to that of the Drummer-Flanagan and Tama-Muscatine soils which dominate the cash-grain and hog farm areas.

[d] Remaining capital cost on January 1.

[e] Inventory value on January 1.

[f] Gross farm production accounts for changes in inventory and excludes purchases of feed and feeder livestock.

cash-grain and hog areas who keep supervised farm account records are typical of this above-average group (Table 2). Their achievements reflect the use of progressive practices. Such farm businesses were a major source of data for this study, and they provide a basis for evaluating its results.

The one-man, record-keeping farms ranked in the upper one-third of the farms in the two areas with respect to acreage. The two-man farms were in the top 10 percent. Records from farming operations with a regular labor force larger than two men were not available in sufficient numbers to provide reliable averages by type of farm.

Nearly 75 percent of the tillable land on these farms was used for corn and soybean production in 1964. Corn dominated land use, especially on the hog farms. Several other crops appear in the organization in small quantities, but averages hide the fact that many farmers produced only corn and soybeans.

Poultry and dairy enterprises were kept on only a few farms in the two areas. The trend toward specialization, however, has not eliminated beef production and hog raising from cash-grain farming. Small beef cow herds with some feeding of cattle were rather common. Hog production was also of some importance in the cash-grain area. Cattle feeding remained a major enterprise on the hog farms.

Investments in land, remaining value of depreciable assets, and operating capital ranged to nearly one-half million dollars on the two-man, cash-grain farms. Gross production per man-year of labor was $20,000 to $30,000 with the larger output being achieved on the cash-grain farms.

Assumptions and Definitions

The results of this study should be evaluated in light of the assumptions on which the analyses were based. The physical, technical, and economic relationships expected to exist in 1970 were used as guidelines. Cost-price relationships and technical coefficients were based on information supplied by subject-matter specialists, practices and achievements of the more progressive and successful commercial farmers in the areas under study, and judgment of the authors.

Type of Farm

Source of gross income is the criterion determining type of farm in this study.[4] Cash-grain farms were required to generate at least 75 percent of gross income from sale of corn and soybeans. On hog farms at least 60 percent of gross income was required to come from the sale of hogs.

Enterprise Alternatives

Crop alternatives included corn, soybeans, wheat, oats, and legumes. Corn could be combined for sale, stored at high moisture for feed, or made into silage. Legumes could be harvested for hay, pastured, or used as a green manure crop. Livestock alternatives included hogs, beef cow herds, and beef cattle feeding. Dairy and poultry were not offered as alternatives.

Calves from beef cow herds either could be sold as feeders or fed to slaughter weights. Cattle-feeding programs included six alternatives ranging from long-fed, choice steer calves to short-fed, common-to-medium yearlings. Rations were based on either hay or corn silage, plus the neces-

[4] See Madden, *loc. cit.*

sary corn and protein supplement. The degree of mechanization was allowed to vary.

Hog production alternatives included both pasture and confinement systems. Frequency of farrowing ranged from one to six times a year. Alternative farrowing periods were permitted to allow for seasonal variations in labor requirements and hog prices.[5]

Levels of Efficiency

Farmers who have units at or near optimal size and organization in 1970 are expected to be managers capable of achieving a high level of performance. The input-output coefficients used in this analysis therefore reflect a high level of efficiency.

Crop yields were set at the levels achieved by the top one-fifth of the supervised Illinois farm record keepers during 1963 and 1964 (Appendix Tables 3 and 4). Inputs were supplied in amounts sufficient to maintain such yields (Appendix Tables 5 and 6).

Livestock production requirements were based on recommendations of production specialists and levels of performance being achieved by leading livestock producers.[6] Labor requirements reflect effective work routines and specified levels of mechanization. Labor, power, and machine requirements for crop production were based on engineering standards of performance for specific machines and practices.[7]

Miscellaneous farm operating expenses were based on costs actually incurred by farmers in the two areas under study (Appendix Table 7).

Management

Limited capabilities of management place a major restriction on size of business. Relatively few of the farmers now in operation have the capacity to be as effective in the use of resources in a multi-man business as they can be in a one-man operation. This analysis, however, assumes that managers will be available in the future who can handle farms requiring up to five full-time employees without adverse effect on efficiency. Thus attention focuses on the amount of managerial time needed for supervision and coordination rather than on any change in input-output ratios.

[5] For a complete description of the beef and hog enterprises considered in this analysis, see R. N. Van Arsdall, Resource Requirements, Investments, Costs, and Expected Returns From Selected Beef-Feeding and Beef-Raising Enterprises, AE-4075, and Resource Requirements, Investments, Costs, and Expected Returns From Hog Production Systems, AE-4074, Dept. Agr. Econ., Univ. Ill., September, 1965.

[6] Van Arsdall, AE-4074 and AE-4075, *loc. cit.*

[7] R. N. Van Arsdall, Labor Requirements, Machinery Investments, and Annual Costs for the Production of Selected Field Crops in Illinois, 1965, AE-4112. Dept. Agr. Econ., Univ. Ill., August, 1966.

In this study, use of the operator's time was shifted progressively from work to supervision and coordination as the labor force increased. About two-thirds of a man-year was devoted to supervision and coordination on a six-man cash-grain farm, while practically a full man-year was used for this purpose on a six-man hog farm (Appendix Table 8).

Labor

Optimal organizations were developed for farms with up to five full-time employees. An employee was permitted to work as much as 260 hours per month to handle seasonal labor peaks, but his total annual input was limited to 2,500 hours.

Employees will have to be qualified, reliable, and industrious persons if the assumed high levels of efficiency are to be realized. They will command salaries competitive with opportunities in alternative employment.

Salaries considered necessary to meet such conditions were set at nearly twice 1966 average rates. They ranged from $5,350 to $6,850 per year on cash-grain farms (Appendix Table 9). On hog farms the salaries were set 10 percent above the amounts paid on grain farms (Appendix Table 10).

Limited employment of seasonal labor was permitted. The contribution of full-time and seasonal labor combined was not allowed to exceed the capacity of the regular labor force, including the operator, which was 2,500 hours per man. For instance, a one-man farm was allowed 2,500 hours of labor per year, but if pressures required it the operator could hire seasonal labor. The combination of this seasonal labor and the operator's labor could not exceed 2,500 hours. The wage rate for seasonal labor was set at $1.37 per hour for November through March, and $1.65 per hour during other months.

Field Machinery

Various complements of general purpose field machinery were combined with each of the labor forces under study. The machine sizes considered in this analysis were arbitrarily called four-, six-, and eight-row units. These units were built around 40-, 70-, and 100-drawbar horsepower tractors with matching sizes of implements and harvesting machines.[8] Machine capacity was the maximum acreage that could be handled so that each field operation could be completed with a 90-percent level of confidence. Special-purpose machines were added as needed.

Annual tractor use was set at 800 hours per tractor for a single annual depreciation charge. An additional 400 hours annual use was permitted at a charge per hour to cover the extra wear and tear.

[8] Van Arsdall, AE-4112, *loc. cit.*

Asset Valuation

Land is the major investment on both cash-grain and hog farms in Illinois. The price of unimproved land was based on 1964 prices projected to 1969 at the 1959-1964 rate of change. These prices averaged $491 per acre in the cash-grain area and $332 per acre in the hog area (Appendix Table 11). Purchase of land to develop farms of optimal size was permitted without limit at these prices.

Recent increases in land prices were such that it seemed probable that land prices in 1969 would be higher than these levels. Optimal farm organizations were therefore determined both with land prices at the projected levels and for prices ranging high enough to cause complete specialization in livestock production.

Farm service buildings, machinery, and other depreciable assets were inventoried at 55 percent of new cost. Items in working capital accounts were valued at market price adjusted to reflect the amount of time the funds were tied up in the business. Total investments thus reflect the average capital requirement of an on-going business and not the capital needed to establish a given size of business.

Capital Charges

Interest was charged on all capital used in the farming operations. The rate was 5 percent on investments in land and depreciable assets, and 6 percent on working capital.[9]

Feed Grain and Wheat Programs

Optimal farm plans were developed both with and without participation in the 1964 feed grain and wheat programs.[10] Base acreage for feed grains averaged 44 percent of total farmland in the cash-grain area and 41 percent in the hog area. Average wheat allotment was too small to be of significance in either area, but conserving acreage requirements averaged 9.4 percent of total farmland in the cash-grain area and 16.7 percent in the hog area. All prices and payments reflect weighted area averages of actual 1964 rates in the respective areas (Appendix Table 12).

Prices Received

Prices for farm products were projected to 1970 using 1953-1962 averages to develop price relationships among commodities and seasonal price variations (Appendix Table 12). Support prices effective during 1964 were applied to feed grains and wheat.

[9] Higher rates of interest may be justified by circumstances, but moderate increases in rates will have little effect on optimal farm organization.

[10] U.S. Department of Agriculture, ASCS. The 1964 Feed Grain Program, PA-612. 1964. USDA, ASCS. The Voluntary Wheat Program for 1964, PA-619. 1964.

Results

Optimal[11] Organization of Cash-Grain Farms

Crop and livestock enterprises. On an optimally organized cash-grain farm one man handles from 514 to 760 acres of cropland, depending on size of field equipment (Table 3). As additional full-time employees and equipment are added to the operation, the cropland per farm increases, but at a declining rate per man because the operator must devote increasing amounts of his time to coordination and supervision. The larger farms in Table 3 include a hog enterprise.

Nearly 80 percent of the cropland is planted to corn and soybeans. Acreages of these two crops are approximately equal, corn being planted to the limit permitted by minimum compliance with the 1964 Feed Grain Program.

Legumes are grown on half of the remaining cropland to satisfy the established conservation acreage requirements. They are harvested for hay and sold. Most of the remaining cropland is diverted from production. The small acreage of wheat appearing in the optimal farm plans is included only to add enough small grain to the diverted acreage to satisfy the nurse crop requirements for legume seedings. An operational plan would likely exclude this wheat.

Livestock are not included in the optimal farm plans until the full-time labor force reaches four men. On the four-, five-, and six-man farms a confinement hog enterprise large enough to realize most of the scale economies in buildings and equipment is added to the cash-grain operation (Table 3). Farrowings come in February and August taking advantage of both available labor and favorable seasonal hog prices.

Hogs on pasture are included only in sub-optimal[12] farm plans when the labor force and field equipment are substantially under-employed and gross farm income is low. They are small, one-litter, pasture programs with farrowing in the winter. Beef-cow herds are not in any of the optimal farm plans even though substantial acreages of permanent pasture thus remain unused. Cattle-feeding enterprises enter the solution only when the farm business is placed under extreme pressure to produce the largest possible gross income. They are not a part of any of the least-cost farm plans.

Income. Gross income, which includes the returns from all sales plus government payments, ranges from $58,000 on optimally organized one-

[11] In this report "optimal" refers to the organization which gives the low point on the average cost curve, i.e., least cost per dollar of gross output, except when maximization of profit is the objective (see p. 4).

[12] Sub-optimal means that least cost is not achieved. However, at all levels of operation (see the cost curve in Figure 5) the least possible average cost is being achieved for that specific level of gross income.

Table 3. — Optimal Organization of Cash-Grain Farms of Selected Sizes, Illinois, 1970[a]

Land use and livestock enterprises	Gross income, labor force, and size of equipment[b]								
	1 man			2 men		3 men, 8-row	4 men, 8-row	5 men, 8-row	6 men, 8-row
	4-row	6-row	8-row	6-row	8-row				
Gross income[b]	$58,000	$70,000	$86,000	$134,000	$166,000	$242,000	$302,000	$374,000	$438,000
Total land, acres[c]	574	692	850	1,325	1,641	2,393	2,684	3,378	3,937
Cropland, acres	514	620	760	1,185	1,468	2,139	2,399	3,020	3,520
Corn	202	244	299	466	578	842	945	1,189	1,386
Soybeans	203	245	301	469	581	847	950	1,196	1,394
Wheat	3	4	4	7	9	13	14	18	21
Oats	0	0	0	0	0	0	0	0	0
Legumes	54	65	80	124	154	225	252	318	370
Diverted	52	62	76	119	146	212	238	299	349
Non-cropland, acres	60	72	90	140	173	254	285	358	417
Permanent pasture	34	42	51	80	98	144	161	203	236
Woodland	6	8	9	15	18	26	30	37	43
Farmstead, roads, and waste	20	22	30	45	57	84	94	118	138
Hogs[d]									
Two-litter systems	0	0	0	0	0	0	147	156	192
Six-litter systems	0	0	0	0	0	0	0	0	0

[a] Optimal organization is defined as that resulting in least cost per dollar of gross income for a given labor force and size of equipment, except when maximum profit is the objective.

[b] Gross income is that achieved at the optimal organization. It includes government payments and all farm sales without deducting for value added by purchased livestock and feed.

[c] Land classification is the average for the nine-county area (Fig. 3).

[d] Hog enterprises are two-litter confinement systems with farrowing in February and August.

man cash-grain farms operated with four-row equipment to $438,000 on six-man farms with eight-row equipment (Table 4). None of the least-cost farm solutions is affected by the requirement that corn and soybean sales account for at least 75 percent of gross income. On the straight cash-grain units corn accounted for 55 percent and soybeans 36 percent of gross income. These two crops accounted for 77 percent of gross income on the four-, five-, and six-man farms where hogs contributed about 14 percent of the total. Income from sale of hay averaged about 9 percent of gross income (Appendix Table 13).

Net returns to management, a residual after deducting all other costs, range from $16,970 on the one-man unit with four-row equipment to $137,618 on the six-man farm with eight-row equipment. Returns per man are greatest for the one-man farm with four-row equipment and decline gradually as more men are added to the operation.

Returns to operator labor and management are simply net management returns increased by the $5,350 allowed for operator labor. Returns to operator labor, capital, and management, the measure commonly used to indicate returns to a farm business, are quite large, ranging to over a quarter million dollars on the largest size of cash-grain farm (Table 4).

The net returns to management on these optimally organized cash-grain farms are higher than realized by most farmers. Three major factors should be noted: (1) the level of efficiency projected for 1970 exceeds that of the average farmer now in business; (2) few farmers have yet been able to achieve an optimal size of farm; and (3) the land values used in the analysis, and hence the interest and taxes charged against the business, may be low if recent advances in land prices predict the future. Later analysis which considers different levels of land prices shows that higher land costs slash net income, but have little effect on the optimal organization of a farm business in the cash-grain area until land values become quite high.

Field machinery. Cash-grain farms of optimal size require essentially a full complement of field machinery for each full-time man in the regular labor force to assure timeliness (Table 5). The use of tractor power approaches capacity of the tractors in the machinery complement (Appendix Table 15). Pressure is greatest on plowing because of the heavy power requirements and the need to cover practically all of the land each year. Rotary hoeing is also under pressure because of the short time during which weeds can be controlled effectively in the emerging crop.[13]

[13] Machine capacity is limited to the work that can be done during the typical work season for each operation at a 90-percent level of confidence. For detailed estimates, see R. N. Van Arsdall, Labor Requirements, Machinery Investments, and Annual Costs for the Production of Selected Field Crops in Illinois, 1965, AE-4112, Dept. Agr. Econ., Univ. Ill., August, 1966.

Table 4. — Gross Income, Total Costs, and Selected Measures of Returns for Optimally Organized Cash-Grain Farms, Illinois, 1970[a]

	1 man			2 men		3 men,	4 men,	5 men,	6 men,
	4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Gross income	$58,000	$70,000	$86,000	$134,000	$166,000	$242,000	$302,000	$374,000	$438,000
Total cost[b]	41,030	48,831	58,682	92,947	112,721	164,255	205,543	254,858	300,382
Net returns to management	16,970	21,169	27,318	41,053	53,279	77,745	96,457	119,142	137,618
Operator labor	5,350	5,350	5,350	5,350	5,350	5,350	5,350	5,350	5,350
Returns to operator labor and management	22,320	26,519	32,668	46,403	58,629	83,095	101,807	124,492	142,968
Interest on:[c]									
Working capital	391	495	586	956	1,169	1,639	2,461	2,972	3,508
Other capital	15,340	18,573	22,867	35,549	44,092	64,052	73,692	92,211	107,720
Total	15,731	19,068	23,453	36,505	45,261	65,691	76,153	95,183	111,228
Returns to operator labor, management, and capital	38,051	45,587	56,121	82,908	103,890	148,786	177,960	219,675	254,196

[a] Optimal organization is defined as that resulting in least cost per dollar of gross income.
[b] Total cost includes a charge or allowance for all inputs except management.
[c] Interest on working capital is charged at 6 percent. The interest rate on other capital in 5 percent. This includes the investment in land and the inventory value of buildings and equipment.

