An Analysis of Returns From Farm and Nonfarm Employment Opportunities On Shelby-Grundy-Haig Soils

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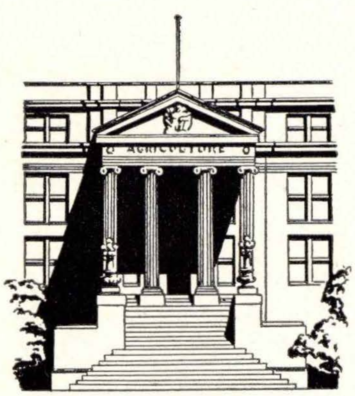

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SUMMARY

The objective of this study is to examine alternative methods for increasing incomes of farm families on Shelby-Grundy-Haig soils of southern Iowa. Prospects for increasing incomes through greater capital use, improved technology, larger farm size, part-time farming and shifts to nonfarm occupations are considered. Linear programming is used in deriving optimum farm plans and farm size under various resource situations.

Plans are first computed for "typical" or modal resource situations on farms of 80, 160 and 240 acres, using current farming techniques of the soil area. These plans provide, for each farm size, a "benchmark" income figure for comparison of earnings from other farm and nonfarm alternatives. The benchmark income for each farm size is first compared with incomes from farm plans where capital is increased and all other resources and technology remain at the benchmark level. Returns on this additional capital are high for all three farm sizes studied. Computed next are increases in income possible from use of improved farming techniques while operating capital and other resources are held constant at the benchmark level. Use of improved techniques with capital held constant also produces high returns. When improved techniques and greater capital are used together, however, the income increases are greater than from either used alone. This complementarity suggests a need for integrated educational and credit programs.

The optimum, or most profitable, farm size in the area studied was computed where plans were restricted by a family labor supply and a "typical" livestock buildings supply. Farms with about 260 acres of cropland and permanent pasture were found to maximize profits in this situation; incomes were substantially increased by this expansion in farm size. However, with livestock buildings nonlimitational and family labor the only restricting resource, greater profits resulted from intensified livestock production rather than from increased farm size. Even with the latter resource restrictions, however, many farmers might prefer to expand farm size rather than intensify livestock production since less capital is required and lower risk is involved. These results support the hypothesis that pressure will continue for larger farms in southern Iowa.

Under "typical" farm situations in the Shelby-Grundy-Haig soil area, the analysis indicates that little or no sacrifice in income is required when farmers on 80 or 160 acres obtain part-time off-farm work. In fact, if these farmers have only average managerial ability and limited capital, they can hold full-time off-farm jobs, in addition to farming, with little sacrifice in income. In these situations, incomes are maintained at high levels through shifts toward enterprises with low labor requirements. However, if managerial ability and capital are at higher levels on 160-acre farms of this type, considerable sacrifice in farm income results when the operator takes an off-farm job. Total income from the two sources, however, is greater than from farming alone. Thus, off-farm work and farming, if this combination is available, appear promising for families in the area who wish to improve earnings, yet remain in agriculture. Part-time farming might also serve as an intermediate step for some families in a complete transition from farm to nonfarm employment.

Finally, incomes from farming and from part-time farming in the area studied are compared with incomes from use of the same resources in nonfarm pursuits. It is assumed here that when the operator moves to full-time nonfarm employment he reinvests, at 4 percent interest, the capital previously used in farming. In this soil area, average managers on 80 acres with limited capital ($4.200) maximize income by moving to nonfarm employment and reinvesting their capital. This also is true for average managers of 160 acres at all levels of operating capital. However, an above-average manager on either 80 or 160 acres should, for maximum profits, combine a full-time off-farm job with farming. One exception is that an above-average manager on 160 acres with nonlimitational capital has greater returns in farming if the nonfarm wage rate is only $1.35 per hour or less. This analysis indicates that, in general, operators in the Shelby-Grundy-Haig soil area who have above-average managerial ability should "keep at least one foot on the farm"; they obtain maximum profits from combining farming with off-farm work or by farming alone. Average managers, however, ordinarily maximize income by using labor and other resources entirely for nonfarm purposes.

The analysis clearly indicates that farm family incomes may be increased in the area studied by greater capital use, improved techniques or nonfarm employment. Reluctance by farmers to use additional capital appears to be related primarily to risk and uncertainty. Lack of knowledge concerning nonfarm jobs and preferences for farm living are probably the major obstacles to more rapid adjustments in the farm labor force of the area.

An Analysis of Returns From Farm and Nonfarm Employment Opportunities on Shelby-Grundy-Haig Soils[1]

BY GERALD W. DEAN, EARL O. HEADY AND H. H. YEH

Historically, income per farm family has been lower in southern Iowa than in other parts of the state. Under pre-emption, homestead and other settlement rights, the initial (modal) size of farm in southern Iowa was the same as for the rest of the state—160 acres. However, because of differentials in soil productivity, and as research developed techniques allowing extension of yield levels nearer to the potential of soil capacity, this number of acres has consistently provided less net income than the same number of acres in other major areas of the state. Too, southern Iowa has no large urban industrial centers which provide markets for labor-intensive enterprises such as dairying or vegetable production; or, which provide a large number of nonfarm employment opportunities near at hand. In relation to other sections of Iowa, fewer southern Iowa farms have electricity, telephones and hot and cold running water. Townships with the lowest "level of living" indexes are concentrated in southern Iowa.[2]

These economic characteristics suggest that agriculture in southern Iowa has not yet made sufficient adjustment, in number of farms and farm people, to compare favorably in income with other sections of the state. Adjustments have been taking place, however, in the number and size of farms. For example, the mean acreage per farm in the five principal counties of the Shelby-Grundy-Haig soil association increased from 164.3 acres in 1930 to 168.9 acres in 1940, 185.8 acres in 1950 and 201.7 acres in 1954.[3] In the 20-year period, 1930-50, rural population declined by 17 percent.

However, it appears that further adjustment of labor resources to capital and land resources is necessary if productivity and income per family in southern Iowa are to compare favorably with the remainder of the state. A 1951 survey showed southern Iowa commercial farms to have an average investment per farm of $32,736, as compared with $61,371 per farm in north-central Iowa.[4] The value of gross product per farm worker was $9,076 and $14,076 in the two areas, respectively.

Size and income per farm can be increased through the addition of acreage and/or intensification of a given acreage. Both methods are likely needed in southern Iowa. Expansion in acreage is difficult for operators who have limited funds and cannot readily increase their acreage through renting. A relatively high rate of farm ownership exists in southern Iowa.[5] This may be partially explained by the fact that less capital is required for purchase of a given acreage than in other areas of Iowa. Large acreages of permanent pasture in southern Iowa also help explain the relatively high rate of farm ownership. Landlords generally realize a small return from permanent pasture rented for cash. Similarly, beginning tenants often lack sufficient funds for the cattle or sheep necessary to allow a farm with a large acreage of permanent pasture to be most profitable. Accordingly, farmers in southern Iowa place a premium on farm ownership. This ownership, however, often is attained through purchase of a small, inefficient farm—one too small to provide a satisfactory level of family living.

Several opportunities exist for increasing family incomes where farms are too small or otherwise give insufficient returns. In addition to expansion in size, farmers can improve farming techniques, take a part-time job off the farm or move into another occupation. The fact that, from 1930 to 1954, there was an 18-percent decline in number of farms in the five southern Iowa counties mentioned, indicates that many farm families have chosen the latter alternative. The data of table

[1] Project 1220 of the Iowa Agricultural Experiment Station.

[2] See: Background of Iowa agriculture. Iowa Agr. Ext. Ser. (Mimeo). 1954.

[3] The average farm size indicated is a weighted average for the following five counties: Clarke, Decatur, Lucas, Ringgold and Union. Data were compiled from the Iowa Census of Agriculture for 1930, 1940, 1950 and 1954.

[4] See: Heady, Earl O. and Shaw, Russell. Resource returns and productivity coefficients in selected farming areas of Iowa, Montana and Alabama. Iowa Agr. Exp. Sta. Res. Bul. 425. 1955.

[5] Only 24.1 percent of farms are rented in the five southern Iowa counties mentioned, compared with 49.4 percent in 14 counties of north-central Iowa. The 14 north-central Iowa counties are: Kossuth, Winnebago, Hancock, Franklin, Hardin, Story, Greene, Calhoun, Pocahontas, Wright, Hamilton, Boone, Webster and Humboldt. Data are compiled from the 1954 Iowa Census of Agriculture.

TABLE 1. PERCENTAGE OF FARM OPERATORS WORKING OFF THE FARM MORE THAN 1 DAY ANNUALLY AND MORE THAN 100 DAYS ANNUALLY IN FIVE SOUTHERN IOWA COUNTIES.

		Southern Iowa counties*					
	Year	Clarke	Decatur	Lucas	Ringgold	Union	Av. of the five counties
Percent of operators working off-farm more than 1 day annually	1940	19.6	25.4	19.9	19.9	23.8	21.7
	1950	25.7	31.4	34.1	29.2	25.4	29.2
	1954	39.3	41.6	38.7	37.6	40.0	39.4
Percent of operators working off-farm more than 100 days annually	1940	5.2	9.0	8.6	5.8	7.5	7.2
	1950	10.9	13.6	14.5	10.5	10.4	12.0
	1954	12.6	14.3	19.0	14.0	18.6	15.7

* The present studv deals only with farms in the Shelby-Grundy-Haig soil association. The five counties shown in this table are the counties containing primarily these soils.

1 indicate that an increasing number are turning to part-time work in other occupations as a means of supplementing farm earnings.

OBJECTIVES

The purpose of this study is to examine alternatives for increasing incomes of farm families in southern Iowa. Since the amount by which a specific course of action will increase incomes depends on soil types and other physical characteristics, as well as on prices of products and resources, this study is restricted to a specific soil association—Shelby-Grundy-Haig soils. This soil association is contained almost entirely in Clarke, Decatur, Lucas, Ringgold and Union counties. The study has been made to determine the extent to which farms of specified sizes might increase incomes by improving technology or practices and by using more capital. An auxiliary objective is to examine the scale of operations in acres and the income of farms which might expand in size up to the limits of the family labor supply. (While farm size could be increased, through use of hired labor, considerably beyond the acreage determined, the purpose of this study included only the analysis of a strictly family-labor farm.) A final objective is to determine the conditions under which farmers operating with different amounts of capital and different acreages might realize a greater income by shifting to part- or full-time nonfarm occupations. In attaining these objectives, the following steps are included in the study:

1. Plans which maximize profits have been computed, using current farming techniques of the area, for farms of 80. 160 and 240 acres; labor was restricted to that of the family, and operating capital was set at a medium level for each farm size. This step provides, for each farm size, a "benchmark" income figure for comparison of earnings when improved techniques and/or additional operating capital is used. It also provides "benchmarks" in comparing incomes from farm and nonfarm employment opportunities.
2. Plans were computed for 80-, 160- and 240-acre farms, assuming several different levels of operating capital. The incomes from these plans, compared with those of the benchmark situations, suggest the opportunities for increasing income through use of additonal funds alone, while techniques remain unchanged.
3. Plans have been computed which assume above-average management and imuroved techniques. The incomes obtained under these plans then may be compared with those derived from plans involving the same amount of capital, but based on currently used techniques. These comparisons show the possibilities of increasing incomes by improved techniques alone. Finally, incomes for plans involving both greater operating capital and improved techniques may be compared with those for less capital and currently used techniques. These plans show how changing capital and technology together may increase income.
4. Acreage and capital restraints were lifted for the 160- and 240-acre units to determine to what size they might expand with operations restricted only by the family labor supply. As mentioned previously, extremely large farms would be possible with use of hired labor. However, the purpose here was to examine income possibilities under a purely family-labor situation.
5. Plans were computed for 80- and 160-acre units to show the farm plan which maximized income with the operator engaged in part- or full-time work off the farm. This step was taken as an aid for guidance of farm families who are not satisfied with present income levels, who have insufficient funds for farm expansion but wish to remain in farming and who do have opportunities for off-farm work.
6. Wage returns in alternative off-farm employment opportunities were compared with the farm incomes computed under the various situations mentioned above. These comparisons suggest the amounts of operating capital, farming techniques and management levels necessary before real income from agriculture equals that from nonfarm employment alternatives.

The analysis which follows relates to farms of 80, 160 and 240 acres. Census data suggest these sizes to be predominant in the area under analysis.

FARM RESOURCE SITUATIONS

The farm plans and incomes which follow were determined by linear programming. Plans were computed for situations estimated to be typical of the Shelby-Grundy-Haig soil area. As a basis for programming, it was necessary to define the restrictions which limit the plan in each of the farm situations analyzed. Hence, the land area for each farm size was divided, on the basis of county and farm soil maps, into categories by soil type and slope criteria. Specification of the percentage of land in the various categories and in permanent pasture was made with the aid of personnel from the Department of Agronomy, Iowa State College. Operator and family labor available for farm work was approximated from interviews with farmers in the area. Machinery and building facilities were estimated from inventories on Clarke County farms of 80, 160 and 240 acres, judged by Extension personnel to be typical of the area. Six different levels of operating capital were assumed; the range being sufficiently wide to include the majority of farmers in the area. Details of the resource restrictions and price situations used in deriving farm plans and incomes are discussed in the following sections.

Land

The soil types commonly found in the area studied are Grundy-Haig silt loam, Grundy silt loam and Shelby loam. Shelby soils usually occur on sloping hillsides and narrow spur ridges, with slope varying from 4-7 percent and over; erosion is a serious problem. Grundy soils usually occur on gently sloping upland ridges and flats with slopes of 2-8 percent. Generally, Haig soils have slopes of 0-1 percent and are found on flat ridges and depressions in the Grundy soils.

To restrict crop rotations to soil capabilities, the crop area is divided into three categories on the basis of slope and soil type. Soil class I includes only Grundy-Haig silt loam of 0-1 percent slope; soil class II is predominately Grundy silt loam of 2-5 percent slope; soil class III is primarily Shelby loam of 4-7 percent slope but includes small areas of up to 12 percent in slope. All land over 12 percent in slope is in permanent bluegrass pasture. The crop and pasture land for each farm size is divided on the basis of proportions of these soil classes existing on "typical" farms in the area. Percentages of total crop and pasture land in the various soil classes are as follows: 16.7 percent in soil class I, 34.6 percent in soil class II, 27.9 percent in soil class III and 20.8 percent in permanent pasture. Within the Shelby-Grundy-Haig soil area a rather wide range exists in composition of soils. Some farms may have much higher percentages of class I soils than the "typical" situation discussed; others may have higher percentages of class III soils and permanent pasture. Inferences from this study should be limited to farms which approximately meet the soil restrictions specified. A range of crop rotations is allowed on each soil class; crop yields for various rotations, fertilizer rates and soil types are presented later.

Labor

Three levels of labor availability are considered for the various farm situations studied. Labor situations include those where the operator is (a) farming full-time, (b) holding a part-time nonfarm job and (c) holding a full-time nonfarm job.

TABLE 2. HOURS OF SEASONAL LABOR AVAILABLE FOR FARM WORK WHEN THE OPERATOR IS (1) FARMING FULL-TIME, (2) WORKING OFF-FARM PART-TIME AND (3) WORKING OFF-FARM FULL-TIME.

Months	(1) Farming full-time			(2) Part-time off-farm job			(3) Full-time off-farm job
	Operator	Family	Total	Operator	Family	Total	Total
Dec.-Jan.-Feb.	720	135	855	345	135	480	309
March-April	610	90	700	360	90	450	206
May-June	610	140	750	360	140	500	256
July-Aug.	610	140	750	360	140	500	206
Sept.-Oct.-Nov.	765	135	900	390	135	525	309

Part 1 of table 2 shows the seasonal breakdown of operator and family labor for a full-time farmer. From March through August 305 hours of operator labor are available per month. The operator labor supply decreases to 255 hours per month in the fall and to only 240 hours per month in the slack winter season. Family labor of 45 hours per month is available from September through February and increases to 70 hours per month during the summer, when school-age children are on vacation.

Part 2 of table 2 shows the labor available for farming when the operator holds a part-time off-farm job. This situation supposes that, yeararound, 5.5 hours per day for a 5-day week are required on the off-farm job—4 hours at work and 1.5 hours for transportation. Operator labor is accordingly 125 hours per month less than the full-time labor supply shown in part 1 of table 2. Family labor, however, remains unchanged.

Part 3 of table 2 indicates total hours of labor remaining for farm work when the operator holds a full-time off-farm job of 40-hours per week yeararound. In this situation, family and operator labor is reduced to only 103 hours monthly for farm work. With full-time work, however, the operator generally is entitled to an annual vacation; hence, 1 week (50 hours) of this vacation is assumed to be used for farm work in the labor-critical May-June period.

Operating Capital

The quantities of *operating* capital (exclusive of that invested in machinery, buildings and land) used on farms of 80, 160 and 240 acres for benchmark comparisons are $4,200, $8,400 and $12,600, respectively. These amounts approximate the average quantity of operating capital used on farms of the three sizes in 20 southern Iowa counties studied by Heady and Shaw.[6] However, average capital use per farm in the Shelby-Grundy-Haig area is somewhat greater than these amounts. To cover situations including a greater

[6] Heady, Earl O. and Shaw, Russell. op. cit. The 20 counties studied were: Clarke, Decatur, Lucas, Ringgold, Union, Taylor, Wayne, Appanoose, Davis, Van Buren, Lee, Adams, Monroe, Wapello, Jefferson, Madison, Warren, Marion, Mahaska and Keokuk.

number of farmers, six different levels of operating capital are considered in deriving plans for each farm size: the benchmark amount of operating capital, 50 percent less than the benchmark amount, 25 percent less, 25 percent greater, 50 percent greater and a nonlimitational level of operating capital. At the latter level, sufficient capital is available such that only resources other than capital restrict the farm plan. The operating capital level in each situation refers to the available quantity, whether it is owned or borrowed. However, incomes shown for the following farm plans assume that all operating capital expended is owned. If part of the operating capital is borrowed, interest charges should be deducted from the resulting farm incomes.