Table 5. — Estimated Number of Primary Field Machines Needed To Handle the Maximum Acreages of Crops Produced on Two- to Six-Man Cash-Grain Farms, Illinois, 1970[a]

Type and size of machinery[b]	Regular labor force and size of equipment					
	2 men		3 men,	4 men,	5 men,	6 men,
	6-row	8-row	8-row	8-row	8-row	8-row
			(number)			
Tractor, 40 DBHP	2	2	3	4	5	6
Tractor, 70, 100 DBHP	2	2	3	4	5	6
Stalk chopper, 3-, 4-row	2	2	2	3	3	4
Plow, 5-14, 7-14	3	3	4	5	6	7
Disk, 19-, 28-foot	3	2	3	4	5	6
Harrow, 4-, 5-section	3	2	3	4	5	6
Planter, 6-, 8-row	2	2	3	4	5	6
Cultivator, 6-, 8-row	2	2	3	4	4	5
Rotary hoe, 3-, 4-row	3	3	4	5	6	7
Sprayer, 8-row	2	2	3	4	4	5
Fertilizer spreader, 10-, 30-foot	3	2	3	4	5	6
Mower, 7-foot	2	2	3	3	4	5
Grain drill, 14-foot	1	1	2	2	3	3
Wagon	4	4	6	8	10	12
Combine, 65, 78 DBHP	2	2	3	4	5	6
Grain platform, 14-, 20-foot	2	2	3	4	5	6
Corn head, 3-, 4-row	2	2	2	3	3	4
Hay rake	1	1	2	2	3	3
Hay conditioner	1	1	2	2	3	3

[a] Capacity of machines for specific operations is based on a combination of size, operating speed, field efficiency, and a work period that will permit a sufficient number of good work days to get the job done at a 90-percent level of confidence. Based on these factors an extra machine was added whenever theoretical capacity was exceeded by more than 10 percent. See R. N. Van Arsdall, Labor Requirements, Machinery Investments, and Annual Costs for the Production of Selected Field Crops in Illinois, 1965, AE-4112, Dept. Agr. Econ., Univ. Ill., August, 1966.

[b] The first number denotes size of 6-row machines; the second the size of 8-row machines.

The suggested number of plows and rotary hoes needed on farms of optimal size and organization exceeds the number of regular workers. In actual operation the necessary machine capacity would likely be obtained through a combination of longer working days, custom hiring, and performance of some operations at less than an opportune time.

One 40-drawbar horsepower tractor is added for each combine included in the equipment complement. These tractors are needed for miscellaneous work, extra power during the critical work periods, and hauling of grain during harvest. These tractors, plus wagons, take the place of trucks in the equipment complement.

In the optimal farm plans legumes, grown because of the required minimum acreage of soil-conserving crops for participation in the 1964 feed grain and wheat programs, are harvested as hay with farm-owned equipment and sold. Only when the labor force is under extreme pressure does the optimal farm plan call for custom harvest of hay or plow down of the crop. Nonparticipation in the feed grain program, hence elimina-

tion of most forage production, or failure to secure a suitable cash market for hay would eliminate the need for the hay harvesting and hay-handling equipment listed in the machinery requirements (Table 5).

Capital requirements. Capital requirements include first the basic field equipment and headquarters buildings needed for cash-grain production. These are essentially fixed capital requirements to complement a given labor force, and range from nearly $17,000 to over $27,000 per man (Table 6).

Total capital requirements per farm range from $313,322 for the one-man farm with four-row equipment to $2,212,876 for the six-man unit (Table 6). Land accounts for nearly 90 percent of total investment on the straight cash-grain farms and is nearly as important even with a sizable hog enterprise included in the farm organization.

Investment per man is highest on the one-man farm with eight-row equipment and declines gradually as number of men in the operation increases. It falls sharply in the larger operations that include a hog enterprise, as labor is a relatively more important cost in hog production.

Annual overhead costs. Salaries of the regular employees, the allowance for operator labor, and the overhead costs of a headquarters unit and complement of basic field equipment are fixed regardless of the size of farm. They total $10,000 to $12,000 per man on cash-grain farms (Table 7). Labor accounts for about one-half of these charges. Depreciation, interest on investment, taxes, and insurance on equipment and buildings comprise the other half.

Once the optimal organization is determined, additional annual overhead costs that are fixed in the short run can be determined. These added costs, chiefly annual charges for the use of land, account for about two-thirds of the $30,000 to $40,000 total annual overhead cost per man in the regular labor force (Table 7). These overhead costs are more than twice the amount of annual operating expenses.

Labor use. Cash-grain farms of optimal size and organization do not make full use of the regular labor force. Typically, the farm requires full-time services of the operator or employees for only six months. From December through March the labor requirements are less than half the amount available (Fig. 4).

The optimizing criterion of least cost per dollar of gross income prevents addition of livestock enterprises even though labor is available in the off season. Use of labor during winter does not increase until the regular labor force becomes large enough to handle a confinement hog enterprise of substantial size. This pattern of farm organization and labor use is becoming more prevalent with the growth of specialized cash-grain farms and the rapid decline in livestock enterprises on these farms.

Table 6. — Basic and Added Investment Necessary To Equip and Operate Cash-Grain Farms at the Optimum Level, Illinois, 1970[a]

Investment	Number of men and size of equipment								
	1 man			2 men		3 men,	4 men,	5 men,	6 men,
	4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Basic investment for all sizes									
Crop equipment[b]	$ 13,959	$ 18,112	$ 23,634	$ 37,179	$ 46,752	$ 65,354	$ 89,869	$ 106,658	$ 128,397
Machine shed and shop[c]	1,100	1,392	1,683	2,475	3,030	4,378	5,924	7,222	8,635
Shop equipment, small tools, and water system[d]	1,842	2,062	2,172	2,200	2,337	2,502	2,667	2,832	2,997
Total	16,901	21,566	27,489	41,854	52,119	72,234	98,460	116,712	140,029
Per man	16,901	21,566	27,489	20,927	26,060	24,078	24,615	23,342	23,338
Added investment for optimal size									
Land	281,598	339,860	417,541	650,590	805,952	1,174,943	1,317,829	1,658,858	1,933,200
Grain storage[e]	8,308	10,026	12,317	18,533	23,776	34,662	38,878	48,938	57,031
Hog facilities[f]	0	0	0	0	0	0	18,680	19,720	24,147
Working capital	6,515	8,250	9,773	15,933	19,489	27,313	41,024	49,537	58,469
Total	296,421	358,136	439,631	685,056	849,217	1,236,918	1,416,411	1,777,053	2,072,847
Per man	296,421	358,136	439,631	342,528	424,608	412,306	354,103	335,411	345,474
All investments for optimal size									
Total	313,322	379,702	467,120	726,910	901,336	1,309,152	1,514,871	1,893,765	2,212,876
Per man	313,322	379,702	467,120	363,455	450,668	436,384	378,718	378,753	368,813

[a] Unimproved land is valued at $491 per acre. Land investment should be increased by $9.24 per acre for the new cost to fence 80-acre tracts cattle tight; $11.55 per acre to fence 80-acre tracts hog tight. (All depreciable assets are valued at 55 percent of new cost.)

[b] Crop equipment needed to equip the labor force for capacity production of cash grain.

[c] Shed space is provided for all crop equipment. Shop space is 10 percent of the space needed for machinery storage.

[d] Includes a 4-inch, deep-well system costing $1,350 to construct and equip and charged at a depreciated value of $742.

[e] In-storage drying and storage facilities are charged at an initial cost of $0.50 per bushel of storage space for corn. Soybeans and small grains are stored for an initial cost of $0.30 per bushel of storage space.

[f] Hog facilities in the optimal farm organizations are two-litter confinement systems with a complete complement of mechanical equipment for feed processing and distribution.

Table 7. — Annual Basic and Added Overhead Costs for Facilities and Salary of the Regular Labor Force Incurred in Operation of Cash-Grain Farms at the Optimal Level, Illinois, 1970[a]

Costs	Number of men and size of equipment								
	1 man			2 men		3 men,	4 men,	5 men,	6 men,
	4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Labor[b]	$ 5,350	$ 5,350	$ 5,350	$10,700	$10,700	$ 16,450	$ 22,200	$ 27,950	$ 34,400
Basic facilities for all sizes[c]									
Crop equipment	3,299	4,281	5,586	8,788	11,050	15,447	21,242	25,210	30,348
Machine shed and shop	210	266	321	472	579	836	1,131	1,379	1,648
Shop equipment, small tools, and water system[d]	647	747	797	809	872	947	1,022	1,097	1,172
Miscellaneous[e]	700	700	700	990	990	1,230	1,450	1,620	1,740
Total	10,206	11,344	12,754	21,759	24,191	34,910	47,045	57,256	69,308
Added costs for optimal size[c]									
Land[f]	17,401	21,001	25,801	40,201	49,802	72,602	81,432	102,504	119,457
Grain storage	1,775	2,142	2,632	3,975	5,080	7,406	8,308	10,457	12,186
Hog facilities	0	0	0	0	0	0	4,123	4,360	5,371
Total	19,176	23,143	28,433	44,176	54,882	80,008	93,863	117,321	137,014
All overhead costs for optimal size	29,382	34,487	41,187	65,935	79,073	114,918	140,908	174,577	206,322

[a] Labor and basic facilities are fixed charges regardless of the size or organization of the farm business.

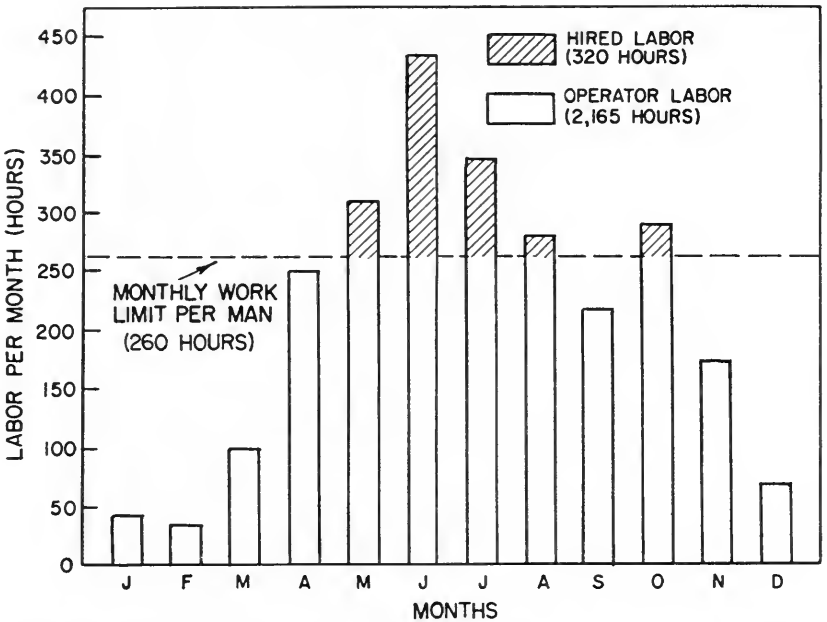
[b] Labor cost includes an allowance for operator labor plus regular hired workers at increasing salaries as labor force and responsibilities for supervision increase.

[c] Overhead costs of equipment are 13 percent of new investment and are composed of depreciation, interest on investment, taxes, and insurance. Repairs are variable costs. Overhead costs of buildings are 10.5 percent of new investment and include repairs in addition to all of the charges made against equipment.

[d] Illinois farm records show the annual cost of shop equipment and small tools to be about $1.00 per acre on one-man, conventionally equipped grain farms. Larger farms are assumed to add hand tools for each self-propelled vehicle. Average life of shop equipment and tools is placed at five years. Other costs bring annual overhead costs to 25 percent of new investment.

[e] Cash expenses for organization dues, electricity for farmstead lights and shop tools, telephone, automobile operating expenses, and other miscellaneous items.

[f] Charges for use of land include interest and taxes.

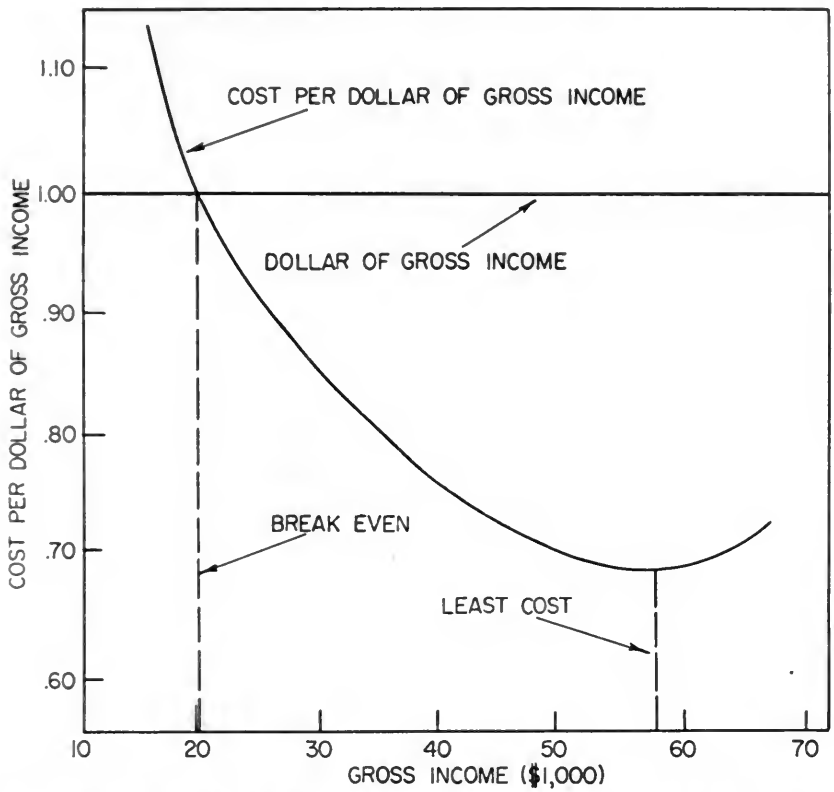


Distribution of operator and hired seasonal labor use on a one-man cash-grain farm with four-row equipment. (Fig. 4)

Some seasonal labor is used in the optimal farm plans for peak summer and harvest months, but it amounts to only about 12 percent of total labor requirements (Appendix Table 14). In actual operation, a cash-grain farmer might rid himself of much of this part-time seasonal labor through custom hiring, working longer hours, and spreading the work season.

Size economies. The average cost per dollar of gross income produced on cash-grain farms presents the typical "U"-shaped pattern as volume of production is expanded to the capacity of a given labor force and equipment complement. Unused equipment capacity and underemployment of the labor force result in high fixed costs per unit of production for low volumes. Average cost declines as output expands and fixed resources become more fully utilized. Average cost increases sharply after reaching a minimum as the farm organization is restructured for maximum production and higher cost methods and enterprises have to be included in the business.

On a one-man cash-grain farm operated with four-row equipment, costs are not covered until gross income is about $20,000 annually (Fig. 5 and 6). Below the $45,000 gross income level, a one-litter pasture hog enterprise is included to utilize excess labor and pasture. The acreage of legumes is too small to justify farm-owned haying equipment and custom



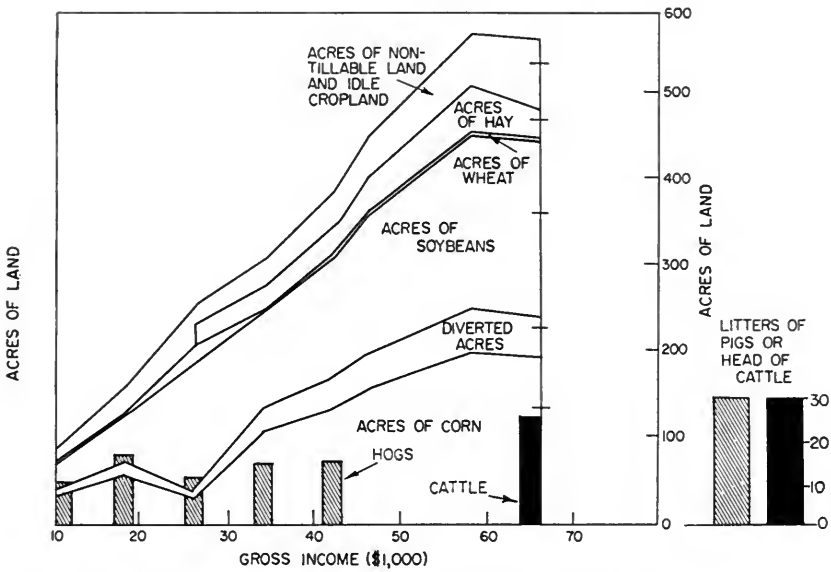
Average total cost of production on a one-man cash-grain farm with four-row equipment at various levels of gross income (farm organized to achieve least cost per gross dollar at all income levels). **(Fig. 5)**

harvest rates are too high. Legumes not used for hog pasture are therefore plowed under for green manure.