Machinery and Buildings

The owner-operator in each situation is assumed to have an adequate line of machinery for the cropping operations. In computing total investment, the value of machinery, buildings and land must be added to the operating capital shown. These statements do not imply, of course, that all machinery must be owned; machine services also may be obtained on an exchange or custom basis. In either case, machinery costs are relatively inflexible and, hence, are treated as fixed costs. That is, machinery costs are not included in linear programming, but are merely deducted from income.

Hay-storage facilities, granaries and corncribs are assumed adequate (or can be easily increased) in all cases, for handling production from cropland. The floor areas of building space available for various types of livestock on 80-, 160- and 240-acre farms are shown in table 3. Building costs also are treated as "fixed" and are subtracted from income in the manner described for machinery costs.

Total fixed costs (taxes, insurance, building repairs and depreciation on machinery and buildings) deducted from incomes on 80-, 160- and 240-acre farms are $1,484, $2,125 and $2,405, respectively.[7] These fixed costs are approximate and may require adjustment in individual situations.

Management and Technology

One objective of this study is to determine income increases possible from adoption of improved farm technological developments combined with above-average managerial ability. Hence, two alternative conditions are used with respect to management level and state of technology: (1) average management and use of presently accepted farm technology and (2) above-average management and use of improved farm technology. Differences in management and technology are reflected in the input-output coefficients used in programming. Resource requirements and returns for various crop and livestock enterprises under the two management and technological conditions are shown later in tables 6, 7 and 8. Important differences in the cropping system occur under conditions (1) and (2). Under the first condition, the cropping system approximates the average of those actually followed in the area. Iowa Farm Census data were used to derive the average cropping pattern, fertilizer use and yields for the 5-year period 1949-53 in the Shelby-Grundy-Haig soil area. Under the second condition, several improved rotations and fertilizer methods or rates are used for the various soil classes; these improved crop practices, together with selection of improved seed varieties, timeliness of field operations, etc., are reflected in increased yields.

Differences between the two levels of management and technology also occur for livestock. Major differences in hog production practices under conditions (1) and (2) are reflected in feed requirements per 100 pounds of pork produced and in number of pigs marketed per litter. Differences in management and techniques in feeder cattle production are assumed to appear mainly in marketing, rather than in feeding efficiency. Thus, the analysis supposes that an above-average manager is able to purchase a more uniform group of feeder cattle and can sell fat cattle at higher prices than an average manager. In comparing management practices for beef cows, average management results in a lower percentage calf crop and a lower selling weight and price for the calf.

CROP ENTERPRISES

Table 4 indicates crop yields expected from improved rotations and fertilization methods (i.e., corresponding to above-average management) on three soil types. Rotations considered for each soil class previously have proven profitable alternatives under farm conditions. Three rotations are included for soil class I, four rotations for soil class II and two for soil class III. The yield estimates of table 4 assume (a) a cropping system in operation for at least 10 years, (b) terraces and contour cultivation used where needed to control soil loss to less than 5 tons per acre per year and (c) average weather conditions. The crop system and yields under currently used practices (i.e., average management) were compiled from the 1954 Iowa Farm Census (see table 5). Census data show the average amount of fertilizer used by southern Iowa farmers is even less than the first or "low" rate indicated in table 4.

[7] Fixed costs taken from the 1955 "Iowa Farm Record Summary" for the southern Iowa pasture area (see table A-1, Appendix).

TABLE 3. SQUARE FEET OF AVAILABLE BUILDING SPACE FOR HOGS, BEEF CATTLE AND POULTRY ON FARMS OF 80, 160 AND 240 ACRES.

Farm size (acres)	Building space for hogs (sq. ft.)	Building space for cattle (sq. ft.)	Building space for poultry (sq. ft.)
80	414	720	432
160	512	1,640	432
240	624	2,208	480

TABLE 4. FERTILIZATION RATES AND CROP YIELD ESTIMATES FOR VARIOUS ROTATIONS ON THE MAIN SOIL TYPES OF THE SHELBY-GRUNDY-HAIG SOIL ASSOCIATION.*

Soil type	Rotation	First or "low" fertilization rate: 1st year corn	2nd year corn	Oats	Soybeans	Hay
Grundy-Haig silt loam,	CCSb	10-15-10	30-15-10	—	0-0-0	—
0-1 percent slope		45	40	—	22	—
(soil class I)	CSbCOM	5-15-10	10-15-10	10-20-0	0-0-0	0-0-0
		55	50	28	22	1.9
	CCOM	5-15-10	30-15-10	10-20-0	—	0-0-0
		55	50	28	—	1.9
Grundy silt loam,	CCOM	5-15-10	30-15-10	10-20-0	—	0-0-0
2-5 percent slope		60	55	30	—	2.2
(soil class II)	CCOMM	5-15-10	30-15-10	10-20-0	—	0-0-0
		60	57	30	—	2.2
	CSbCOM	5-15-10	20-15-10	10-20-0	0-0-0	0-0-0
		60	57	30	22	2.2
	COM	5-15-10	—	15-20-0	—	0-0-0
		60	—	35	—	2.2
Shelby loam,	COM	5-20-10	—	15-30-0	—	0-0-0
4-7 percent slope		35	—	30	—	1.8
(soil class III)	COMM	5-20-10	—	10-30-0	—	0-0-0
		40	—	32	—	2.0

Soil type	Rotation	Second or "high" fertilization rate: 1st year corn	2nd year corn	Oats	Soybeans	Hay
Grundy-Haig silt loam,	CCSb	40-20-10	50-20-10	—	0-0-0	—
0-1 percent slope		55	50	—	25	—
(soil class I)	CSbCOM	5-20-10	30-20-10	20-30-0	0-0-0	0-0-0
		65	60	35	25	2.2
	CCOM	5-20-10	50-20-10	10-30-0	—	0-0-0
		65	60	35	—	2.2
Grundy silt loam,	CCOM	5-20-10	60-20-10	15-30-0	—	0-0-0
2-5 percent slope		70	65	35	—	2.5
(soil class II)	CCOMM	5-20-10	50-20-10	15-30-0	—	0-0-0
		72	68	35	—	2.8
	CSbCOM	5-20-10	50-20-10	10-30-0	0-0-0	0-0-0
		70	65	35	25	2.5
	COM	5-20-10	—	20-30-0	—	0-0-0
		70	—	35	—	2.5
Shelby loam,	COM	5-50-10	—	30-30-0	—	0-0-0
4-7 percent slope		45	—	35	—	2.5
(soil class III)	COMM	5-50-10	—	30-40-0	—	0-0-0
		48	—	35	—	2.6

* Upper three figures of each group of figures are pounds of nitrogen, phosphorus and potassium applied per acre of crop; lower figures are yields in bushels per acre for grain and tons per acre for hay. Data in this table were obtained from W. D. Shrader, Department of Agronomy, Iowa State College.

Table 6 indicates the resource requirements, returns and physical output per acre of the cropping systems used in this study. The abbreviations for rotations and fertilizer rates used in table 6 will be used throughout the text (e.g., $CSbCOM_1$ is a corn-soybeans-corn-oats-meadow rotation fertilized at the first or "low" rate; $COMM_2$ is a corn-oats-meadow-meadow rotation fertilized at the second or "high" rate). Crop rotations on soil classes I, II and III in table 6 are operated under above-average management and use of improved technology; the final column of table 6 assumes average management and currently used technology. No value is placed on hay produced by the various rotations other than the yield-increasing effects on grain crops. Forage is assumed to give direct returns only when used in livestock production. Therefore, hay harvesting expenses are charged to the livestock utilizing the forage rather than to the crop rotation producing it. This accounting procedure by-passes the difficult problem of valuation of an intermediate product (hay) for which there is no ready market in the area; also, the procedure explains negative returns for the COMM rotations on soil class III, table 6.

LIVESTOCK ENTERPRISES

A total of 11 livestock enterprises are allowed to compete for scarce farm resources: three calf feeding enterprises, three yearling feeding enterprises, three hog-raising systems, a beef cow herd and a poultry enterprise. Following is a brief description of each enterprise.

TABLE 5. CROP PATTERN AND AVERAGE YIELD PER ACRE USED IN THIS STUDY FOR CROPS UNDER AVERAGE MANAGEMENT AND CURRENT TECHNOLOGY.*

Crop	Proportion of land in crop (percent)	Yield per acre
Corn	22	38.1 bu.
Oats	10	28.0 bu.
Hay	47	2.0 tons
Permanent pasture	21	1.0 tons
Total	100	

*Cropping pattern and yields are averages of 1949-53 compiled from Iowa Farm Census data for the following five counties located in the Shelby-Grundy-Haig soil area: Clarke, Decatur, Lucas, Ringgold and Union.