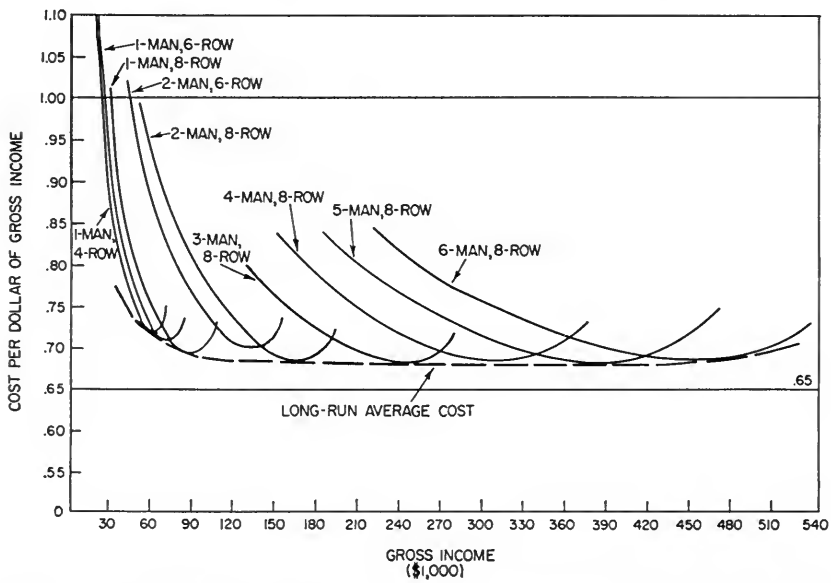
Continued expansion of gross income results in elimination of the hog enterprise. Specialization in cash-grain production occurs between the $45,000 and $60,000 gross income levels. Costs are minimized at $0.71 per dollar of gross income at the $58,000 gross-income level.

Attempts to increase gross income beyond $58,000 cause average costs to rise rapidly. Relatively high-cost beef cattle enterprises have to be brought into the farm organization to generate additional gross income. Production of corn and soybeans is reduced. Haymaking has to be handled by custom methods instead of farm-owned equipment.

Increases in equipment size to six- and eight-row complements result in further reductions in minimum average costs on the one-man farm. Costs are minimized on the one-man cash-grain farm at $70,000 gross in-



Organization of a one-man cash-grain farm with four-row equipment to achieve least cost per dollar of gross income at various levels of gross income. (Fig. 6)



Short-run and long-run average cost curves for cash-grain farms with one to six regular workers and selected sizes of field machinery. (Fig. 7)

come when six-row equipment is used and at $86,000 with eight-row equipment. Cost per dollar of gross income is $0.70 on the six-row farm and $0.68 on the eight-row farm. The optimal organization remains straight cash grain.

Addition of a second or third full-time employee and adequate eight-row equipment permits reduction of minimum average cost to slightly less than $0.68 per dollar of gross income. Minimum average costs rise slightly as the labor force is expanded beyond three men and a confinement hog enterprise becomes part of the operation.

The long-run cost situation is approximated by a curve fitted to the cost curves for each of the farm sizes from one through six men (Fig. 7). The least-cost point on this curve occurs with the two- or three-man farm operated with eight-row equipment. This represents the optimal size of farm in the long run and is the size toward which farming units should trend, given the assumptions and restrictions posed in this analysis.

Conclusions. Several conclusions are apparent from the cost analyses of the several farm sizes and the relationships among them.

1. A substantial volume of production is needed to achieve a break-even situation even on the one-man farms.

2. Average costs drop rapidly on one-man farms as output approaches capacity of the labor-equipment complement.

3. The output range within which a one-man farm can be operated profitably is relatively narrow with average costs rising sharply on either side of the optimal level of operation.

4. A one-man farm benefits economically from enlarging field equipment before adding to the labor force when additional output is desired.

5. The six-row equipment complement results in a higher cost situation on the two-man farm than does eight-row equipment on either a one- or two-man farm when the time period is long enough to permit adjustment of the land base.

6. A two- or three-man farm using eight-row equipment achieves the least cost of all sizes and hence represents the optimal size of cash-grain farming unit, given the optimizing criteria assumed in this analysis.

7. Other sizes of farms, including a one-man unit and ranging to six-man units, achieve cost economies that permit them to compete effectively with the optimal size of two- and three-man units.

8. Livestock enterprises are not included in the optimal farm plans until the labor force reaches four or more men.

9. Net returns to management are sufficient to encourage expansion of farming operations beyond optimal size by expanding either the labor force or other resources, or both.

10. Total cost is about $0.68 per dollar of gross income on a farm of optimal size and organization, leaving a residual of $0.32 for management and profit.

Optimal Organization of Hog Farms

Crop and livestock enterprises. Optimally organized hog farms require a substantial acreage of land and crop production under the conditions posed in this analysis. Specialized, single-enterprise hog operations do not occur in any of the optimal farm plans. Generally, the optimal farm plans include an acreage of corn sufficient to supply the feed grain needs of the hog enterprise.

Cropland on the one-man hog farms ranges from 271 acres when four-row equipment is used to 311 acres when the farm is operated with eight-row equipment (Table 8). As additional full-time men are added to the organization the acreage of cropland per man declines from these maximums as it does on the cash-grain farms.

Only 56 percent of the cropland is planted to row crops. Differences in land characteristics and the requirement to participate in the feed grain and wheat programs account for most of the drop from the 80-percent level found on the cash-grain farms. Of the remaining cropland one-fourth is seeded to small grains, one-half to legumes which are harvested for hay and are sold, and one-fourth is set aside as diverted acreage under the provisions of the feed grain and wheat programs.

Corn is planted to the maximum allowed by minimum compliance with the feed grain program and accounts for three-fourths of the row-crop acreage (Table 8). Soybeans occupy the remainder of the row-crop acreage.

Small grains and legumes are forced into the farm plan largely by the necessity to comply with the conservation and diverted-acreage provisions of the feed grain and wheat programs. The combined acreage of small grains and diverted land provide the nurse crop needed to establish the required acreage of legumes. In reality the small acreage of wheat would likely be replaced entirely by oats except on individual farms having a larger than average wheat base.

The hog enterprises in the optimal solutions are all handled in confinement even though substantial pasture is available on which hogs can be produced. Both two- and six-litter systems are used. Farrowing cycles begin in February with the two-litter systems farrowing in February and August, and the six-litter systems farrowing in February and every other month thereafter. These farrowing periods permit most complete use of the regular labor force, which must also handle crop production, and they place hogs on the market when prices are most favorable. Continued ex-

Table 8. — Optimal Organization of Hog Farms of Selected Sizes, Illinois, 1970[a]

Land use and livestock enterprises	Gross income, labor force, and size of equipment[b]								
	1 man			2 men		3 men, 8-row	4 men, 8-row	5 men, 8-row	6 men, 8-row
	4-row	6-row	8-row	6-row	8-row				
Gross income[b]	$54,000	$58,000	$62,000	$110,000	$118,000	$170,000	$226,000	$276,000	$324,000
Total acres[c]	355	381	408	716	770	1,122	1,468	1,793	2,104
Cropland, acres	271	290	311	546	587	855	1,119	1,366	1,603
Corn	117	126	135	236	254	370	485	592	695
Soybeans	35	37	40	70	75	110	144	176	206
Wheat	7	7	7	13	14	20	27	32	38
Oats	23	24	26	46	50	72	94	115	135
Legumes	59	64	68	120	129	188	245	299	351
Diverted	30	32	35	61	65	95	124	152	178
Non-cropland, acres	84	91	97	170	183	267	349	427	501
Permanent pasture	67	72	77	135	145	211	276	337	396
Woodland	7	8	8	14	15	22	29	36	42
Farmstead, roads, and waste	10	11	12	21	23	34	44	54	63
Hogs[d]									
Two-litter systems	35	47	71	236	202	0	548	669	786
Six-litter systems	97	95	81	32	86	419	0	0	0

[a] Optimal organization is defined as that resulting in least cost per dollar of gross income.
[b] Gross income is that achieved at the optimal organization.
[c] Land classification is the average for the eight-county area.
[d] Hogs are produced in confinement with the two-litter systems farrowing in February and August, and the six-litter systems farrowing in February and every other month thereafter.

pansion of confinement production and multiple farrowing may alter seasonal price patterns in the future.

Excess capacity of field machinery on farms with fewer than four men frees some labor and permits intensified use of fixed hog facilities by six-litter farrowing systems. Competition for labor between crops and hogs forces all of the hogs on the four-, five-, and six-man farms into two-litter confinement systems timed like the common pasture programs of years past. In the absence of crop production the specialized six-litter system would be preferred over the other methods of handling hogs.

Capacity per man is about 275 litters in a single-enterprise hog operation in which multiple farrowing is practiced. The maximum number handled in these farm plans is 152 litters per man, since a combination of crop and hog production is more effective than complete specialization in hogs. Time needed for supervision and coordination reduces the litters handled per man to 131 as farm size increases to a six-man unit.

Beef cow herds and feeder cattle operations do not compete effectively with hog production and are therefore not a part of any of the optimal farm plans in this analysis.

Income. Gross income ranges from $54,000 on one-man farms of optimal size and organization to $324,000 on the six-man units (Table 9). Gross income per man is highest at $62,000 on the one-man farms with eight-row equipment and declines gradually to $54,000 on the six-man farms. Hog production is a more labor-intensive activity than cash-grain production, so gross income per man is as much as $20,000 lower on the hog farms than on the cash-grain farms.

The optimal farm plans provide for hog enterprises just about large enough to consume the home-raised corn. Sale of hogs accounts for 76 percent of total gross income. The programmed constraint requiring hogs to provide at least 60 percent of gross income did not influence any of the optimal solutions. Sales of corn account for only 3.8 percent of gross income. Soybeans account for 6.6 percent of gross income, small grains 3.1 percent, and hay 10.5 percent (Appendix Table 16).

Net returns to management range from $15,983 on the one-man farms with four-row equipment to $102,441 on the six-man units (Table 9). Returns to operator labor, management, and capital are quite substantial on these hog farms, ranging from just over $30,000 to nearly $157,000. They fall short, however, of returns achieved on cash-grain farms with the same size labor force largely because both productivity and capital investment per man are lower in hog production than in cash-grain production.

The level of land values raises the same questions on these hog farms as on the grain farms. A later section of this report considers the effect of variable land prices on the optimal organization of farms in the hog area.

Table 9. — Gross Income, Total Costs, and Selected Measures of Returns for Optimally Organized Hog Farms, Illinois, 1970[a]

	Number of men and size of equipment								
	1 man			2 men		3 men,	4 men,	5 men,	6 men,
	4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Gross income	$54,000	$58,000	$62,000	$110,000	$118,000	$170,000	$226,000	$276,000	$324,000
Total cost[b]	38,107	41,382	44,856	74,640	80,659	115,632	154,723	189,621	221,559
Net returns to management	15,893	16,618	17,144	35,360	37,341	54,368	71,277	86,379	102,441
Operator labor	5,770	5,770	5,770	5,770	5,770	5,770	5,770	5,770	5,770
Returns to operator labor and management	21,663	22,388	22,914	41,130	43,111	60,138	77,047	92,149	108,211
Interest on:[c]									
Working capital	761	820	886	1,542	1,667	2,429	3,185	3,949	4,226
Other capital	7,728	8,471	9,304	15,196	16,591	23,639	31,514	38,360	44,493
Total	8,489	9,291	10,190	16,738	18,258	26,068	34,699	42,309	48,719
Returns to operator labor, management, and capital	30,152	31,679	33,104	57,868	61,369	86,206	111,746	134,458	156,930

[a] Optimal organization is defined as that resulting in least cost per dollar of gross income.
[b] Total cost includes a charge or allowance for all inputs except management.
[c] Interest on working capital is charged at 6 percent. The interest rate on other capital is 5 percent. This includes the investment in land and inventory value of buildings and equipment.

Table 10. — Estimated Number of Primary Field Machines Needed to Handle the Maximum Acreages of Crops Produced on Two- to Six-Man Hog Farms, Illinois, 1970[a]

Machinery[b]	Regular labor force and size of equipment					
	2 men		3 men,	4 men,	5 men,	6 men,
	6-row	8-row	8-row	8-row	8-row	8-row
			(number)			
Tractor, 40 DBHP	1	1	1	2	2	2
Tractor, 70, 100 DBHP	1	1	2	2	3	3
Stalk chopper, 3-, 4-row	1	1	1	2	2	2
Plow, 5-14, 7-14	1	1	2	2	3	3
Disk, 19-, 28-foot	1	2	2	3	3	3
Harrow, 4-, 5-section	1	2	2	3	3	3
Planter, 6-, 8-row	1	1	1	2	2	2
Cultivator, 6-, 8-row	1	1	1	2	2	2
Rotary hoe, 3-, 4-row	1	2	2	3	3	4
Sprayer, 8-row	1	1	1	2	2	2
Fertilizer spreader, 10-, 30-foot	1	2	2	3	3	3
Mower, 7-foot	1	1	2	2	3	3
Grain drill, 14 x 7	1	1	2	2	3	3
Wagon	2	2	2	4	4	4
Combine, 65, 78 DBHP	1	1	1	2	2	2
Grain platform, 14-, 20-foot	1	1	1	1	1	2
Corn head, 3-, 4-row	1	1	1	2	2	2
Hay rake	1	1	2	2	3	3
Hay conditioner	1	1	2	2	3	3

[a] Capacity of machines for specific operations is based on a combination of size, operating speed, field efficiency, and a work period that will permit a sufficient number of good work days to get the job done at a 90-percent level of confidence. Based on these factors, an extra machine was added whenever theoretical capacity was exceeded by more than 10 percent. See R. N. Van Arsdall, Labor Requirements, Machinery Investments, and Annual Costs for the Production of Selected Field Crops in Illinois, 1965, AE-4112, Dept. Agr. Econ., Univ. Ill., 1966.

[b] The first number denotes size of 6-row machines; the second the size of 8-row machines.

Field machinery. Operators of hog farms are confronted with the problem of obtaining a satisfactory and economical complement of field machinery, but the problem differs from the one faced by cash-grain producers. Generally, excess machine capacity is the chief problem on one-man farms, while matching of machines to needs is the task on the larger farms.

One set of field machinery provides considerable excess capacity on one-man hog farms, yet the service of each separate machine is needed. One complement of equipment is even adequate to handle all of the field operations on a two-man hog farm operated with six-row equipment and is adequate for most of the operations when eight-row equipment is used (Table 10). A single machine is adequate for some operations when the regular labor force is increased to three men. For larger farms ranging to a full-time labor force of six men the number of machines needed averages about half the number of regular employees. Unused machine capacity, including tractor power, occurs frequently (Appendix Table 17).

The problem arises partly because the number and size of power units must be adequate to handle the jobs requiring timeliness and the heaviest draft.

Whenever a certain complement of machines is necessary for one size of farm but is also adequate for the next larger farm in terms of number of regular employees, the overhead costs are especially high for the smaller farm. Special provision to lengthen the hours that a machine can be used, employment of custom operators, or adjustments in crop production may be advisable on farms where machine capacity is considerably out of balance with need. In any case, matching machine capacity and labor force to crop needs on hog farms of optimal size and organization is more difficult than on cash-grain farms where a full complement of field machines for each regular employee provides near optimal usage of machinery.

Optimal land use combined with the requirements of the feed grain and wheat programs specify productions of legumes for harvest as hay. Non-compliance with the program or lack of a ready market for hay would eliminate most legumes and the need for hay-making equipment.

Capital requirements. The capital needed to own and operate a hog farm of optimal size and organization in west central Illinois ranges from $167,242 on one-man farms operated with four-row equipment to $966,953 on six-man units using eight-row field equipment (Table 11). The basic investment for field machinery and shop equipment is about the same on one-man hog farms as on one-man cash-grain farms. Thereafter investments per man on farms with larger labor forces are much lower on the hog farms. Much of the labor supply on the hog farms is devoted to hog production. Crop production is not great enough to require a full complement of field machinery for each man in the labor force as is necessary on the cash-grain farms.

Production of hogs reduces the need for a large land base to produce high gross incomes and make optimal use of resources. Also the western Illinois hog area contains a higher percentage of unproductive land lower in value than the land in the cash-grain area. As a consequence the total investment in land on hog farms is only one-third to one-half the investment on cash-grain farms with the same labor force. Land comprises about 70 percent of total investment in the hog area compared with 90 percent in the cash-grain area.

Hog facilities and the working capital needed in the farming operation both represent important investments. Each category generally equals or exceeds the investment in field machinery needed in the operation.

The highest investment per man is $200,853 on the one-man farm operated with eight-row equipment. Minimum investment per man is $161,159 on the six-man farms.

Annual overhead costs. Salaries of the regular employees and allow-

Table 11. — Basic and Added Investment Necessary to Equip and Operate Hog Farms for Capacity Operation at the Optimal Level, Illinois, 1970[a]

Investment	Number of men and size of equipment								
	1 man			2 men		3 men, 8-row	4 men, 8-row	5 men, 8-row	6 men, 8-row
	4-row	6-row	8-row	6-row	8-row				
Basic investment for all sizes									
Crop equipment[b]	$ 13,959	$ 18,112	$ 23,634	$ 20,765	$ 28,047	$ 36,968	$ 51,455	$ 61,049	$ 62,367
Machine shed and shop[c]	1,100	1,392	1,683	1,595	2,008	2,640	3,658	4,345	4,455
Shop equipment, small tools, and water system[d]	2,365	2,585	2,695	2,613	2,723	2,805	2,970	3,080	3,107
Total	17,424	22,089	28,012	24,973	32,778	42,413	58,083	68,474	69,929
Per man	17,424	22,089	28,012	12,486	16,389	14,138	14,521	13,695	11,655
Added investment for optimal size									
Land	117,860	126,492	135,456	237,712	255,640	372,504	487,376	595,276	698,528
Grain storage[e]	4,128	4,436	4,755	8,326	8,966	13,050	17,068	20,878	24,480
Hog facilities[f]	15,142	16,401	17,864	32,910	34,440	44,820	67,758	82,582	96,916
Working capital	12,688	13,672	14,766	25,705	27,787	40,485	53,079	65,817	77,100
Total	149,818	161,001	172,841	304,653	326,833	470,859	625,281	764,553	897,024
Per man	149,818	161,001	172,841	152,326	163,416	156,953	156,320	152,911	149,504
All investments for optimal size									
Total	167,242	183,090	200,853	329,626	359,611	513,272	683,364	833,027	966,953
Per man	167,242	183,090	200,853	164,813	179,806	171,091	170,841	166,605	161,159

[a] Unimproved land is valued at $332 per acre. Land investment should be increased by $9.24 per acre new cost to fence 80-acre tracts cattle tight; $11.55 per acre to fence 80-acre tracts hog tight. (All depreciable assets are valued at 55 percent of new cost.)

[b] Crop equipment needed to equip the labor force for capacity production of cash grain.

[c] Shed space is provided for all crop equipment. Shop space is 10 percent of the space needed for machinery storage.

[d] Includes a 6½-inch, deep-well system costing $2,300 to construct and equip, and charged at a depreciated value of $1,265.

[e] In-storage drying and storage facilities are charged at an initial cost of 50 cents per bushel of storage space for corn. Soybeans and small grains are stored for an initial cost of $0.30 per bushel of storage space.

[f] Hog facilities in the optimal farm organizations are two- and six-litter confinement systems with a complete complement of mechanical equipment for feed processing and distribution.

ances for operator labor on a hog farm, plus the fixed costs of the headquarters unit and the basic complement of field equipment, range from $9,261 to $13,327 per man (Table 12). The highest cost occurs on the one-man farms. Labor accounts for more than one-half of these charges reaching a maximum of two-thirds on the six-man units. Labor is of greater importance as an input in hog production than in cash-grain farming. Also, a higher salary is assumed necessary to attract and hold capable men for work in hog production.

Once the crop-livestock program is established and the quantities of needed inputs determined, additional annual overhead costs can be calculated in the traditional manner. Land accounts for about 60 percent of the added overhead costs. Charges for the use of hog facilities comprise most of the remainder. Together these added overhead costs are approximately equal to the overhead costs of the basic facilities and regular labor force. Total overhead costs range from $21,041 to $26,718 per man employed in the operation. They represent slightly more than half of all costs.

Labor use. A single-enterprise hog operation with year-round farrowing in confinement would eliminate most seasonal variations in labor requirements. The size and organization of hog farms that result in least cost per dollar of gross income, however, include both crop and hog production. As a result, substantial variation remains in the seasonal requirements for labor (Appendix Table 18).

The regular labor force is more fully utilized throughout the year on hog than on the cash-grain farms (Fig. 8). Utilization of available labor falls below 50 percent only in January as compared with four months on cash-grain farms when employment is well below 50 percent of the capacity of the labor force.

The pattern of labor use is least efficient on the smaller hog farms that use six-litter confinement systems. Farms with four to six full-time men employ a two-litter confinement system and thus combine crop-livestock labor demands into a more effective year-round labor program.

Seasonal day labor is a relatively unimportant part of the total labor requirement on optimally organized hog farms. Such labor accounts for only 6 percent of the total labor requirement compared with 12 percent on cash-grain farms. Summer crop care and hay harvest are responsible for the day labor that is needed. The need for this additional seasonal labor on hog farms could be eliminated by handling the forage crop through a custom operator.[14]

Size economies. Average costs per dollar of gross income produced on hog farms represent the same typical "U"-shaped pattern found on cash-grain farms as volume of business is expanded to the capacity of the

[14] Cost would be slightly higher. Custom hay harvest was one of the alternatives tested.

Table 12. — Annual Basic and Added Overhead Costs for Basic Facilities and Salary of the Regular Labor Force Incurred in Operation of Hog Farms at the Optimal Level, Illinois, 1970[a]

Costs	Number of men and size of equipment								
	1 man			2 men		3 men,	4 men,	5 men,	6 men,
	4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Labor[b]	$ 5,770	$ 5,770	$ 5,770	$11,540	$11,540	$17,740	$23,940	$30,140	$37,100
Basic facilities for all sizes[c]									
Crop equipment	3,299	4,281	5,586	4,908	6,629	8,738	12,162	14,430	14,741
Machine shed and shop	210	266	321	304	383	504	698	830	850
Shop equipment, small tools, and water system[d]	750	850	900	863	913	950	1,025	1,075	1,087
Miscellaneous[e]	750	750	750	1,040	1,040	1,280	1,500	1,670	1,790
Total	10,779	11,917	13,327	18,655	20,505	29,212	39,325	48,145	55,568
Added costs for optimal size[c]									
Land[f]	7,331	7,868	8,425	14,785	15,901	23,169	30,314	37,025	43,448
Grain storage	884	951	1,021	1,784	1,920	2,797	3,657	4,474	5,246
Hog facilities	3,325	3,613	3,945	7,375	7,730	10,136	15,328	18,712	21,984
Total	11,540	12,432	13,391	23,944	25,551	36,102	49,299	60,211	70,678
All overhead costs for optimal size, including labor	22,319	24,349	26,718	42,599	46,056	65,314	88,624	108,356	126,246

[a] Labor and basic facilities are fixed charges regardless of the size or organization of the farm business.

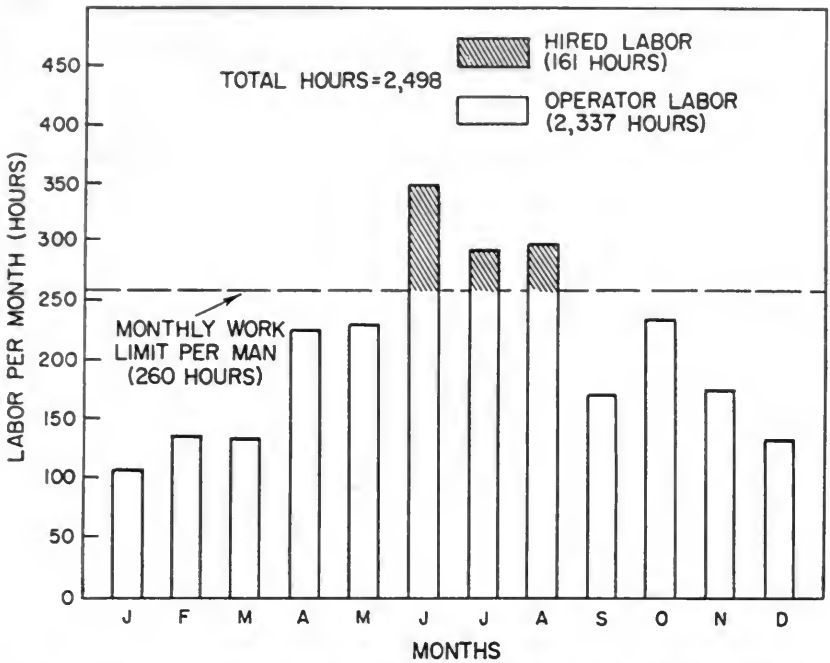
[b] Labor cost includes an allowance for operator labor plus regular hired workers at increasing salaries as labor force and responsibilities for supervision increase.

[c] Overhead costs of equipment are 13 percent of new investment and are composed of depreciation, interest on investment, taxes, and insurance. Repairs are variable costs. Overhead costs of buildings are 10.5 percent of new investment and include repairs in addition to all of the charges made against equipment.

[d] Illinois farm records show the annual cost of shop equipment and small tools to be about $1.00 per acre on one-man, conventionally equipped hog farms. Larger farms are assumed to add hand tools for each self-propelled vehicle. Average life of shop equipment and tools is placed at five years. Other costs bring annual overhead costs to 25 percent of new investment.

[e] Cash expenses for organization dues, electricity for farmstead lights and shop tools, telephone, automobile operating expenses, and other micsellaneous items.

[f] Charges for use of land include interest and taxes.

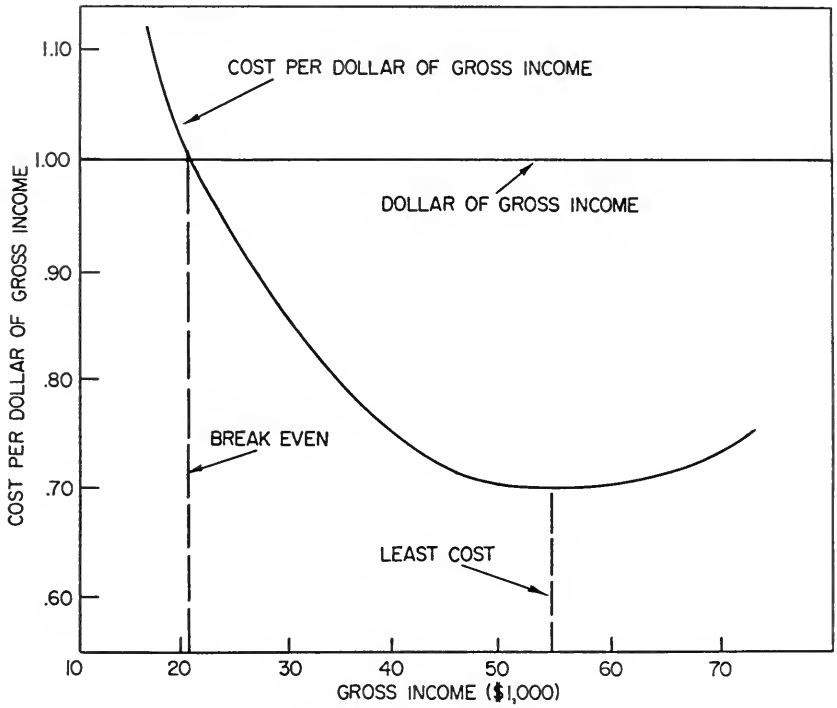


Distribution of operator and hired seasonal labor use on a one-man hog farm with four-row equipment. (Fig. 8)

labor force. Reduction in average costs results from more complete utilization of labor and the fixed complement of the equipment. After minimum costs are achieved, further increases in gross income are possible only at a sacrifice in timeliness or with a substitution of new enterprises. Cattle feeding, for example, produces a large gross income per unit of labor, but it does not make effective use of other resources and hence raises costs per unit of gross output.

The organizational structure and cost situation of a one-man hog farm on which four-row field equipment is used change with size (Fig. 9 and 10). Costs exceed income until gross income reaches approximately $20,000. Below $35,000 gross income the farm organization that results in least cost per dollar of gross income is oriented toward cash-grain with emphasis on soybeans. Hogs are produced in small, two-litter pasture systems with a March-September farrowing sequence. High overhead costs prevent use of a confinement system. In fact, hogs enter the optimal farm plan at the lower gross income levels only because provisions of the programming model require that they produce at least 60 percent of gross income.

The size of hog enterprise that can be handled becomes large enough at the $35,000 gross farm income level to justify the higher fixed costs of



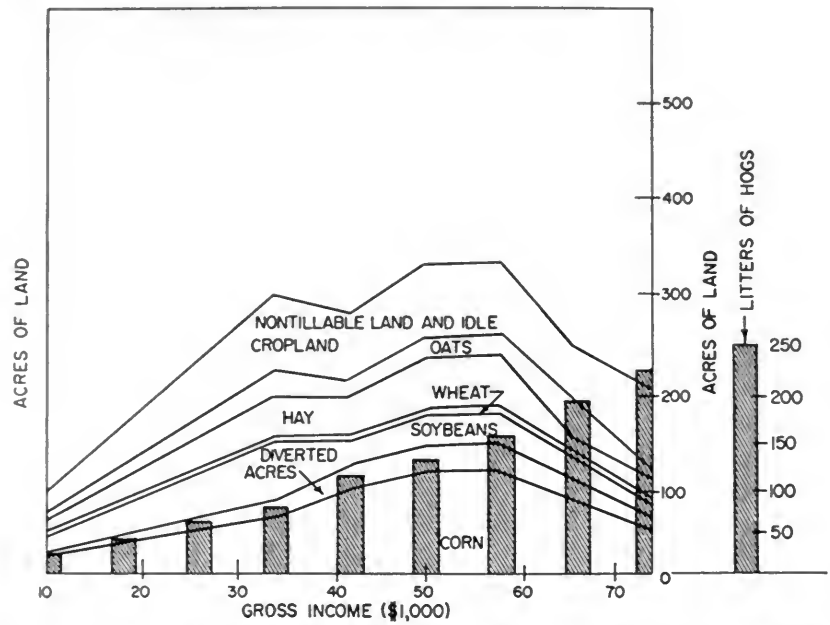
Average total cost of production on a one-man hog farm with four-row equipment at various levels of gross income (farm organized to achieve least cost per dollar of gross income at all income levels). (Fig. 9)

confinement systems. Hogs become more profitable. Their relative importance rises above the minimum of 60 percent of gross income. Land drops to an acreage just sufficient to provide enough corn to feed the hogs.

Optimal size for the one-man farm using four-row equipment occurs at a gross income of $54,000. Costs are $0.71 per dollar of gross income. Continued expansion beyond this level places pressure on the labor force. Crop production has to be cut back to permit expansion of hog production. Corn is purchased for feed. Average cost of production rises.

Six- or eight-row equipment permits one man to handle a larger acreage of crops and produce a higher gross income than possible with four-row equipment but the minimum average cost increases with size of equipment. It is $0.71 per dollar of gross income with six-row equipment and $0.72 with an eight-row unit. Four-row equipment provides excess capacity on a one-man hog farm and larger equipment only aggravates the cost situation.