Good-choice steer calves fed in drylot: Good-to-choice steer calves weighing 430 pounds are purchased in October and wintered in drylot. In early summer they are put in drylot and full-fed until marketed in August. Average gain per animal is 550 pounds. Death loss is assumed to be 2.5 percent.

Good-choice steer calves fed on pasture: Good-to-choice steer calves weighing 430 pounds are purchased in October and wintered on roughage and a limited quantity of grain. Feed is increased while the calves are on pasture from May to July. In July the calves are put in drylot and full-fed until sold in September at 990 pounds. Death loss is assumed to be 2.5 percent.

Good-choice steer calves, deferred-fed: Good-to-choice steer calves are purchased in October at an average weight of 402 pounds. They are wintered on roughage, then fed without grain on pasture from May to August. The animals are taken off pasture in August and fed an intensive grain ration for about 6 weeks. They are marketed at a grade of good-to-choice in the latter part of November at a weight of 1,056 pounds. A death loss of 3.0 percent is assumed.

Good-choice yearling steers fed in drylot: Good-to-choice yearling steers are purchased in November at about 650 pounds and are marketed in September at a weight of 1,070 pounds. Feeding practices for this enterprise are similar to those described above for good-choice calves fed in drylot. Death loss is assumed to be 1.5 percent.

Good-choice yearling steers fed on pasture: Good-choice yearling steers are purchased in October at an average weight of 621 pounds. They are wintered in drylot on roughage and a small amount of grain. About May 1 they are put on pasture while grain is increased. In July the calves are put in drylot and full-fed until marketed in

TABLE 6. RESOURCE REQUIREMENTS, RETURNS AND PHYSICAL OUTPUT PER ACRE OF SELECTED CROPPING SYSTEMS UNDER ABOVE-AVERAGE AND AVERAGE MANAGEMENT ON VARIOUS SOIL CLASSES IN THE SHELBY-GRUNDY-HAIG SOIL ASSOCIATION.

Item	Soil classes, rotations and fertilization rates for above-average management*																		Cropping system under average management†
	Soil class I						Soil class II								Soil class III				
	$CCSb_1$	$CCSb_2$	$CSbCOM_1$	$CSbCOM_2$	$CCOM_1$	$CCOM_2$	$CCOM_1$	$CCOM_2$	$CCOMM_1$	$CCOMM_2$	$CSbCOM_1$	$CSbCOM_2$	COM_1	COM_2	COM_1	COM_2	$COMM_1$	$COMM_2$	
Labor (man-hrs.):																			
Dec.-Jan.-Feb.	0.24	0.24	0.15	0.15	0.18	0.18	0.18	0.18	0.15	0.15	0.15	0.15	0.12	0.12	0.12	0.12	0.09	0.09	0.10
March-April	0.75	0.75	0.72	0.72	0.80	0.80	0.80	0.80	0.64	0.64	0.72	0.72	0.79	0.79	0.79	0.79	0.59	0.59	0.43
May-June	2.55	2.55	1.53	1.53	1.32	1.32	1.32	1.32	1.06	1.06	1.53	1.53	0.89	0.89	0.89	0.89	0.66	0.66	0.74
July-Aug.	0.72	0.72	1.18	1.18	1.31	1.31	1.31	1.31	1.05	1.05	1.18	1.18	1.50	1.50	1.50	1.50	1.13	1.13	0.68
Sept.-Oct.-Nov.	2.87	2.87	1.72	1.72	1.30	1.30	1.30	1.30	1.04	1.04	1.72	1.72	0.87	0.87	0.87	0.87	0.65	0.65	0.72
Operating capital required (in dollars):‡	22.46	26.23	19.93	21.90	21.28	23.31	21.64	24.19	20.83	22.66	20.57	22.46	19.88	21.06	19.17	21.48	18.74	20.80	12.95
Net return (in dollars):§	27.52	33.93	18.45	23.48	14.70	19.79	17.66	21.91	11.09	15.42	20.94	25.32	11.59	14.40	1.23	3.99	—1.62	—0.80	2.03
Feed grain produced (in bu.):**	28.33	35.00	23.80	28.50	29.75	35.62	32.50	38.12	26.40	31.50	26.40	30.50	25.83	29.17	16.67	20.83	14.00	16.38	12.48
Hay produced (in tons):	0.00	0.00	0.38	0.44	0.48	0.55	0.55	0.62	0.88	1.14	0.44	0.50	0.73	0.83	0.60	0.83	1.00	1.30	1.19

*Soil classes I, II and III were defined earlier in the text (see sub-section entitled "Land"). Subscripts after the rotation designation indicate fertilizer rates, e.g., $CCSb_1$ is a corn-corn-soybeans rotation fertilized at the first or "low" rate, table 4.
†This system assumes the cropping pattern, fertilizer use and yields obtained from census data. Figures in this column assume average management and current techniques.
‡Does not include capital required for fixed costs.
§Net return per acre = gross return per acre − variable costs per acre.
**Oats converted to feed grain on the basis of 2 bushels oats = 1 bushel corn.

August at an average weight of 1,108 pounds. Death loss is assumed to be 1.6 percent.

Medium yearling steers fed in drylot: Medium yearling steers are purchased in November at an initial weight of 670 pounds. They are kept on drylot and fed a moderately high grain ration until marketed in April or May at an average weight of 957 pounds. Death loss is assumed to be 1.5 percent.

Beef cow enterprises: Stock cows are bred to calve in the spring. Cow and calf are carried on pasture throughout the grazing season and the calf is marketed in October. Under above-average management and improved technology, a 90-percent calf crop is assumed, with the calves sold at an average weight of 450 pounds. Under average management and currently used technology an 85-percent calf crop is assumed, with the calves sold at 415 pounds per head. The herd is completely replaced every 8 years.

Spring hog enterprises: Spring litters are farrowed in April and marketed the following October. One gilt is kept per litter for replacement. Under above-average management and improved technology, 6.11 pigs are sold per litter and 333 pounds of corn are required per 100 pounds of pork produced. Total quantity of pork marketed per litter, including the sow, is 1,675 pounds. Under average management and currently used technology, 5.44 pigs are sold per litter and 396 pounds of corn are required per 100 pounds of pork produced. The total quantity of pork marketed per litter, including the sow, is 1,524 pounds.

Fall hog enterprises: Fall litters are farrowed in August and marketed the following April. One gilt is kept per litter for replacement. Under above-average management and improved technology, 7.01 pigs are sold per litter and 355 pounds of corn are required to produce 100 pounds of pork. An average of 1,877 pounds of pork, including the sow, are marketed per litter. This hog system was not included with average management and currently used technology.

Two-litter hog enterprises: Two litters of hogs are marketed annually from each sow. Spring litters are farrowed in April and marketed in October; fall litters are farrowed in August and marketed in March. One gilt is kept from the fall litter for replacement. Under above-average management and improved technology, 13.12 pigs are marketed per sow (two litters per year) and 339 pounds of corn are required per 100 pounds of pork produced. A total of 3,352 pounds of pork, including the sow, are marketed annually. Under average management and current technology, 11.78 pigs are marketed per sow (two litters per year) and 415 pounds of corn are required per 100 pounds of pork produced. A total of 3,052 pounds of pork, including the sow, are marketed annually.

Poultry enterprise: The poultry flock is completely replaced each year. Sexed chicks are purchased and kept for laying hens. Cull hens are estimated as 11 percent of the total. Mortality rates are 10 percent for chicks and 15 percent for hens. Average annual egg production per hen is 180 eggs.

Resource requirements and returns for the 11 livestock enterprises operated under above-average management and improved technology are shown in table 7. Table 8 gives similar information for livestock enterprises operated under average management and currently used technology. Differences in input-output coefficients for the same livestock enterprises in tables 7 and 8 reflect changes in management and technology. These differences are as follows: In the feeder cattle enterprises, fat cattle are sold at $1.25 per hundredweight higher under above-average management and improved technology. For the beef cow enterprise, a smaller calf crop and lower selling weight per calf are assumed under average management and current technology. Also, the calves produced under this condition sell at a price $1.50 per hundredweight lower than those produced under above-average management and improved technology. Thus, in all beef enterprises, differences in management and technology are reflected only in the returns per unit; resource requirements are the same under both conditions. However, for the hog enterprises, differences in input-output relationships outlined previously result in changes in resource requirements as well as returns. Differentiation in terms of management and technology is not made for the poultry enterprise.

TABLE 7. RESOURCE REQUIREMENTS AND RETURNS PER UNIT OF SELECTED LIVESTOCK ENTERPRISES UNDER ABOVE-AVERAGE MANAGEMENT AND IMPROVED TECHNOLOGY.