Addition of a full-time employee to a one-man hog farm lowers average cost per dollar of gross income to $0.68. One complement of six-row



Optimal organization of a one-man hog farm with four-row equipment to achieve least-cost per dollar of gross income at various levels of gross income. (Fig. 10)

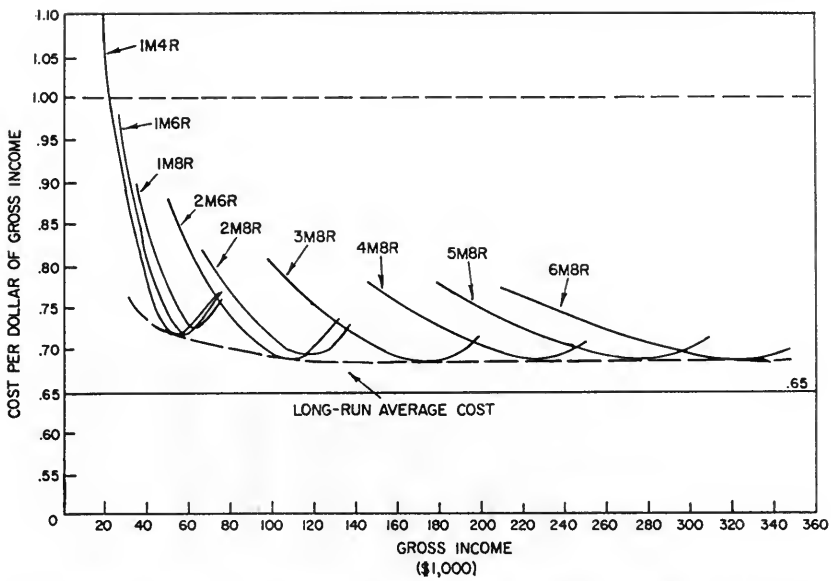
equipment is generally adequate for a two-man hog farm, thus a much larger volume of business is possible with no increase in overhead costs for field machinery. In fact, a two-man labor force with six-row equipment results in the lowest average cost per dollar of gross income of all the hog farm sizes tested. A three-man hog farm with adequate eight-row field machinery achieves about the same average cost of production. Four-, five-, and six-man hog farms of optimal size and organization have a slightly higher minimum average cost.

The series of short-run average cost curves for the one- to six-man hog farms summarizes the results of this analysis (Fig. 11). An "envelope" or long-run average cost curve has been fitted to the short-run cost curves. Least cost occurs with the two-man farm equipped with six-row field equipment. However, cost differences among farms are small and resource efficiency is essentially the same on farms with from two to six men under the conditions posed in this analysis.

Conclusions: The cost relationships within and among these hog farms lead to several conclusions:

1. A substantial amount of gross income is needed to reach a break-even situation even on the one-man farms.

2. Average costs decrease rapidly with initial increases in size of busi-



Short-run and long-run average cost curves for hog farms with one to six regular workers and selected sizes of field machinery. (Fig. 11)

ness and then rise again as volume is expanded beyond the optimal size of business. The rate of change is most rapid on the farms with the smaller labor force.

3. Labor limits size of business on the one- and two-man hog farms, whereas capacity of field equipment was the limiting factor on cash-grain farms.

4. Field equipment of the four-row size results in lower average costs on the smaller farms than are possible with larger equipment.

5. A two- or three-man hog farm with field equipment that matches needs achieves the least cost per dollar of gross income and hence represents the optimal size of farm.

6. Hog production does not provide for most efficient use of resources on a one-man farm unless nearly optimal size is achieved.

7. Hogs compete effectively with other enterprises when volume is sufficient to spread the high overhead costs of modern confinement systems of production.

8. Farms with four to six full-time men have higher costs per dollar of gross income than do farms with two or three men, but the differences are insufficient to be an effective constraint on the larger farms.

9. Costs are about $0.70 per dollar of gross income on farms of optimal size and organization leaving a residual about $0.30 for management and profit.

Effects of Land Price on Optimal Farm Organization

Land prices have increased much more rapidly than anticipated at the outset of this study when the 1969 estimate was fixed at 10 percent above the 1964 level. In 1967, average land prices in Illinois were already about 28 percent above the 1964 level.[15] Increases in the cash-grain and hog areas have been below the state average, but they still have been large enough to warrant further examination of the relationship of land costs to farm size and organization.

Specialized Grain Farms

Most farmers in the cash-grain area have continued to specialize in production of corn and soybeans throughout this period of rising land prices. If this holds true for the farm plans developed in this analysis, the result is simply an increasing squeeze on returns to management and profit. For example, a two-man cash-grain farm of optimal size for use of eight-row field equipment requires 1,641 acres of land. Net returns to management are $53,279 when land charges are based on a price of $491 per acre. As land prices rise, interest on investment (at 5 percent) and taxes add $6.18 per acre for each $100 increase in price. A land price of $800 per acre cuts management returns to about $22,000; a $900 price reduces returns to about $12,000; and a price of $1,000 per acre nearly eliminates returns to management. Further, the range in size of farm that can be operated profitably narrows as land prices increase. Management of less than the superior quality on which this analysis is based would result in lower net returns at any given level of land prices.

Organizational Adjustments in the Cash-Grain Area

Higher land prices, other costs and prices remaining unchanged, require shifts in combinations of enterprises for most effective use of resources.

The general effect of higher land costs on the optimal long-run organization of farms in the cash-grain area is a reduction in crops and an increase in hog production. Cash-grain production, however, is the dominant system over a substantial range in land values. For example, the two-man farm of optimal size produces only crops until land prices rise to nearly $700 per acre (Table 13). Then part of the farm resources are more effectively devoted to production of hogs in confinement than to crop production. A land value of $750 to $850 per acre causes the farm organization to shift strongly toward production of hogs. Such organizational adjustments would require the operator to have an equally high

[15] Economic Research Service, U.S. Department of Agriculture. Farm Real Estate Market Developments, CD-69, p. 5. June 20, 1967.

Table 13. — Effect of Rising Land Costs on the Optimal Long-Run Organization of a Two-Man Farm in the Cash-Grain Area[a]

	Land price per acre[b]				
	$491	$682	$766	$824	$1,353
Total acres[c]	1,641	1,174	256	216	3
Corn, acres	578	413	90	76	1
Soybeans, acres	581	416	91	76	1
Small grains, acres	9	6	2	1	0
Legumes, acres	154	110	24	20	0
Corn purchased, bu.	0	0	32,100	35,100	51,100
Corn sold, bu.	72,200	36,600	0	0	0
Hogs, litters	0	155	446	459	525
Net returns to management[d]	$52,700	$33,800	$30,600	$29,700	$29,300
Cost per dollar gross income, dollars	.68	.80	.82	.82	.82

[a] These farm plans produce a gross income of $166,000 which was the optimal with land at the base price of $491 per acre. Eight-row field equipment is used. The farm plan is in compliance with the provisions of the 1964 feed grain and wheat programs.

[b] Annual charges for land are 5 percent of value for interest and 1.18 percent for taxes.

[c] Minor uses of land are not recorded.

[d] When the farm plan includes hogs as the major or only enterprise, the cost of field machinery can be reduced or eliminated. Without these costs, the returns to management would be over $11,000 higher than indicated; unit costs about $0.07 lower.

managerial capability with all enterprises and an objective of least cost per unit of input.

Increases in land prices have relatively little effect on the amount of gross income needed to achieve lowest unit cost. On the two-man farm in the cash-grain area, least cost is obtained with a gross income of $166,000 when the land price is $491 per acre. The farm plan is dominated by corn and soybeans. As the land price increases, hogs begin to replace crops in the optimal farm plan. The gross income at which costs are minimized drops by $15,000 to $20,000. When the operation is finally converted entirely to hogs, however, the gross income at which average costs are minimized returns to the original level of $166,000.

Organizational Adjustments in the Hog Area

The effect of rising land prices on farm organization in the hog area is similar to that in the cash-grain area. Hogs, which account for three-fourths of gross income at the base land price of $332 per acre, continue to increase in importance as land values rise and it becomes relatively less profitable to raise than to purchase feed grains. Again, however, land prices can increase substantially before significant enterprise adjustment becomes desirable (Table 14).

The two-man hog farm of optimal size and organization produced all feed grain requirements on the farm when land costs were $332 per acre. Costs were minimized at a gross annual output of $110,000. This situation

Table 14. — Effect of Rising Land Costs on the Optimal Long-Run Organization of a Two-Man Farm in the Hog Area[a]

	Land value per acre[b]							
	$332	$558	$714	$725	$740	$775	$818	$848[d]
Total acres[c]	716	714	534	502	270	227	101	0
Corn, acres	236	236	176	166	89	75	33	0
Soybeans, acres	70	70	52	49	26	22	10	0
Small grains, acres	59	59	44	41	22	19	8	0
Legumes, acres	120	119	89	84	45	38	17	0
Corn purchased, 1,000 bu.	0	0	8.6	10.1	21.2	23.2	29.2	34.0
Corn sold, 1,000 bu.	0	0	0	0	0	0	0	0
Hogs, litters	268	268	288	292	319	324	338	350
Net returns to management, $1,000[d]	35.4	25.3	18.4	18.0	17.5	17.0	16.4	16.2
Cost per dollar gross income, dollars	.68	.77	.83	.84	.84	.85	.85	.85

[a] These farm plans all produce a gross income of $110,000, which was the optimal with land at the base price of $332 per acre. Six-row field equipment is used in crop production. The farm plan is in compliance with the provisions of the 1964 feed grain and wheat programs.
[b] Annual charges for land are 5 percent of value for interest and 1.22 percent for taxes.
[c] Minor uses of land are not recorded.
[d] When the farm plan includes hogs as the only enterprise, the field machinery can be eliminated. Returns to management would be about $5,000 higher than indicated; unit costs $0.05 lower.

remains essentially unchanged until land price rises to more than $700 per acre (Table 14). However, even at a land price of $725 per acre, or well over twice the base value used in this study, over two-thirds of the feed grain requirement is still produced on the farm. Not until land price reaches $848 per acre is crop production forced completely out of the farm plan in favor of a single-enterprise hog operation.

Hog production as a single enterprise, based on all feed purchased and no crop production, becomes the most profitable alternative in the hog area only when land prices reach $848 per acre under the assumptions used in this study. At lower land values it is more profitable to base the hog system on home-grown feed grain.

Basically, this analysis suggests that the size and organization of both cash-grain and hog farms which generate least cost per unit hold relatively constant over a rather wide range in land prices. High land prices, other costs and prices remaining unchanged, place hog production in a more favorable position relative to crop production.

Land Use Based on Land Capability

All farm plans developed in this analysis were based on compliance with the 1964 feed grain and wheat programs at the minimum level. In this portion of the analysis these restrictions are removed so that land use is limited only by the capability of the land. Class I and II land is assumed suitable for continuous row crops. Class III and IV land is assumed suitable only for small grains and rotation meadow (Appendix Table 19).

Table 15. — Effect of Varying Prices of Corn on Optimal Organization of Two-Man, Cash-Grain Farms Equipped With Eight-Row Equipment To Produce a Gross Income of $166,000 Both With and Without Compliance in the 1964 Feed Grain and Wheat Programs, Illinois[a]

Land use, acres[b]	Acres of crops				
	With participation in the feed grain and wheat programs[c]	Without participation in the feed grain and wheat programs[b]			
		Corn at $1.10	Corn at $1.15	Corn at $1.20	Corn at $1.25
Total land	1,641	1,841	1,627	1,284	1,235
Corn	578	0	467	1,055	1,025
Soybeans	581	1,513	870	0	0
Wheat	9	66	58	46	44
Hay	154	66	58	46	44
Diverted acres	145	0	0	0	0

[a] Price of soybeans is $2.56 per bushel in all cases. Open market price for wheat is $1.30 per bushel.

[b] Land use is restricted only by capability of the land. Livestock did not appear in any of the optimal solutions.

[c] Requirements of the 1964 feed grain and wheat programs are met at the minimum level. Support price on corn is $1.10 per bushel, direct payments are $0.15 × normal yield, and diversion is 20 percent of corn base. Organization is the same as that reported in Table 3.

Prices remain the same as in the preceding analyses (Appendix Table 12) except for corn and wheat. Corn prices are ranged from $0.90 to $1.25 per bushel, and the wheat price is set at $1.30 per bushel.

The effect on farm organization of nonparticipation in the feed grain and wheat programs was tested on a two-man cash-grain farm operated with eight-row equipment. The first test was applied at the gross income level of $166,000, which was the farm size found to be optimal under conditions of participation in the feed grain and wheat programs (Table 15).

Corn and soybeans are highly competitive crops. Removal of the program restrictions permits them to compete for the better quality lands and other resources. With soybeans at $2.56 per bushel and an optimizing criterion of least cost per dollar of gross income, all class I and II land would be devoted to soybeans when the price of corn is $1.10 or less. The two crops produce similar cost-income ratios when the corn price is $1.15 and soybeans are $2.56. Thus a more balanced production of them achieves optimum results. When the corn price rises to $1.20 all class I and II land should be planted to corn. Class III and IV land is devoted equally to wheat and legumes harvested for hay and sold regardless of the corn-soybean price ratio.

Total land needed to produce a given amount of gross income from an optimal combination of enterprises changes directly with the price of corn. For example, production of a gross income of $166,000 requires an 1,841-acre farm on which all of the class I and II land is planted to soybeans when corn is $1.10 per bushel and soybeans are $2.56. When the price of

corn advances to $1.20 per bushel the class I and II land is shifted to continuous corn and the total acreage requirement drops by one-third (Table 15).

The cost ratio on an optimally organized farm that is participating in the 1964 feed grain and wheat programs and producing a $166,000 gross income is $0.68 per dollar of gross income. Cost drops to $0.66 per dollar of gross income when the program participation requirement in the analysis is dropped and corn is $1.10 per bushel. It falls to nearly $0.60 when the price of corn advances to $1.25. The shift of high-priced land from legumes and diverted acres to crop production is largely responsible for these declines in cost per dollar of gross income.

The price of corn has been below $1.15 per bushel relative to soybeans at $2.56 during many of the past several years, yet farmers have not switched as strongly to soybeans as this analysis seems to suggest they should. Most farmers are confronted with a relatively fixed complement of machinery and labor, as assumed in this analysis. They also have a limited acreage of land which was assumed to be readily available in this analysis. Farmers are concerned first with maximizing residual income above variable costs. This objective approaches compatibility with the least-cost objective only slowly through time as adjustments in fixed resources become possible.

Profit Maximization

Farmers generally try to organize their farming operations to maximize net returns. Most do not have enough land to set up a cost-minimizing business, hence profit maximization becomes the overriding objective. Analyses in this section show profit maximizing farm organizations for selected fixed land bases. Type-of-farm constraints are removed. This compares with the previous analysis where land was assumed variable and the objective was least-cost production.

Farm Organizations With Program Participation

When a farmer has less land than needed for an optimal size of business, he is commonly forced to generate volume by adding livestock. In the cash-grain area hogs provide the most profitable alternative for most farmers under existing cost-price relationships. For example, a one-man, 165-acre farm requires specialization in hog production if net returns are to be maximized (Table 16). When land use is restricted by compliance with the 1964 feed grain and wheat programs, nearly 12,000 bushels of corn must be purchased to support the 196-litter hog enterprise needed for full employment. Only a part of the capacity of field equipment is utilized. Costs are high, averaging nearly $0.82 per dollar of gross income, but gross

Table 16. — Farm Organization To MAXIMIZE RETURNS to Management on Farms in the Cash-Grain Area, Given the Farm Acreage, One Man, a Four-Row Complement of Field Equipment, and Program Participation, Illinois, 1970[a]

	Acres in farm				
	165	260	391	494	574[b]
Income and costs, dollars					
Gross income	70,326	60,882	58,172	58,421	58,330
Total costs[c]	57,478	46,681	42,620	42,065	41,380
Net returns to management	12,848	14,201	15,552	16,356	16,950
Cost per dollar gross	.82	.77	.73	.72	.71
Enterprises					
Corn, acres	58	92	138	174	202
Soybeans, acres	58	92	138	175	203
Small grain, acres	1	1	2	3	4
Legumes, acres	16	24	37	46	54
Diverted acres	15	23	35	44	51
Hogs, litters	196	150	90	41	1
Other activities					
Corn purchased, 1,000 bu.	11.8	3.1	0	0	0
Corn sold, 1,000 bu.	0	0	8.5	17.8	25.1

[a] Assuming minimum participation in the 1964 feed grain and wheat programs. No restrictions are placed on type of farm.
[b] Optimal acreage with respect to the cost-minimizing objective.
[c] Total cost includes an allowance for interest on the investment in land at 5 percent of $491 per acre.

income is large enough to leave a substantial net return to management. Efficiency in the use of resources is sacrificed to maximize income.