Item	Good-choice calves		Good-choice calves, deferred fed	Good-choice yearlings		Medium yearlings, drylot	Beef cow herd	Spring hog system	2-litter hog system	Fall hog system	Poultry
	Drylot	Pasture		Drylot	Pasture						
	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 litter)	(2 litters)	(1 litter)	(100 birds)
Labor (man-hrs.):											
Dec.-Jan.-Feb.	3.01	3.25	3.31	1.70	1.32	6.30	5.61	5.95	12.92	9.31	44.10
March-April	2.38	2.56	0.45	1.22	1.01	4.20	3.80	5.07	16.11	4.09	37.80
May-June	6.43	6.62	0.22	5.42	6.97	2.39	3.61	4.52	9.20	3.27	53.76
July-Aug.	6.22	6.35	0.22	5.42	6.68	1.14	3.30	4.32	6.96	4.36	33.18
Sept.-Oct.-Nov.	3.00	4.48	8.25	3.20	4.43	3.07	4.03	6.14	14.34	11.98	41.16
Building space (in sq. ft.):	30.00	20.00	20.00	40.00	30.00	40.00	50.00	42.66	70.10	72.23	412.00
Feed grain (in bu.):*	61.00	50.00	53.70	55.00	50.00	33.00	6.68	96.53	202.86	119.01	162.66
Hay (in tons):†	0.70	1.60	2.77	1.70	2.42	0.67	5.47	0.70	0.70	0.00	0.00
Operating capital required (in dollars):‡	119.07	117.96	121.52	161.53	146.18	126.51	188.83	141.82	240.43	177.43	367.00
Net return (in dollars):§	34.41	52.38	64.93	22.44	49.42	22.87	67.32	97.61	168.44	54.32	43.21

* Oats converted to feed grain on the basis of 2 bushels oats = 1 bushel corn.

† Pasture requirements have been converted into tons of hay equivalent.

‡ Does not include capital required for fixed costs. Does include purchase cost of feeder cattle and poultry and initial investment in breeding stock for beef cow herd and hog enterprises.

§ Net return per unit = gross return per unit — variable costs per unit.

TABLE 8. RESOURCE REQUIREMENTS AND RETURNS PER UNIT OF SELECTED LIVESTOCK ENTERPRISES UNDER AVERAGE MANAGEMENT AND CURRENTLY USED TECHNOLOGY.

Item	Good-choice calves		Good-choice calves, deferred fed	Good-choice yearlings		Medium yearlings, drylot	Beef cow herd	Spring hog system	2-litter hog system
	Drylot	Pasture		Drylot	Pasture				
	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 head)	(1 litter)	(2 litters)
Labor (man-hrs.):	Same labor requirements as shown in table 7.								
Building space (in sq. ft.):	30.00	20.00	20.00	40.00	30.00	40.00	50.00	38.63	73.46
Feed grain (in bu.):*	61.00	50.00	53.70	55.00	50.00	30.00	6.68	107.61	226.30
Hay (in tons):†	0.70	1.60	2.77	1.70	2.42	0.67	5.47	0.72	0.72
Operating capital required (in dollars):‡	119.06	117.96	121.52	161.53	146.18	126.51	188.83	128.92	219.88
Net return (in dollars):§	22.29	40.03	51.73	9.06	35.48	10.94	56.45	65.49	121.54

* Oats converted to feed grain on the basis of 2 bushels oats = 1 bushel corn.

† Pasture requirements have been converted into tons of hay equivalent.

‡ Does not include capital required for fixed costs. Does include purchase cost of feeder cattle and initial investment in breeding stock for beef cow herd and hog enterprises.

§ Net return per unit = gross return per unit — variable costs per unit.

PRICES USED

Prices used in this study are based on long-run price ratios between commodities, with adjustment to the 1955 price level relative to corn at $1.20 per bushel. The method used in adjusting prices is as follows: The average product price over a complete "price cycle"[8] is divided by the average corn price over the same period; this quotient is then multiplied by the 1955 price of corn.[9] The first step guarantees that the historic price relationship between commodities is maintained. The second step adjusts all prices to the 1955 price level, using the price of corn as an indicator of this level. Table 9 gives the purchase price and/or selling price for various items included in this study.

METHOD OF ANALYSIS

Linear programming is used to determine the most profitable farming plan for each of the resource situations studied.[10] Maximum profit plans are not computed as a prediction of what farmers, on the average, are now doing. Instead, they are used to illustrate the highest incomes possible under the various resource and farm practice situations. From these several maximum profit plans, prediction can be made of the extent to which farm incomes might be increased by (1) getting more capital into the hands of farmers, with technology remaining constant, (2) using education to increase knowledge of farm practices, capital levels remaining the same, (3) increasing both capital and technical knowledge, (4) adjusting farm size to the limits of the farm labor supply or (5) shifting by farmers to part- or full-time off-farm employment.

Under each situation with respect to resources and techniques, a program is obtained which allows the condition of equation (1) where c is a column vector of the returns per unit of the crop

$$(1)\ \text{maximize } f(X) = c'X$$

and livestock enterprises mentioned earlier and X is a column vector of the level of output of these enterprises. With the addition of slack variables, profit is maximized subject to the restraints outlined in equation (2) where X_1 is initially a column vector of disposal activities (i.e., so that the plan does not force use of every unit of labor or other resources), X_2 is a column vector of crop and livestock enterprises, P_1 is an identity matrix, P_2 is a matrix of the input-output coefficients explained earlier and R is a column vector of resource restrictions described above. (In successive iterations, however, X_1^* includes activities at levels greater than zero which are included in feasible plans while X_2^* includes activities which are zero level, but which can be brought into the plan to increase profits.) Since c' can be partitioned into c'_1 and c'_2 and since X_1 can be expressed as a function of X_2 as in equation (3), profit maximization can be expressed as in equation (4), by substitution of equation (3) into equation (1). The matrix $c'_2 - c'_1 P_1{}^{-1} P_2$ then is used as a basis for selecting enterprises to include in the plan, with each incoming activity increased to the limits of resource restrictions. This procedure is continued until all elements in the $c'_2 - c'_1 P_1{}^{-1} P_2$ matrix are negative, denoting maximum profits. Obviously, then, profits are limited in terms of the magnitude of the elements in R and P_2; the figures on following pages should be interpreted accordingly.

$$(2)\ P_1X_1 + P_2X_2 = R$$

$$(3)\ X_1 = P_1^{-1}R - P_1^{-1}P_2X_2$$

$$(4)\ \text{profit} = f(X) = c_1'\, P_1^{-1}R + (c_2' - c_1'\, P_1^{-1}P_2)\, X_2$$

TABLE 9. AVERAGE ADJUSTED PRICES USED IN THE ANALYSIS.*

Item	Unit	Purchase price ($)	Selling price ($)
Seed and fertilizer:			
Corn	bu.	11.50	——
Oats	bu.	1.00	——
Soybeans	bu.	4.30	——
Nitrogen (N)	lb.	0.15	——
Phosphorus (P_2O_5)	lb.	0.11	——
Potassium (K_2O)	lb.	0.06	——
Feed and grain:			
Corn	bu.	1.30	1.20
Oats	bu.	0.63	0.63
Soybeans	bu.	——	2.20
Soybean oilmeal	cwt.	4.42	——
Hog supplement (40%)	cwt.	5.30	——
Laying mash	cwt.	4.12	——
Livestock and livestock products:			
Good-choice calves (drylot)	cwt.	19.79	21.91†
Good-choice calves (pasture)	cwt.	19.79	22.10†
Good-choice calves (deferred-fed)	cwt.	19.79	22.48†
Good-choice yearlings (drylot)	cwt.	18.85	22.10†
Good-choice yearlings (pasture)	cwt.	18.85	21.91†
Medium yearlings (drylot)	cwt.	15.21	18.49†
Beef cow	cwt.	16.03	——
Cull beef cow	cwt.	——	12.47
Calf raised from beef cow herd	cwt.	——	19.79‡
Sows	cwt.	15.84	14.61
March—market hogs	cwt.	——	18.00
April—market hogs	cwt.	——	18.00
October—market hogs	cwt.	——	18.00
Eggs	doz.	——	0.28
Farm chickens	lb.	——	0.14
Broilers	lb.	——	0.22

* All prices based on above-average management and improved techniques.

† Selling prices are $1.25 lower per hundredweight under average management and current technology.

‡ Selling price is $1.50 per hundredweight lower under average management and current technology.

[8] The length of "price cycle" varies between products. For example, the price cycle period for hogs is about 7 years, hence average hog prices over the 7-year period, 1948-55, are used in the adjustment procedure. The price cycle for grain and poultry is 10 years (1946-55) while the beef price cycle for beef cattle is almost 20 years (1936-55).

[9] Corn price of $1.20 per bushel (average price received by Iowa farmers in September, October, November and December, 1955) is used in the adjustment.

[10] For other applications of linear programming see: Bowlen, Bernard and Heady, Earl O. Optimum combinations of competitive crops at particular locations. Iowa Agr. Exp. Sta. Res. Bul. 426. 1955; Heady, Earl O. and Gilson, J. C. Optimum combinations of livestock enterprises and management practices on farms including supplementary dairy and poultry enterprises. Iowa Agr. Exp. Sta. Res. Bul. 437. 1956; and Heady, Earl O., Loftsgard, Laurel D., Paulsen, Arnold and Duncan, E. R. Optimum farm plans for beginning farmers on Tama-Muscatine soils. Iowa Agr. Exp. Sta. Res. Bul. 440. 1956.

PROFIT-MAXIMIZING PLANS FOR VARIOUS FARM SIZES

This section is devoted to a discussion of maximum-profit plans for each of the situations studied for 80-, 160- and 240-acre farms. Two sets of plans are shown for each farm size: The first set of plans presents the results where current technology or practices and average managerial ability are used for various capital levels. The second set of plans presents the results for various levels of operating capital where improved production techniques are used. Several comparisons then can be made from these two sets of plans. From the first set of plans it is possible to appraise the income effects of increasing capital availability, given current techniques. Comparison of incomes from the two sets of plans, at each capital level, provides estimates of increases in income possible from closing the "technological gap," i.e., from using improved techniques with capital held constant. Finally, the combined effects of increasing capital availability and improving techniques used by farmers can be estimated by comparing incomes under high capital levels and improved techniques with incomes from lower capital levels and currently used techniques.

Profit-Maximizing Plans for 80-Acre Farms

Table 10 presents the farm plans and incomes at two capital levels for an 80-acre farm operated with currently accepted production techniques and average management. The plan for a capital level of $4,200 will be referred to as the "benchmark" situation for the 80-acre farm size. It will be used in comparison of incomes from other capital levels, farming practices and employment opportunities.

Net income for the benchmark situation (part 1, table 10) is —$139. This negative income is probably lower than the net incomes realized on some 80-acre farms in the area with only $4,200 in operating capital; it may be higher than incomes on others. However, most 80-acre farmers in the area probably use considerably more than $4,200 in operating capital. Obviously, production cannot continue long if returns are consistently negative. In practice, some farmers probably reduce fixed costs sufficiently to avoid a negative return. Others, as census data show, abandon farming. To reduce fixed costs, the farmer might use older machinery, hire harvesting done on a custom basis, own machinery jointly, etc. At any rate, the resulting farm income indicates that, in the soil area studied, the operation of an 80-acre farm with average management and only $4,200 in operating capital is little better than a "break-even" proposition.

Small acreages of corn and oats, along with relatively low yields attained under current practices, result in a low feed grain supply on the 80-acre farm. Therefore, hog production, which requires large quantities of feed grain, is not undertaken at the benchmark capital level (see part 1, table 10).[11] Deferred-fed calves and beef cows are more profitable than hogs because they have higher returns per bushel of feed grain and utilize permanent pasture which would otherwise go unused. However, when capital is made nonlimitational (part 2, table 10), hogs are included. With greater capital, corn can be purchased for hog production. Hay also becomes limitational at the higher capital level, causing calves fed on pasture, which have a high return on forage, to replace beef cows in the program. Many farmers limited to the operating capital of the benchmark situation would, because of risk considerations, choose to raise hogs rather than feed cattle. However, the purpose of this study is to estimate the most profitable plan which farmers might adopt, for particular resource situations, rather than to predict what they might do to meet risk preferences or related conditions.

Unlike the plans in table 10, those in table 11 are no longer restricted to the current practices and cropping pattern of the area. Plans now use improved production techniques (i.e., an above-average level of management). These plans are computed for six levels of operating capital—ranging from 50 percent less than the benchmark capital level to a nonlimitational capital level. In the plans for improved techniques, corn acreage generally is larger than under the techniques currently in use. This is true because the improved

[11] This finding is not surprising, since, in one Clarke County township studied intensively, 13 of 29 80-acre farmers raised no hogs in 1954 while 9 others raised five litters or less.

TABLE 10. PLANS FOR AN 80-ACRE FARM, ASSUMING CURRENT TECHNIQUES AND AVERAGE MANAGEMENT.

Operating capital	Optimum combinations of enterprises: "Typical" cropping plan* — Crops	Acres	Livestock — Type	Number	Corn purchased or sold	Limiting resources	Net income†
(1) Benchmark capital = $4,200	Corn	18	Deferred-fed calves	14 head	17 bu. purchased	Land	—$139
	Oats	8	Beef cows	9 head		Capital	
	Hay‡	37				Cattle space	
	Permanent pasture	17				Feed grain	
(2) Nonlimitational capital = $10,738	Corn	18	Deferred-fed calves	26 head	2,387 bu. purchased	Land	$836
	Oats	8	Calves on pasture	10 head		Hog space	
	Hay‡	37	2-litter hog system	11 litters		Cattle space	
	Permanent pasture	17				Feed grain	
						Hay	

* Proportions of various crops and yields from Iowa Farm Census data for 1949-53.

† Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

‡ Includes rotation pasture.

TABLE 11. OPTIMUM PLANS FOR AN 80-ACRE FARM, ASSUMING IMPROVED TECHNIQUES AND ABOVE-AVERAGE MANAGEMENT.

Operating capital	Optimum combinations of enterprises: Cropping plan: Soil class	Cropping plan: Rotation	Cropping plan: Acres	Crop acreage: Crop	Crop acreage: Acres	Livestock: Type	Livestock: Number	Corn purchased or sold	Limiting resources	Net income*
(1) 50% less than benchmark capital = $2,100	I II III	CCSb$_2$ CSbCOM$_2$ Cropland rented out† Permanent pasture	13 28 22 17	Corn Soybeans Oats Hay‡	20 10 6 6	2-litter hog system	9 litters	355 bu. sold	Soils I, II Capital	$ 591
(2) 25% less than benchmark capital = $3,150	I II III	CCSb$_2$ CSbCOM$_2$ Cropland rented out† Permanent pasture	13 28 22 17	Corn Soybeans Oats Hay‡	20 10 6 6	2-litter hog system Spring litter hog system Deferred-fed calves	1 litter 9 litters 7 head	None	Soils I, II Capital Hog space Feed grain	$1,178
(3) Benchmark capital = $4,200	I II III III	CCSb$_2$ CSbCOM$_2$ COM$_2$ Cropland rented out† Permanent pasture	13 28 15 7 17	Corn Soybeans Oats Hay‡	25 10 11 11	Spring litter hog system Deferred-fed calves	10 litters 13 head	None	Soils I, II Capital Hog space Feed grain	$1,536
(4) 25% greater than benchmark capital = $5,250	I II III	CCSb$_2$ CSbCOM$_2$ COM$_2$ Permanent pasture	13 28 22 17	Corn Soybeans Oats Hay‡	27 10 13 13	Spring litter hog system Deferred-fed calves Calves on pasture	10 litters 11 head 8 head	138 bu. purchased	Soils I, II, III Capital Hog space Feed grain Hay	$1,803
(5) 50% greater than benchmark capital = $6,300	I II III	CCSb$_2$ CSbCOM$_2$ COM$_2$ Permanent pasture	13 28 22 17	Corn Soybeans Oats Hay‡	27 10 13 13	Spring litter hog system Deferred-fed calves Calves on pasture	10 litters 2 head 23 head	413 bu. purchased	Soils I, II, III Capital Hog space Feed grain Hay	$1,991
(6) Nonlimitational capital = $9,292	I II II III	CCSb$_2$ CCOMM$_2$ CSbCOM$_2$ COM$_2$ Permanent pasture	13 20 8 22 17	Corn Soybeans Oats Hay‡	27 6 13 17	2-litter hog system Calves on pasture Poultry	12 litters 36 head 105 hens	1,375 bu. purchased	Soils I, II, III Hog space Cattle space Poultry space Feed grain Hay	$2,349

* Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

† Cropland rented out at $6 per acre.

‡ Includes rotation pasture.

techniques rely more heavily on mechanical erosion-control practices. Terracing and contouring are used with heavier grain rotations, rather than dependence largely on grasses and forage in the rotation to control soil loss.

In the optimum plan for $2,100 of operating capital (50 percent less than the benchmark capital level, table 11), the severe capital limitation overshadows all other restricting resources. Therefore, the optimum cropping plan and livestock program are selected on the basis of greatest return per dollar of operating capital. Accordingly, soil classes I and II are planted to $CCSb_1$ and $CSbCOM_2$ rotations, respectively, while soil class III (the least productive land) is rented out at $6 per acre. Some farmers, however, would be likely to increase profits by spreading their limited capital over the entire crop acreage, rather than farming the I and II soils intensively while renting out land in soil class III. That is, combination of the same quantity of capital with a larger acreage may increase returns to capital. This possibility should be recognized in interpreting all plans showing land in soil class III as "rented out." The 2-litter hog enterprise enters the optimum plan with limited capital for the reason stated above: It gives higher returns to capital than other livestock enterprises.

Many farmers with small acreages would not incorporate two rotations into a single plan (as shown in part 1, table 11). However, as the plan indicates, the most productive soil (class I) should be planted intensively to grain, while soil class II should be cropped heavily, but not as intensively as soil class I. In actuality, many farmers probably accept some sacrifice in profit and plant an acreage of each crop consistent with "practical" farm operations. The total acreages of each crop shown in the tables serve as a guide in such decisions. The "high" (second) rate of fertilization used on all class I and II soils, indicates that capital invested in fertilizer has high value productivity.