The farm organization that maximizes net returns shifts away from hogs toward cash grain as farm acreage increases. The one-man farm of 574 acres achieves maximum returns to management with essentially the same enterprise organization that results in least cost per dollar of gross income. Both income and resource use objectives are satisfied. Further enlargement of the farm acreage would make possible a small increase in net returns, but only at a substantial increase in unit cost of production.

Essentially the same relationships occur when the income maximization is the objective on larger farms in the cash-grain area. For example, two men with eight-row field equipment concentrate on hog production when they have only 661 acres of farmland. Compliance with the feed grain and wheat programs prevents production of enough corn to feed the hogs. Average costs are relatively high.

As acreage increases the farm organization shifts toward cash grain. Average cost is minimized when farm acreage is 1,641 as in the preceding analysis (Appendix Table 20).

Returns are above average costs with a 1,641-acre farm. Additional returns to management can be obtained by adding about 300 more acres of

Table 17. — Farm Organization To MAXIMIZE RETURNS to Management on Farms in the Cash-Grain Area Given Specific Farm Acreages, One-Man, and a Four-Row Complement of Field Equipment, With Land Use Limited Only by Land Capability, Illinois, 1970[a]

	Acres in farm				
	165	260	391	494	574[b]
Income and costs, dollars					
Gross income	58,774	57,111	56,471	56,481	56,503
Total costs[c]	40,061	38,744	38,811	39,671	40,587
Net returns to management	18,713	18,367	17,660	16,810	15,916
Cost per dollar gross	.68	.68	.69	.70	.72
Enterprises					
Corn, acres	136	112	103	153	185
Soybeans, acres	0	101	219	253	286
Small grain, acres	12	19	28	36	6
Legumes, acres	0	0	0	0	0
Hogs, litters	184	144	87	34	6
Other activities					
Corn purchased, 1,000 bu.	1.0	0	0	0	0
Corn sold, 1,000 bu.	0	0	4.4	15.9	22.6

[a] No restrictions are placed on type of farm. Assumes no participation in the 1964 feed grain and wheat programs.
[b] Optimal acreage with respect to the cost-minimizing objective.
[c] Total cost includes an allowance for interest on the investment in land at 5 percent of $491 per acre.

land. With this extra land it is necessary to use much of the forage crop for plowdown instead of hay. Labor and equipment are used for the high-value crops. Net returns are maximized, but efficiency in use of resources has been reduced.

Farm Organization Without Program Participation

The optimal combination of enterprises for maximization of net income changes substantially when a small farm does not participate in the 1964 feed grain and wheat programs. Specialization in hog production is still required on a one-man, 165-acre farm in the cash-grain area, but land use is directed as much as possible to satisfying the feed grain requirement of the hogs (Table 17).

The feed grain needs of hogs can be met more economically through production than purchase of corn. Therefore, all class I and II land on the 165-acre farm is planted to corn. Soybeans, although they have a slightly lower cost-income ratio than corn, are not produced. The net income per acre is greater for corn than for soybeans whether the corn is fed to the hogs or sold. The class III and IV land is planted to wheat with a legume catch crop.

When the farm is enlarged to 260 acres all feed grain requirements

are met by production of corn. Some soybeans become part of the operation. The balance among enterprises and resources results in efficient use of resources and a large net income.

Further expansion of the farm acreage results in a decrease in hog production and consequent lessening of the feed grain requirements. Pressures on the labor force and field equipment rise. The organizational structure of the farm business shifts toward cash grain. Soybean production becomes increasingly important as more land becomes available. When capacity of the labor force is reached, wheat is dropped from the operation. The class III and IV land is left idle.

The same general relationships apply to farms with a larger labor force and eight-row field equipment except that soybeans enjoy a more favorable position (Appendix Table 21).

Farm plans for enterprise combinations that do not provide for participation in the feed grain and wheat programs permit farmers to make rather efficient use of resources even though they have small acreages. Cost per dollar of gross income is between $0.68 and $0.72 on the one-man farm regardless of acreage. Again, larger farms exhibit the same general relationships with respect to costs as found on the one-man farm (Appendix Table 21).

Forage Production

Forage crops account for a significant portion of land use in Illinois. In 1959-60, forage crops in rotation occupied 9 percent of total land in the cash-grain area and 16 percent of total land in the hog area.

Forage crops, most of which are legumes, can be quite productive. Estimated yields under good management on the best soils are 4.8 tons of hay equivalent per acre (Appendix Table 4). The potential is much higher. Losses incurred in pasturing reduce recovery to about half of the harvestable yield. This factor, plus the trend toward confinement production of livestock, suggests increased harvesting of forage crops either for feed on the farm or for sale.

A cash market exists for hay in Illinois, but it is not well developed. Traditionally, sale of forage off the farm has been considered a mark of poor management. Advances in fertilizer technology and high forage yields, however, have made it both possible and economical to practice conservation, maintain soil fertility, and still use hay as a cash crop. In fact, situations may arise in the future in which a hay crop will compete effectively with corn and soybeans for use of good land.

Farmers who participated in the 1964 Feed Grain Program were required to keep a specified minimum acreage in legumes or other soil-conserving crops. They could use this crop as they chose.

Table 18. — Examples of the Effect of Changes in the Sale Price of Hay on the Optimal Organization of Two-Man Cash-Grain and Hog Farms for a Given Level of Gross Income, Illinois

	Hog farm with $114,000 gross income and hay prices of:			Cash-grain farm with $158,000 gross income and hay prices of:		
	$20	$14	$0	$20	$14	$0
Total acres	752	785	841	1,562	1,608	1,651
Corn, acres	248	259	278	550	566	581
Soybeans, acres	74	77	82	553	569	584
Wheat, acres	14	14	15	8	9	9
Oats, acres	48	50	54	0	0	0
Legume, acres[a]	126	131	141	147	151	155
Harvested hay, acres	126	114	0	147	103	0
Hogs —						
Confinement, litters	281	293	314	0	0	0
Pasture, litters	0	0	0	0	17	34
Variable cost, dollars	57,913	59,905	60,387	84,195	86,636	86,904

[a] A minimum acreage of legumes is needed to meet the conservation acreage requirements of the 1964 Feed Grain Program.

In anticipation of continued development of a cash market for hay in Illinois the alternatives offered in this study in both the cash-grain and hog areas included hay for sale at $20 per ton, hay for livestock feed on the farm, and legumes for pasture. Under these conditions the optimal farm plans always excluded pasturing of legumes except when acreages were so small as to result in prohibitive harvesting costs. Small acreages were then utilized by one-litter, pasture hog enterprises in the cash-grain area. Specialized hog farms practiced confinement production and left legumes for plowdown if they could not be harvested for hay. Whenever hay was harvested, it was always sold as a cash crop.

Since a cash market for large volumes of hay is not yet well developed in east central and western Illinois, it is presumptuous to assume that a $20-a-ton market exists without also examining the problems that might be encountered during a transition period. The price of hay was therefore reduced in successive stages from $20 a ton to zero to test the effect on optimal farm organizations (Table 18).

Optimal farm plans remain essentially the same whether hay has a market value of zero or $20 a ton. Production of a specific gross income requires a larger land area when hay cannot be sold, but the basic land-use pattern and livestock enterprises are relatively unaffected by the price of hay.

One-litter, pasture hog enterprises become relatively more important in the cash-grain area as hay prices fall, but they are too small to be of significance. The essentially free pasture has no effect on selection of hog production systems in the hog area nor does it give beef feeding enough of

an advantage to enter any of the optimal farm plans in either area. Thus over time it appears unlikely that optimal farm plans in either area will be affected by the price of hay unless it becomes high enough for hay to compete directly with corn and soybeans for land.

Deterrents to Farm Expansion

Internal cost economies resulting from larger sizes of operation do not provide large cash-grain or hog farms with a significant unit cost advantage over small farms. The larger farms, however, do provide large residual returns to management and profit and thus offer a substantial incentive for expansion in size of farm business. Growth in farm size is occurring, however several factors not included in the analytical portion of this study may deter growth in farm size.

Income Tax

The returns to operator labor, management, and profit increase from around $20,000 for an optimally organized one-man cash-grain or hog farm to over $100,000 for a six-man, cash-grain or hog farm. These incomes would be substantial rewards for enlarging a business, but they do not allow for the graduated state or federal income taxes.

Tax management becomes progressively more important as size of business increases. Operators of the larger farms may employ many measures to lessen the impact of taxes. In any case, it is important to recognize that the labor and management earnings reported in this analysis represent gross earnings subject to income taxes and do not reflect proportionate rewards for managing successively larger farms.

Spatial Problems

Optimal size for cash-grain farms ranges from 574 acres for a one-man unit operated with four-row equipment to 3,937 acres for a six-man unit operated with eight-row equipment. In 1959 only 4.4 percent of all farms in the state equaled or exceeded the optimal size for one man with four-row equipment. Few multi-thousand-acre farms exist in Illinois in any form.

Farm expansion, even at modest levels, commonly requires the acquisition of non-contiguous tracts of land. It is not uncommon for one-man, cash-grain farms to include three or four tracts of land separated by several miles and under different ownership. Such locational fragmentation necessarily results in operational inefficiencies resulting from higher transport costs from headquarters to work areas and increasing difficulty of worker supervision.

Ownership fragmentation of land operated as a single farm business may also affect the optimal combination and hence cost of production. A cash-grain farm may in practice require more men and smaller equipment to assure each landlord of timely performance of the field work on his particular tract of land. The input-output coefficients used in this study do not reflect differences caused by distance or fragmentation of land holdings. Hence, the larger farms may in actuality have higher costs than here assumed. Further, leasing arrangements that involve sharing of costs and income may require a decision model different from the one used in this study.

Capacity of Management

Input-output ratios are assumed to be constant with respect to size of farm in this analysis. Actually, little is known about the capacity of management to coordinate and control operations on farms of varying sizes. Farm records show that operators of family size farms often decline rapidly in their ability to convert inputs into output as they add employees and assume additional responsibilities.

The constant coefficients used in this analysis may therefore present a more favorable result for the larger sizes of farms than possible with the management now available or likely to become available in the near future. Efficiency could be positively related to size within the observed sizes of farms included in this analysis, but the fragmentary evidence available suggests that the opposite may well be the case. Further study of the economies of size should benefit from a detailed examination of the supply and capacity of management.

Labor Supply

Realization of the levels of efficiency assumed for the multi-man farms included in this study depends as much or more on the quality of employees as on the capacity of management. Getting and keeping skilled and dependable farm employees has been a strong deterrent to growth of farm size, especially livestock farms. Unsatisfactory management-labor relations are partially responsible for the problem, but the low quality of available labor causes much of the difficulty.

The preceding analyses are based on the assumption that an annual salary equivalent to about twice average annual salaries for farm employees in 1966 will be sufficient to attract and hold the quality of employees needed to achieve high levels of efficiency.

Capital Requirements

Operation of a six-man, cash-grain farm of optimal size requires control of assets with an average value in excess of $2 million. The six-man hog farm involves about $1 million.

Control over much of the land, which accounts for the major portion of total capital required, might be gained through various leasing arrangements as is already common practice. Field equipment alone, however, necessitates an initial outlay of about a quarter of a million dollars on the six-man, cash-grain farm. Obtaining adequate financing could be a problem. Most rural banks do not have the capital structure adequate to handle loans of such large amounts.

A corporate organization might help to preserve a farm business intact through time and ease the problem of acquiring capital. Farming corporations, however, have raised problems in the past. Evaluation of the advantages and disadvantages of alternative forms of business organization with respect to problems of finance is needed for a better understanding of the economies of size in agricultural production.

Institutional Factors

Public policy has long favored programs designed to aid farm families to get and maintain control over land. Measures designed to aid and strengthen the family farm have generally been considered desirable.

If farms begin to grow into larger than family units in significant numbers, pressure might be applied to restrict their development. On the other hand, society might well change its attitude. The development of large-scale farms might eventually be favored if they can make more efficient use of resources than can family farms.

Prices of Inputs and Products

Input prices. Quantity purchases of inputs normally result in price advantages to the buyer. The price schedule of a typical feed or fertilizer dealer, for example, may well drop 10 to 20 percent as purchases increase from small bagged lots to bulk purchases in truck or carload quantities.

Prices of inputs used in this study reflect the usual quantity discounts. Even a one-man farm of optimal size uses enough of the major inputs to realize the lowest quoted prices openly offered by dealers. For example, a one-man cash-grain farm of optimal size requires about two carloads of fertilizer each year. A one-man hog farm of optimal size uses about 500 tons of feed annually.

Larger farming operations, such as those using four or more men, are relatively untested with respect to prices of inputs. Purchases in large quantities strengthen their bargaining position. They may well be able to negotiate price concessions greater than those normally available. The flat prices used with all farm sizes examined in this study would therefore not fully reflect advantages of the larger businesses compared with the smaller ones. Study of the pricing policies of input suppliers, and indeed

the entire operation of supply firms, would facilitate measurement of economies of farm size.

Product prices. Farms of one- to six-man size do not control a sufficient part of total supply to affect market prices. Yet potential savings to buyers in the form of quantity lots, uniform quality, reduced assembly costs, and reputation buying without on-sight inspection do suggest the possibility of higher prices to the larger volume producer, particularly for livestock. Prices received for farm products were assumed to be unaffected by volume in this study. Thus, again, the larger farm businesses may not be receiving the credit due them.

Adoption of Optimal Farm Plans

The optimal farm plans developed in this study reflect matured adjustments. They do not account for transitional problems nor are they blueprints for general adoption. They are indicators of the potentials that can be realized under specified conditions. As such they can serve as guides to the individual who knows his managerial limitations.

Results credited to the optimal farm plans cannot be realized unless the farm operator has a high managerial capability for handling the enterprises included in the plans. Few men are so well trained, experienced, or naturally gifted as to be superior with all enterprises. Such inequalities require adjustments. Returns with modified farm plans will likely be less than returns achieved under ideal conditions. They could drop drastically if a farmer chooses an enterprise for which he is not well qualified.

Hogs become a part of the optimal farm plan in the cash-grain area when the labor force is increased to four or more men. Yet if the operator is not a capable hog producer his best alternative may be to leave his labor force partly idle during winter. A farmer who is already an experienced grain or livestock producer should generally continue to concentrate on his specialty.

Summary

Cash-grain production is the dominant type of farming in east central Illinois. Hog production is of major importance in western Illinois. This study examines costs and returns as related to size of farm business in these two areas. The chief objective is to determine the size of business, combination of enterprises, and use of resources that result in least cost per unit of output.

Least-cost farm plans are determined for operations varying as to the number of employees in the regular labor force and the size of field equipment. These farm plans show the least-cost organizations for given

farm situations and, in addition, which of many farm sizes results in most effective use of resources.

In developing the least-cost farm plans, land is assumed available in unlimited amount. Quality of land is specified as the average for the area under study. The major crop and livestock enterprises common to the areas are offered as alternatives for the optimal farm plans. Technology is forward looking. Management is assumed to be highly competent and equally effective with all enterprises. Qualified, full-time employees are made available as needed. Limited part-time labor can be hired. Prices of products and cost of inputs reflect conditions anticipated in 1970.

Specific farm sizes are defined in terms of number of employees and size of field machinery. Regular labor forces range from one to five full-time employees plus the operator. Complements of field machinery include four-, six-, and eight-row units.

The least-cost farm plans developed under these conditions reflect organizations which produce at least cost per unit of output both with and without participation in the 1964 feed grain and wheat programs. Additional plans show the effect on farm size and organization when profit maximization rather than cost minimization is the objective.

Corn and soybeans dominate the least-cost farm plans in the cash-grain area. These two crops account for about 90 percent of gross income. Greater crop specialization is prevented only by the constraints imposed by the feed grain and wheat programs. Hogs produced in confinement enter the optimal plans when four or more men are regularly employed. Otherwise hogs are a part of the production plan only when the labor force is faced with substantial year-round underemployment. Beef cow herds and cattle-feeding operations do not enter the optimal farm plans, even though some free resources are available to them.