As capital is increased, the optimum plans of table 11 undergo continuous change. At the $3,150 level of operating capital (part 2, table 11) the hog program shifts to the spring-litter enterprise, which makes more efficient use of the limited feed grain supply than the 2-litter system. Hog space limits the enterprise, thus releasing capital to be used for deferred-fed calves. Only when a benchmark amount of capital is available does the above-average manager using improved practices maximize profits by including class III soils in rotation. With less capital, his resources bring maximum returns from rotations and fertilization on class I and II soils and from livestock production. However, some farmers may maximize profits by utilizing capital less intensively and by farming the entire acreage. As operating capital is increased above the benchmark level, pasture-fed calves gradually replace deferred-fed calves because the former have lower requirements for the now limiting hay supply and give comparatively high returns on other limited resources. All crop land is cultivated and heavily fertilized at the higher capital levels; however, corn must be purchased for the large livestock programs.

It is possible, of course, to organize highly intensive enterprises on an 80-acre farm, and incomes might be changed accordingly. The entire acreage might be organized as a feedlot for raising hogs or feeding cattle; it might be used intensively in broiler or turkey production. However, the plans of this study include only those enterprises which are consistent with the soil and labor resources of farms in the area studied. Hence, plans cannot exceed the labor and forage supplies of the farm. While some farms can expand beyond these limits, not all can do so. Too, development of highly intensive, specialized farms does not appear in widespread prospect for southern Iowa.

EFFECTS OF CHANGES IN CAPITAL WITH MANAGEMENT AND TECHNOLOGY CONSTANT

Several types of useful comparisons can be made from the results in tables 10 and 11. Starting from the 80-acre benchmark situation in part 1, table 10 (i.e., an average manager using a benchmark amount of capital and current techniques), the following question may be asked: What are the opportunities for increasing farm income through the efforts of credit agencies and educational programs operating individually or jointly?

Table 10 indicates the income changes possible from increasing operating capital alone. Thus, an 80-acre farmer, with the other resource restrictions mentioned earlier, might use a maximum of $10,738 in operating capital—an increase of $6,538 from the benchmark situation.[12] At the same time, income changes from —$139 to $836, an increase of $975 and a return of about 15 percent on additional capital employed. However, no change occurs in the cropping pattern or crop and livestock practices. The increased income is due alone to expansion of livestock volume through purchase of additional grain. Rather than purchase all of the additional grain, some farmers would likely increase grain production through shifts in the cropping plan. In particular, they would probably use heavier fertilizer applications. Previous studies suggest that, at moderate capital levels, investment in fertilizer has relatively high productivity. Thus, inclusion of other cropping and fertilization alternatives would likely result in even further income increases from a given increase in operating capital.

EFFECTS OF CHANGES IN CAPITAL AND EDUCATION OR TECHNIQUES

As demonstrated in the previous discussion, an

[12] Removal of labor and other restrictions might allow profitable use of more capital. However, farm plans were derived only for situations which appeared to be consistent with the quantities of resources controlled by farmers in the area.

increase in capital alone by $6,538 increases income by $975 (part 1 compared with part 2, table 10) where techniques are assumed constant. Estimates are also possible of the extent to which income on an 80-acre farm might be increased by use of education and the same or increased quantities of capital. With capital held constant at $4,200, use of improved techniques, which may be brought about through education, raises income from —$139 to $1,536, an increase of $1,675 (compare part 1, table 10 and part 3, table 11). If capital and techniques are increased together (part 1 of table 10 compared with part 6 of table 11), income increases by $2,488. Hence, capital and technical information or managerial ability are technical complements: The increase in income through use of better techniques and more capital is greater than the increases due to either alone.

These results indicate the need for integrated educational and credit programs. Through education (i.e., improved techniques) alone for the benchmark capital level of $4,200, income can be increased by only about two-thirds as much as when more capital is used with improved techniques. Adding capital alone, up to the limits of other restrictions, adds only one-third as much to income, compared with use of improved techniques along with additional capital. Hence, opportunities exist for credit agencies and educational programs together to substantially increase income on farms in the Shelby-Grundy-Haig soil area. Subsequent analysis investigates similar opportunities for increasing incomes on 160- and 240-acre farms.

Profit-Maximizing Plans for 160-Acre Farms

Table 12 summarizes plans for a 160-acre farm at two capital levels, assuming current techniques and average management. The plan in part 1 of table 12 hereafter is called the 160-acre benchmark situation. As with only 80 acres, a feed grain shortage allows beef enterprises to outcompete hog enterprises when capital is at the benchmark level. It should be remembered that the plan shown is the one of maximum profits for benchmark capital. Many farmers might raise hogs, a less risky enterprise, in preference to cattle feeding. When capital is made nonlimitational ($19,117 capital, part 2 of table 12), a 2-litter hog system enters the optimum plan. Deferred-fed calves form an important part of the livestock plan at both capital levels. At the upper capital level, however, calves fed on pasture replace beef cows because the former are more efficient utilizers of the limited hay supply. This shift also was observed when capital was increased in the 80-acre situation (table 10). Poultry enter the plan with nonlimitational capital because expansion of hog and beef enterprises is halted by building space restrictions.

Table 13 shows the profit-maximizing farm plans at various capital levels for a 160-acre farm operated under above-average management and using improved technology; these plans are quite similar to those of table 11 for an 80-acre farm operated under similar conditions. For example, at the lowest capital level, class III soils become underutilized (i.e., actually rented out at $6 per acre). Hogs and deferred-fed calves are included because they make more efficient use of limited capital than crops grown on soil class III. The cropping plan of $CCSb_2$ and $CSbCOM_2$ on class I and II soils, respectively, is optimum for both farm sizes because it brings high returns on all resources, particularly capital.

When capital is increased to $6,300 and beyond (table 13) larger beef cattle enterprises require more hay. Thus, the high-forage COM_2 rotation is cultivated on class III soils and, at higher capital levels, increases in acreage with the size of the beef cattle program. At the two highest capital levels (parts 5 and 6 of table 13), expansion of the beef cattle program requires even more forage, and the hay acreage increases for each succeeding plan in table 13. Since all land is cultivated at high capital levels, additional hay must be obtained by shifting to high-forage rotations in the cropping plan. Therefore, the $CCOM_2$ rotation replaces $CSbCOM_2$ on class II soils at the $12,600 capital level; with nonlimitational capital, soil classes I and II are shifted toward high-forage rotations. Calves fed on pasture replace deferred-fed calves as the major beef cattle enterprise at high capital levels because they give higher returns per ton of forage consumed. Corn must be

TABLE 12. PLANS FOR A 160-ACRE FARM, ASSUMING CURRENT TECHNIQUES AND AVERAGE MANAGEMENT.

Operating capital	Optimum combinations of enterprises: "Typical" cropping plan* — Crops	Acres	Livestock — Type	Number	Corn purchased or sold	Limiting resources	Net income†
(1) Benchmark capital = $8,400	Corn Oats Hay‡ Permanent pasture	35 16 75 34	Deferred-fed calves Beef cow herd	27 head 18 head	None	Land Capital Feed grain	$ 571
(2) Nonlimitational capital = $19,117	Corn Oats Hay‡ Permanent pasture	35 16 75 34	Deferred-fed calves Calves on pasture 2-litter hog system Poultry	41 head 41 head 14 litters 105 hens	4,419 bu. purchased	Land Hog space Cattle space Poultry space Feed grain Hay	$2,340

* Proportions of various crops and yields from Iowa Farm Census data for 1949-53.

† Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

‡ Includes rotation pasture.

purchased to support the large livestock program obtained at the high capital level in table 13.

EFFECTS OF CHANGES IN CAPITAL WITH MANAGEMENT AND TECHNOLOGY CONSTANT

Table 12 illustrates possible increases in income from use of more capital on 160-acre farms of the area. With an increase in operating capital to $19,117, the additional $10,717 has a return of 16.5 percent. This calculation ignores the fact that other resource inputs may be increased and also contribute to added income. If these other resources, particularly labor, have no alternative uses (i.e., a zero opportunity cost), then increased income is made possible only through use of more capital. Situations are discussed later where labor has profitable off-farm alternatives.

EFFECTS OF CHANGES IN CAPITAL AND EDUCATION OR TECHNIQUES

Referring to the 160-acre benchmark situation (part 1, table 12) the question may be asked: To what extent can educational programs contribute toward greater farm income? Part 3 of table 13 shows that with operating capital remaining at the benchmark level of $8,400, above-average management and adoption of new practices are estimated to raise income by $3,096 (i.e., to $3,667). Of course, a farmer cannot instantaneously change from an average to an above-average manager; both ability and desire are required for a successful transition. However, the figures indicate the possibilities for increasing incomes through educational work, for persons who have the qualifications for making the transition. Even greater income gains might be made by the benchmark farmer who secures additional capital and, in addition, makes use of educational opportunities afforded him. For example, in comparing part 1 in table 12 with part 6 in table 13, income increases by $4,444. This difference again indicates that capital and educational inputs can be complementary. Added capital is much more productive if it takes the form of improved techniques. This comparison assumes that, as capital is added (from part 1 of table 12 to part 6 of table 13), previous investment also is shifted to improved techniques.