Productivity is high on cash-grain farms of optimal size and organization. Generally each full-time man handles 400 to 600 acres of row crops and produces an annual gross income of $60,000 to $80,000 depending upon the capacity of field equipment that he uses.

On a one-man farm with four-row equipment, a gross income of about $20,000 is needed to break even. Average costs drop rapidly as annual production increases to $58,000. They rise with continued expansion beyond this level. Further cost economies are realized as size of field equipment is increased from four- to eight-row size. Still further economies are possible as one or two regular employees are combined with high-capacity field equipment.

A two- or three-man farm of optimal size for use of eight-row field equipment results in the least possible cost per unit of output, but differences in average costs among farms of different sizes are small. Substantial margins for management and profit can be achieved even on a

one-man farm. Thus any size of farm considered in this study can compete effectively with the optimal two- or three-man units.

Hog production is the dominant enterprise on optimally organized farms in the hog area. Hogs account for about three-fourths of gross farm income. All hogs are produced in confinement. Crop production, especially corn, remains of substantial importance. Feed grain requirements of the hogs are met from corn produced on the same farm.

Production per man on hog farms of optimal size ranges from 130 to 150 litters annually, plus enough corn for feed, and small acreages of other crops. Gross output averages $55,000 to $60,000 per man.

One-man hog farms on which four-row field equipment is used must gross about $20,000 annually to cover all costs. Average costs drop rapidly until size of farm is increased to the optimal level. Labor rather than capacity of field equipment limits size of the smaller farms. Large field equipment on one- and two-man hog farms creates excess capacity and high overhead costs. A two- or three-man hog farm with field equipment that matches needs achieves the least possible cost per unit of output and therefore represents the optimal size of hog farm. As with the cash-grain farms, however, farms with from one to six men can compete effectively with two- and three-man units.

Land values in the two areas under study have risen rapidly since 1964. Average values in 1967 already exceeded those used in the study. Tests show, however, that the optimal farm plans are quite stable over a wide range of land values. Little change results in optimal farm plans until land values exceed $700 per acre in the cash-grain area and $500 in the hog area. These values represent an increase of about 50 percent over those used in the analysis. With such land values, hog production becomes a slightly larger part of the optimal farm plans in each area. The strong shift from crops to hog production does not occur until land values rise to nearly double the values used in this study.

Farmers with less land than needed to give a least-cost size of business add livestock to generate volume. The residual returns to management are maximized at the expense of efficiency in the use of resources. With limited land, returns to management can be increased by adding livestock, hogs primarily, to the operation. However, costs per dollar of gross output will increase, indicating that expansion of land instead of livestock would be the preferred way to expand.

This study examines only internal economies of cash-grain and hog farming. It does not evaluate external economies. Even within this restricted scope there is need for further study of a number of important variables. Results of this study, therefore, provide only a general guide as to the optimal size of farm businesses. They are best suited for use as a foundation for further study of the problems of adjustment of farm size.

Appendix Tables

Appendix Table 1. — Change in the Number and Size of Farms in the Cash-Grain Area of Illinois, 1945-1964[a]

Size of group, acres	Number of farms					Percent of farms				
	1945	1950	1954	1959	1964	1945	1950	1954	1959	1964
Less than 10	1,272	1,353	1,131	603	348	6.7	7.3	6.9	4.1	2.8
10–69	2,724	2,431	1,880	1,717	1,296	14.3	13.1	11.4	11.7	10.5
70–139	3,548	3,458	2,702	2,149	1,631	18.6	18.6	16.4	14.6	13.2
140–219	5,275	5,146	4,566	3,488	2,353	27.7	27.7	27.7	23.7	19.1
220–259	1,952	1,919	1,899	1,800	1,277	10.2	10.3	11.5	12.2	10.4
260–499	3,686	3,667	3,669	4,091	4,108	19.4	19.8	22.3	27.9	33.3
500–999	548	555	595	808	1,242	2.9	3.0	3.6	5.5	10.1
1,000 and over	41	36	26	36	71	0.2	0.2	0.2	0.3	0.6
All sizes	19,046	18,565	16,468	14,692	12,326	100.0	100.0	100.0	100.0	100.0

[a] Data are from the Census of Agriculture. Counties included in this area are: DeWitt, McLean, Macon, Champaign, Piatt, Coles, Douglas, Edgar, and Moultrie.

Appendix Table 2. — Change in the Number and Size of Farms in the Hog-Farming Area of Illinois, 1945-1964[a]

Size of group, acres	Number of farms					Percent of farms				
	1945	1950	1954	1959	1964	1945	1950	1954	1959	1964
Less than 10	1,133	1,020	987	465	357	6.4	6.0	6.2	3.2	2.9
10–69	2,317	2,223	1,948	1,828	1,482	13.0	13.1	12.3	12.7	12.0
70–139	4,389	3,957	3,406	2,845	2,200	24.6	23.4	21.4	19.8	17.9
140–219	5,254	4,989	4,611	3,887	2,735	29.5	29.4	29.1	27.0	22.2
220–259	1,650	1,618	1,664	1,555	1,269	9.2	9.5	10.5	10.8	10.3
260–499	2,714	2,722	2,791	3,156	3,318	15.2	16.1	17.6	21.9	27.0
500–999	356	384	432	599	871	2.0	2.3	2.7	4.2	7.1
1,000 and over	25	30	33	53	78	.1	.2	.2	.4	.6
All sizes	17,838	16,943	15,872	14,388	12,310	100.0	100.0	100.0	100.0	100.0

[a] Data are from the Census of Agriculture. Counties included in this area are: Henry, Mercer, Fulton, Knox, McDonough, Warren, Peoria, and Stark.

Appendix Table 3. — Crop Yields on Selected Farms in East Central and West Central Illinois, 1963 and 1964

Area and crop	Average yields per acre								
	All farms[a]			Farms keeping supervised farm records[b]					
				All farms			Top one-fifth[c]		
	1963	1964	Average	1963	1964	Average	1963	1964	Average
	(bushels)								
Cash grain									
Corn	98	87	92	114	104	109	130	122	126
Soybeans	34	27	30	37	30	34	42	36	39
Wheat	45	40	42	52	46	49	59	52	56
Oats	57	46	52	69	57	63	81	76	78
Hog									
Corn	80	81	80	94	95	94	113	108	110
Soybeans	31	28	30	36	36	36	41	38	40
Wheat	37	35	36	44	44	44	56	51	54
Oats	54	48	51	64	58	61	82	76	79

[a] Illinois Cooperative Crop Reporting Service, Illinois Department of Agriculture and U.S. Department of Agriculture. Illinois Agricultural Statistics, Annual Summaries, 1964 and 1965. Yields in the cash-grain area are weighted averages for farms in the following counties: Champaign, Clark, Coles, DeWitt, Douglas, Edgar, Macon, Piatt, Vermilion, Iroquois, and Moultrie. In the hog area, yields are weighted averages for farms in the following counties: Adams, Brown, Fulton, Hancock, Henderson, Henry, Knox, McDonough, Mercer, Peoria, Pike, Rock Island, Schuyler, Stark, and Warren.

[b] Counties included in the cash-grain area are Champaign, Clark, Coles, DeWitt, Douglas, Edgar, Macon, Piatt, Vermilion, Iroquois, and Moultrie. Counties included in the hog area are Adams, Brown, Fulton, Hancock, Henderson, Henry, Knox, McDonough, Mercer, Peoria, Pike, Rock Island, Schuyler, Stark, and Warren. See annual reports of Illinois supervised farm records.

[c] Farms were grouped according to soil-productivity ratings and the top one-fifth with respect to yields were included in this average. Yields on these farms were used as the basis for projected yields for entire areas.

Appendix Table 4. — Estimated Yields of Hay and Pasture on Selected Soils With High Management[a]

Soil type	Alfalfa mix		Bluegrass
	Hay yields	Pasture days[b]	Pasture days
	(tons)	(number)	(number)
Eastern Illinois			
Drummer	4.7	235	175
Flanagan	5.0	250	175
Average	4.8	242	175
Western Illinois			
Tama	4.5	225	150
Muscatine	5.0	250	175
Average	4.8	238	162

[a] Unnumbered mimeograph published by E. C. A. Runge, Dept. Agron., Univ. Ill., October, 1964; projected yields of hay and pasture were based on these data.

[b] Grazing normally results in a recovery of about 55 percent as much forage as harvesting the crop as hay. Thus 100 pasture days represent approximately 1.11 tons of forage equivalent.

Appendix Table 5. — Summary of Estimated Fertilizer Requirements for Specified Crops at Selected Yield Levels, Illinois, 1965

Crop	Yield per acre	Fertilizer requirements per acre		
		Nitrogen[a]	P_2O_5[a]	K_2O[a]
			(pounds)	
Corn, bushels	100	112	37	24
	125	150	46	30
	150	198	55	36
Soybeans, bushels	35	0	30	38
	40	0	34	44
	45	0	38	50
Wheat, bushels	45	67	24	14
	55	87	29	18
	65	113	34	21
Oats, bushels	70	52	18	13
	85	68	21	15
	100	87	25	18
Hay (tons harvested)[b]	4.0	0	44	130
	4.5	0	50	146
	5.0	0	55	162
Hay (tons plowed down)[c]	2.00	−80	0	0
	2.25	−90	0	0
	2.50	−100	0	0

[a] Estimates are based on nutrients removed by the crops plus losses which account for as much as one-third of total nitrogen requirement. Losses are assumed to be negligible for P_2O_5 and K_2O.
[b] Nitrogen fixation is assumed to balance the removal of nitrogen in harvested hay.
[c] Half of potential hay yield is assumed available for plow-down. Nitrogen is assumed to be added to the soil at the rate of 40 pounds per ton of hay equivalent.

Appendix Table 6. — Seed Expense and Miscellaneous Cash Costs Associated With the Production of Specified Crops in East Central Illinois, 1965[a]

Crop	Yield per acre	Cost per acre	
		Seed	Other[b]
Corn, bushels	125	$ 3.28	$ 2.82
Corn silage, tons	25	3.28	2.82
Soybeans, bushels	40	3.75	.75
Wheat, bushels	55	5.12	1.89
(legume)	..	6.00	.35
Oats, bushels[c]	80	3.13	.96
(legume)	..	6.00	.35

[a] Data are based on information in E. R. Swanson, "Choosing the Most Profitable Fertilizer Program," Ill. Cir. 855, Univ. Ill.
[b] Herbicides, insecticides, and other direct cash costs.
[c] Land diverted from the production of feed grain or wheat has the same cost as for oats seeded with a legume.

Appendix Table 7. — Estimated Miscellaneous Expenses for Cash-Grain and Hog Farms of Selected Sizes, Illinois, 1965[a]

Regular labor force	Farm share			Other	Total	
	Auto[b]	Electricity[c]	Telephone		Cash-grain farm	Hog farms[d]
(number of men)						
1 man	$300	$100	$ 45	$255	$ 700	$ 750
2 men	400	130	70	390	990	1,040
3 men	480	160	95	495	1,230	1,280
4 men	540	190	120	600	1,450	1,500
5 men	580	220	145	675	1,620	1,670
6 men	600	250	170	720	1,740	1,790

[a] Based on data from Illinois farm account records.
[b] Includes operating costs of 4 cents a mile. Overhead costs were included with the charges for the basic complement of field equipment.
[c] Electricity used for farmstead lights, shop work, and other purposes is not chargeable to a specific enterprise.
[d] Miscellaneous expenses on the hog farm are estimated to be the same as on the cash-grain farm except for an additional $50 input in the "other" category.

Appendix Table 8. — Estimated Amount of Labor Available for Farm Work and Amount Needed for Supervision and Coordination for Cash-Grain and Hog Farms, Illinois, 1965

Full-time hired laborers	Hired labor available for work	Allocation of operator's time[a]		Total regular labor available for work
		Supervision and coordination[b]	Work	
Cash-grain farms (hours)				
0	0	0	2,500	2,500
1	2,500	225	2,275	4,775
2	5,000	450	2,050	7,050
3	7,500	750	1,750	9,250
4	10,000	1,125	1,375	11,375
5	12,500	1,650	850	13,350
Hog farms (hours)				
0	0	0	2,500	2,500
1	2,500	300	2,200	4,700
2	5,000	600	1,900	6,900
3	7,500	1,050	1,450	8,950
4	10,000	1,650	850	10,850
5	12,500	2,250	250	12,750

[a] These estimates were obtained through a survey of farm management specialists as a preliminary to this study of the economies of farm size.
[b] Supervision is overseeing day-to-day operations of the farm. Coordination is the acquisition of resources necessary for production and the carrying out of adjustments in production and marketing necessary to meet changing conditions. Time for making major, long-term decisions is not included in supervision and coordination.

Appendix Table 9. — Estimated Allowances for Operator Labor and Costs of Full-Time Employees, Cash-Grain Farms, Illinois, 1970[a]

Worker identification	Annual salary	Perquisites[b]	Total[c]
One man			
Operator	$5,350	0	$ 5,350
Total			5,350
Two men			
First employee	4,200	$ 1,150	5,350
Total			10,700
Three men			
First employee	4,500	1,250	5,750
Second employee	4,200	1,150	5,350
Total			16,450
Four men			
First employee	4,800	1,350	6,150
Second employee	4,200	1,150	5,350
Third employee	4,200	1,150	5,350
Total			22,200
Five men			
First employee	4,800	1,350	6,150
Second employee	4,500	1,250	5,750
Third employee	4,200	1,150	5,350
Fourth employee	4,200	1,150	5,350
Total			27,950
Six men			
First employee	5,400	1,450	6,850
Second employee	4,800	1,350	6,150
Third employee	4,200	1,150	5,350
Fourth employee	4,200	1,150	5,350
Fifth employee	4,200	1,150	5,350
Total			34,400

[a] Based on salaries paid by efficient and progressive farm operators in Illinois in 1965. It is assumed that these salaries, which are nearly twice the 1965 average, are sufficient to attract and hold men capable of carrying out a highly efficient farming operation.

[b] Housing and other allowances are provided for employees. All housing is assumed to be separate from the farm business.

[c] The total labor cost includes an allowance for the operator.

Appendix Table 10. — Estimated Allowances for Operator Labor and Costs of Full-Time Employees, Hog Farms, Illinois, 1970[a]

Worker identification	Annual salary	Perquisites[b]	Total[c]
One man			
Operator	$5,770	0	$ 5,770
Total			5,770
Two men			
First employee	4,620	$ 1,150	5,770
Total			11,540
Three men			
First employee	4,950	1,250	6,200
Second employee	4,620	1,150	5,770
Total			17,740
Four men			
First employee	5,280	1,350	6,630
Second employee	4,620	1,150	5,770
Third employee	4,620	1,150	5,770
Total			23,940
Five men			
First employee	5,280	1,350	6,630
Second employee	4,950	1,250	6,200
Third employee	4,620	1,150	5,770
Fourth employee	4,620	1,150	5,770
Total			30,140
Six men			
First employee	5,940	1,450	7,390
Second employee	5,280	1,350	6,630
Third employee	4,620	1,150	5,770
Fourth employee	4,620	1,150	5,770
Fifth employee	4,620	1,150	5,770
Total			37,100

[a] Based on salaries paid by efficient and progressive farm operators in Illinois in 1965. It is assumed that these salaries, which are nearly twice the 1965 average, are sufficient to attract and hold men capable of carrying out a highly efficient farming operation.
[b] Housing and other allowances are provided for employees. All housing is assumed to be separate from the farm business.
[c] The total labor cost includes an allowance for the operator.

Appendix Table 11. — Estimated Price per Acre and Annual Costs Chargeable Against Unimproved Farmland in the Cash-Grain and Hog-Farming Areas of Illinois, 1959-1969

	Value or cost per acre	
	Cash-grain area[a]	Hog area[b]
	(dollars)	
Value of unimproved land[c]		
1959	405.00	275.00
1964	446.00	302.00
1969	491.00	332.00
Annual costs for 1969		
Capital charge[d]	24.55	16.60
Taxes[e]	5.79	4.05
Total	30.34	20.65

[a] Includes all farmland in the counties of Champaign, Coles, Douglas, Edgar, DeWitt, Macon, McLean, Moultrie, and Piatt.

[b] Includes all farmland in the counties of Fulton, Henry, Knox, Mercer, McDonough, Peoria, Stark, and Warren.

[c] The 1959 and 1964 prices of improved farmland as reported by the U.S. Census of Agriculture were adjusted to remove the value of buildings which average 15 percent of the total. See Folke Dovring and W. H. Scofield, Farm Real Estate Sales in Illinois, Ill. Agr. Exp. Sta. Bul. 697, p. 21, Univ. Ill., November, 1963. The value of unimproved farmland was then projected to 1969 at the rate of increase realized between 1959 and 1964.

[d] Interest on investment is charged at 5 percent.

[e] Taxes are 1.18 percent of value in the cash-grain area and 1.22 percent of value in the hog-farming area.

Appendix Table 12. — Average Prices for Farm Products Projected to 1970, Illinois[a]

Product	Price per unit
	(dollars)
Corn, bushels[b]	1.25
Loan rate	(1.10)
Cash payment	(.15)
Wheat, bushels[b]	1.66
Loan rate	(1.30)
Domestic certificate	(.27)
Export certificate	(.09)
Oats, bushels	.59
Soybeans, bushels	2.56
Hay, tons	20.00
Diverted acres[c]	
From corn	
Cash-grain area, acres	20.64
Hog area, acres	18.99
From wheat	
Cash-grain area, acres	6.78
Hog area, acres	8.44
Feeder calves, steers, 400-450 pounds, cwt.	26.74
Feeder calves, heifers, 400-425 pounds, cwt.	24.30
Cull beef cows, cwt.	17.01
Choice steers, 900-1,100 pounds, cwt.[d]	26.25
Choice heifers, 700-900 pounds, cwt.[d]	25.50
Hogs, 200-220 pounds, cwt.[e]	17.61
Sows, 400 pounds, cwt.[e]	14.60
Sows, 400-550 pounds, cwt.[e]	14.40

[a] Average annual prices in this table were used in the computation of gross income.

[b] These prices reflect compliance with the 1964 feed grain and wheat programs.

[c] Weighted average of actual payments for all farms in the respective areas for 1964.

[d] Prices for fat cattle of different grades and weights were used in this analysis and are presented in R. N. Van Arsdall, Resource Requirements, Investments, Costs, and Expected Returns From Selected Beef-Feeding and Beef-Raising Enterprises, AE-4075, Univ. Ill., September, 1965.

[e] Seasonal price variations for slaughter hogs were used in this analysis and are presented in R. N. Van Arsdall, Resource Requirements, Investments, Costs, and Expected Returns From Hog Production Systems in Illinois, 1965, AE-4074, Univ. Ill., September, 1965.

Appendix Table 13. — Relative Importance of Crop and Livestock Enterprises in the Production of Gross Income on Optimally Organized Cash-Grain Farms, Illinois, 1970

Enterprise[a]	Percentage of gross income by size of farm			
	One man with 4-row equipment through 3 men with 8-row equipment	4 men, 8-row	5 men, 8-row	6 men, 8-row
Corn	54.8	44.0	45.6	45.1
Soybeans	35.8	32.2	32.7	32.6
Subtotal[b]	(90.6)	(76.2)	(78.3)	(77.7)
Wheat	.5	.5	.4	.4
Hay	8.9	8.0	8.2	8.1
Subtotal	(9.4)	(8.5)	(8.6)	(8.5)
Hogs	.0	15.3	13.1	13.8
Grand total	100.0	100.0	100.0	100.0

[a] The enterprises listed below are the only ones that entered the optimal solution.
[b] The solution was designed to generate at least 75 percent of total gross income from the sale of corn and soybeans, including government payments.

Appendix Table 14. — Monthly and Annual Use of Regular Full-Time Labor and Hired Seasonal Labor on Optimally Organized Cash-Grain Farms, Illinois, 1970

Type of labor	Period	Labor use by size of farm (hours)[a]								
		1 man			2 men		3 men,	4 men,	5 men,	6 men,
		4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Labor limit										
Annual[b]	....	2,500	2,500	2,500	4,775	4,775	7,050	9,250	11,375	13,350
Monthly[c]	....	260	260	260	500	500	734	962	1,183	1,388
Use of regular labor force	Jan.	37	34	36	66	70	102	224	260	310
	Feb.	32	31	35	59	67	98	277	315	379
	March	91	91	92	174	178	260	383	463	546
	April	248	255	222	489	429	625	813	1,001	1,176
	May	260	260	250	500	480	704	888	1,099	1,287
	June	260	260	260	500	500	734	962	1,183	1,388
	July	260	260	260	500	500	734	962	1,183	1,388
	Aug.	260	260	260	500	500	734	962	1,183	1,388
	Sept.	217	219	219	418	420	617	788	973	1,141
	Oct.	260	260	260	500	500	734	962	1,183	1,388
	Nov.	172	181	186	346	359	524	677	835	979
	Dec.	68	66	70	127	135	195	312	374	442
	Year	2,165	2,177	2,150	4,179	4,138	6,061	8,210	10,052	11,812
Use of hired seasonal labor[d]	Jan.	0	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	0
	March	0	0	0	0	0	0	0	0	0
	April	0	0	0	0	0	0	0	0	0
	May	46	27	0	49	0	0	0	0	0
	June	172	161	159	302	293	449	462	590	685
	July	84	88	97	164	174	275	277	355	412
	Aug.	3	19	40	31	64	115	164	200	236
	Sept.	0	0	0	0	0	0	0	0	0
	Oct.	15	28	48	50	95	133	118	155	179
	Nov.	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	0	0
	Year	320	323	344	596	626	972	1,021	1,300	1,512
All labor	Year	2,485	2,500	2,494	4,775	4,764	7,033	9,231	11,352	13,324

[a] The size of field machinery is designated as four-, six-, and eight-row.
[b] The annual labor limit is the maximum hours of labor available for farmwork from the regular labor force. It reflects the growing burden of supervision and coordination as size of labor force increases.
[c] The monthly labor limit is the maximum hours of labor available for farmwork from the regular labor force.
[d] Seasonal labor is available by the hour in any amount during any month, provided the sum of regular labor used and seasonal labor hired does not exceed the annual labor limit.

Appendix Table 15. — Annual Tractor Use on Optimally Organized Cash-Grain Farms, Illinois, 1970

Classification of tractor time	Tractor hours by size of farm								
	1 man			2 men		3 men, 8-row	4 men, 8-row	5 men, 8-row	6 men, 8-row
	4-row	6-row	8-row	4-row	6-row				
Regular hours[a]									
Available	1,000	1,000	1,000	1,800	1,800	2,600	3,400	4,200	5,000
Used	1,000	1,000	1,000	1,800	1,800	2,600	3,400	4,200	5,000
Additional hours[b]									
Available	400	400	400	800	800	1,200	1,600	2,000	2,400
Used	385	281	288	644	648	1,036	765	1,026	1,096
Total tractor hours									
Available	1,400	1,400	1,400	2,600	2,600	3,800	5,000	6,200	7,400
Used	1,385	1,281	1,288	2,444	2,448	3,636	4,165	5,226	6,096

[a] Tractor time available and used annually within the limits of a 10-year straight-line depreciation schedule. Each main-line tractor provides 800 hours. The equivalent of 200 hours comes from small tractors.

[b] Additional tractor use was permitted within the limits of the stated time "available" at a cost large enough to compensate for wear and tear in excess of that reflected by the straight-line depreciation schedule.

Appendix Table 16. — Relative Importance of Crop and Livestock Enterprises in the Production of Gross Income on Optimally Organized Hog Farms, Illinois, 1970

Enterprise[a]	Percentage of gross income for all sizes of farms[b]
Corn	3.8
Soybeans	6.6
Subtotal	(10.4)
Wheat	1.1
Oats	2.0
Hay	10.5
Subtotal	(13.6)
Hogs[c]	76.0
Total	100.0

[a] The enterprises listed below are the only ones that entered the optimal solutions.

[b] Distribution of income among enterprises was essentially the same for all sizes of farms under conditions of optimal organization.

[c] The solution was designed to generate at least 60 percent of total gross income from the sale of hogs. Six-litter confinement systems accounted for 55.4 percentage points of the 76 percent on one-man farms with four-row equipment, 50.3 points on one-man farms with six-row equipment, 46.0 points on one-man farms with eight-row equipment. On the two-man farms they accounted for 8.8 points when six-row equipment was used, 22.3 points with eight-row equipment. All others were produced in two-litter systems. All hogs were produced in six-litter systems on the three-man farms; all were produced in two-litter systems on the four-, five-, and six-man farms.

Appendix Table 17. — Annual Tractor Use on Optimally Organized Hog Farms, Illinois, 1970

Classification of tractor time	Tractor hours by size of farm								
	1 man			2 men		3 men, 8-row	4 men, 8-row	5 men, 8-row	6 men, 8-row
	4-row	6-row	8-row	4-row	6-row				
Regular hours[a]									
Available	1,000	1,000	1,000	1,300	1,300	2,100	2,600	3,400	3,400
Used	824	740	706	1,300	1,290	1,880	2,452	2,934	3,400
Additional hours[b]									
Available	400	400	400	400	400	800	800	1,200	1,200
Used	0	0	0	91	0	0	0	0	55
Total tractor hours									
Available	1,400	1,400	1,400	1,700	1,700	2,900	3,400	4,600	4,600
Used	824	740	706	1,391	1,290	1,880	2,452	2,934	3,455

[a] Tractor time available and used annually within the limits of a 10-year straight-line depreciation schedule. Each main-line tractor provides 800 hours. The equivalent of 200 hours comes from small tractors.

[b] Additional tractor use was permitted within the limits of the stated time "available" at a cost large enough to compensate for wear and tear in excess of that reflected by the straight-line depreciation schedule.

Appendix Table 18. — Monthly and Annual Use of Regular Full-Time Labor and Hired Seasonal Labor on Optimally Organized Hog Farms, Illinois, 1970

Type of labor	Period	Labor use by size of farm (hours)[a]								
		1 man			2 men		3 men,	4 men,	5 men,	6 men,
		4-row	6-row	8-row	6-row	8-row	8-row	8-row	8-row	8-row
Labor limit										
Annual[b]	....	2,500	2,500	2,500	4,700	4,700	6,900	8,950	10,850	12,750
Monthly[c]	....	260	260	260	490	490	719	932	1,130	1,328
Use of regular labor force	Jan.	108	113	114	223	231	312	453	553	649
	Feb.	136	146	140	319	324	384	666	814	955
	March	136	137	142	250	258	391	484	591	693
	April	227	217	208	395	373	570	696	850	998
	May	231	217	201	405	374	551	709	862	1,013
	June	260	260	260	490	490	719	932	1,130	1,328
	July	260	260	260	490	490	719	932	1,130	1,328
	Aug.	260	260	260	490	490	719	932	1,130	1,328
	Sept.	172	175	182	321	331	478	623	757	890
	Oct.	236	235	245	428	440	671	823	1,005	1,180
	Nov.	175	173	175	320	322	480	607	741	869
	Dec.	136	138	156	228	252	428	446	544	639
	Year	2,337	2,331	2,343	4,359	4,375	6,422	8,303	10,107	11,870
Seasonal labor available										
Annual	....	1,250	1,250	1,250	2,350	2,350	3,450	4,475	5,425	6,375
Monthly	....	1,250	1,250	1,250	2,350	2,350	3,450	4,475	5,425	6,375
Use of hired seasonal labor[d]	Jan.	0	0	0	0	0	0	0	0	0
	Feb.	0	0	0	0	0	0	0	0	0
	March	0	0	0	0	0	0	0	0	0
	April	0	0	0	0	0	0	0	0	0
	May	0	0	0	0	0	0	0	0	0
	June	88	80	82	120	114	220	184	209	248
	July	34	37	30	80	71	75	148	165	196
	Aug.	39	52	43	141	140	111	315	369	436
	Sept.	0	0	0	0	0	0	0	0	0
	Oct.	0	0	0	0	0	0	0	0	0
	Nov.	0	0	0	0	0	0	0	0	0
	Dec.	0	0	0	0	0	0	0	0	0
	Year	161	169	155	341	325	406	647	743	880
All labor	Year	2,498	2,500	2,498	4,700	4,700	6,828	8,950	10,850	12,750

[a] The size of field machinery is designated as four-, six-, and eight-row.
[b] The annual labor limit is the maximum hours of labor available for farmwork from regular labor force. It reflects the growing burden of supervision and coordination as size of labor force increases.
[c] The monthly labor limit is the maximum hours of labor available for farmwork from the regular labor force.
[d] The seasonal labor is available by the hour in any amount during any month, provided the sum of regular labor used and seasonal labor hired does not exceed the annual labor limit.

Appendix Table 19. — Productive Capability of Farmland in the Cash-Grain and Hog-Farming Areas of Illinois, 1962[a]

Capability classes[b]	Cash-grain farming area		Hog-farming area	
	Area	Proportion	Area	Proportion
	(1,000 acres)	(percent)	(1,000 acres)	(percent)
All farmland	3,303.5	100.0	2,893.4	100.0
Class I and II	2,943.7	89.1	1,926.3	66.6
Class III and IV	307.7	9.3	618.5	21.4
Classes V - VII	52.1	1.6	348.6	12.0
Land in crops[c]	2,927.6	100.0	2,154.4	100.0
Class I and II	2,715.1	92.7	1,672.4	77.6
Class III and IV	198.6	6.8	404.1	18.8
Classes V - VII	13.9	.5	77.9	3.6

[a] Data were taken from Illinois Soil and Water Conservation Needs Inventory, Tables 8 and 9, Univ. Ill., August, 1962.
[b] Land capability classes describe in a general way the suitability of land for different uses. They do not necessarily coincide with the actual use of land. Classes I-IV include land suited for cultivation in varying degrees. Classes V-VII include land not suited for cultivation. See *Ibid.*, Appendix Table 3, for a complete description of land capability classes.
[c] Land used for crops regardless of capability.

Appendix Table 20. — Farm Organization To Maximize Returns to Management on Farms in the Cash-Grain Area, Given Specific Farm Acreages, Two Men, an Eight-Row Complement of Field Equipment, and Compulsory Compliance With the Feed Grain and Wheat Programs, Illinois, 1970[a]

	Acres in farm				
	661	1,006	1,285	1,641[b]	1,920
Income and costs, dollars					
Gross	134,721	144,974	154,867	167,491	178,460
Total cost	102,711	105,097	108,910	114,076	122,279
Net return to management	32,010	39,877	45,957	53,415	56,181
Cost per dollar gross	.762	.725	.703	.681	.685
Enterprises					
Corn, acres	233	354	452	578	676
Soybeans, acres	234	356	455	581	680
Small grains, acres	4	5	7	9	10
Legumes, acres	62	95	121	154	180
Diverted acres	59	89	114	145	170
Hogs, litters	318	218	120	7	0
Other activities					
Corn purchased, bushels	1,000	0	0	0	0
Corn sold, bushels	0	24,000	44,900	71,500	84,500
Hay sold, tons	298	354	580	740	76

[a] Minimum compliance with the 1964 feed grain and wheat programs is required. Type of farm is unconstrained.
[b] Optimal size with respect to the cost-minimizing objective.

Appendix Table 21. — Farm Organization To Maximize Returns to Management on Farms in the Cash-Grain Area, Given Specific Farm Acreages, Two Men, an Eight-Row Complement of Equipment, and No Restrictions on Feed Grain and Wheat Acreages, Illinois, 1970[a]

	Acres in farm				
	661	1,006	1,285	1,641[b]	1,920
Income and costs, dollars					
Gross	136,349	149,206	161,479	171,346	175,495
Total cost	93,919	102,035	110,917	116,797	118,245
Net return to management	42,430	47,171	50,562	54,549	57,250
Cost per dollar gross	.689	.684	.687	.682	.674
Enterprises					
Corn, acres	543	720	1,022	849	393
Soybeans, acres	0	107	34	500	1,186
Small grains, acres	24	36	46	24	0
Legumes, acres	24	36	46	24	0
Hogs, litters	281	164	52	0	0
Other activities					
Corn purchased, bushels	0	0	0	0	0
Corn sold, bushels	40,600	74,000	122,700	106,100	49,100
Hay sold, tons	114	174	222	115	0

[a] Type of farm is unconstrained.
[b] Optimal size with respect to the cost-minimizing objective.