The plans of table 13 and table 11 show the optimum farm organization for particular 160- and 80-acre farm situations studied. They include cattle feeding to make the most efficient use of labor and forage resources and suppose that the farmer is able to withstand frequent risks inherent in this type of operation. Some farmers would be reluctant to shoulder this amount of risk and would be financially unable to do so if large amounts of capital were to be borrowed. However, the purpose of this study is to provide, given typical resource restrictions, income expectations from the best possible farm plan. These incomes then might be compared with incomes from nonfarm employment opportunities.

TABLE 13. OPTIMUM PLANS FOR A 160-ACRE FARM, ASSUMING IMPROVED TECHNIQUES AND ABOVE-AVERAGE MANAGEMENT.

Operating capital	Optimum combinations of enterprises: Cropping plan			Crop acreage		Livestock		Corn purchased or sold	Limiting resources	Net income*
	Soil class	Rotation	Acres	Crop	Acres	Type	Number			
(1) 50% less than benchmark capital = $4,200	I	$CCSb_2$	27	Corn	40	2-litter hog system	15 litters	913 bu. sold	Soils I, II	$1,948
	II	$CSbCOM_2$	55	Soybeans	20				Capital	
	III	Cropland rented out†	45	Oats	11	Deferred-fed calves	4 head		Hog space	
		Permanent pasture	33	Hay‡	11					
(2) 25% less than benchmark capital = $6,300	I	$CCSb_2$	27	Corn	41	2-litter hog system	15 litters	63 bu. sold	Soils I, II	$3,032
	II	$CSbCOM_2$	55	Soybeans	20				Capital	
	III	COM_2	3	Oats	12	Deferred-fed calves	21 head		Hog space	
	III	Cropland rented out†	42	Hay‡	12				Hay	
		Permanent pasture	33							
(3) Benchmark capital = $8,400	I	$CCSb_2$	27	Corn	53	2-litter hog system	15 litters	232 bu. sold	Soils I, II	$3,667
	II	$CSbCOM_2$	55	Soybeans	20				Capital	
	III	COM_2	39	Oats	24	Deferred-fed calves	32 head		Hog space	
	III	Cropland rented out†	6	Hay‡	24				Hay	
		Permanent pasture	33							
(4) 25% greater than benchmark capital = $10,500	I	$CCSb_2$	27	Corn	55	Spring hog system	12 litters	86 bu. purchased	Soils I, II, III	$4,199
	II	$CSbCOM_2$	55	Soybeans	20				Capital	
	III	COM_2	45	Oats	26	Deferred-fed calves	10 head		Hog space	
		Permanent pasture	33	Hay‡	26				Feed grain	
						Calves on pasture	39 head		Hay	
(5) 50% greater than benchmark capital = $12,600	I	$CCSb_2$	27	Corn	60	Spring hog system	5 litters	466 bu. purchased	Soils I, II, III	$4,554
	II	$CCOM_2$	55	Soybeans	9				Capital	
	III	COM_2	45	Oats	29	2-litter hog system	9 litters		Hog space	
		Permanent pasture	33	Hay‡	29				Feed grain	
						Calves on pasture	62 head		Hay	
(6) Nonlimitational capital = $17,129	I	$CCSb_2$	15	Corn	52	2-litter hog system	15 litters	2,180 bu. purchased	Soils I, II, III	$5,015
	I	$CSbCOM_2$	12	Soybeans	8				May-June labor	
	II	$CCOMM_2$	55	Oats	28	Calves on pasture	80 head		Hog space	
	III	COM_2	45	Hay‡	39				Cattle space	
		Permanent pasture	33			Deferred-fed calves	2 head		Feed grain	
									Hay	

* Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).
† Cropland rented out at $6 per acre.
‡ Includes rotation pasture.

Finally, it should be remembered that the income figures of table 13 do not include a debit for interest paid on borrowed capital. If $20,000 were borrowed at 5 percent interest for real estate and working capital under part 6 of table 13, income would be decreased by $1,000. Many farmers have such interest payments, and income would be reduced accordingly, even under the optimum plans.

Profit-Maximizing Plans for 240-Acre Farms

Table 14 presents the farm plans and income for a 240-acre farm, assuming techniques currently used and average managerial ability. Restrictions parallel those for the 80- and 160-acre situations of tables 10 and 12, except that operating capital and building space are increased corresponding with farm size. The benchmark plan for the 240-acre farm (part 1, table 14) is similar to the plans for the 80- and 160-acre benchmark situations (parts 1, in tables 10 and 12). The same beef cattle enterprises enter the plan, but on a larger scale because they use forage while making the most efficient use of the limited feed grain supply (as compared with hogs which use little forage). However, when capital is nonlimitational (part 2, table 14) corn is purchased, and 16 litters of pigs are included in the plan. Spring pigs outcompete the 2-litter hog enterprise in this plan because the former require less of the limiting fall labor supply. Sufficient capital is available to expand beef cattle production to the limits of building space. Calves fed on pasture replace beef cows in this plan because they give highest returns for limited building space.

Table 15 summarizes the optimum farm organizations for various capital levels under improved techniques and above-average management. These plans are not discussed in detail because their pattern is similar to those for the 80- and 160-acre situations (see tables 11 and 13). The principal difference is this: Labor restrictions for a 240-acre farm play a more important role in determining the final organization and account for the complex cropping plans which appear in table 15. In practice, the farmer following these plans would probably attempt to plant acreages of each crop consistent with those shown rather than exactly following the rotation scheme presented.

Modification of the farm plans presented in tables 11, 13 and 15 might be made in view of risk and uncertainty considerations. For example, considerable risk is associated with the large beef-feeding enterprises shown for high capital levels. While these beef enterprises are considered quite safe relative to feeding heavy cattle, they normally embody more risk than production of dairy cattle, hogs and crops. Thus, some farmers might prefer to incorporate risk precautions, in the form of diversification and/or low risk enterprises, into their plans. Here again, the interest payments on any capital which might be borrowed have not been subtracted in computing the income figures of tables 14 and 15.

EFFECTS OF CHANGES IN CAPITAL WITH MANAGEMENT AND TECHNOLOGY CONSTANT

Table 14 shows that the income of a 240-acre farm might be doubled if operating capital were made a nonrestricting resource, starting from the benchmark level of $12,600. As farm size is increased from 80 to 160 to 240 acres, a smaller percentage increase in farm income occurs as operating capital is increased from the benchmark to the nonlimitational level in each case. However, the additional return per dollar of additional operating capital used remains relatively constant for the three farm sizes. Starting from the various benchmark situations, increases in income through use of more capital alone require sizable purchases of corn. Some farmers might restrict purchase of corn and the livestock plan accordingly as a risk consideration. This procedure would result in sacrifices in income since the plans shown maximize incomes, given the current cropping system and resource restrictions.

EFFECTS OF CHANGES IN CAPITAL AND EDUCATION OR TECHNIQUES

Through use of improved techniques and greater managerial ability, the 240-acre farmer can increase income from approximately $1,633 to $6,087 (compare part 1, table 14 and part 3, table 15). For all three farm sizes, improved management and techniques, with operating capital held constant, result in sizable income increases. It should be recognized, however, that the *form* of operating capital used is often changed with the adoption of improved techniques. Many new practices require no more capital than currently used practices. As examples, new seed varieties and improved livestock rations require little, if any, increase in expenditure. Improved low-cost practices, along with greater managerial ability, account for the increases in incomes shown. Too, resources other than capital are more fully utilized under situations of improved technology and above-average management.

Use of improved techniques, if accompanied by increased capital, may increase income to $7,252 (part 6, table 15). Additional profits are limited by labor restrictions for crops and livestock. Many farmers undoubtedly possess the operating capital and managerial ability to profitably employ hired labor. Returns on additional part-time hired labor in restrictive months may be exceptionally high. Some 240-acre farmers might maximize income by hiring labor year-around and greatly intensifying the livestock program. Such plans, however, involve high risk. Since emphasis in this study is on comparative returns from only a family labor supply, situations using hired labor are not employed.

The preceding results show that farmers in the benchmark situations increase incomes through joint utilization of more capital and improved technology. Ordinarily, however, farmers can obtain funds from lending agencies only in amounts

TABLE 14. PLANS FOR A 240-ACRE FARM, ASSUMING CURRENT TECHNIQUES AND AVERAGE MANAGEMENT.

Operating capital	Optimum combinations of enterprises: Typical cropping plan* — Crops	Acres	Livestock — Type	Number	Corn purchased or sold	Limiting resources	Net income†
(1) Benchmark capital = $12,600	Corn	53	Deferred-fed calves	41 head	None	Land	$1,633
	Oats	24				Capital	
	Hay‡	113	Beef cow herd	28 head		Feed grain	
	Permanent pasture	50					
(2) Nonlimitational capital = $24,287	Corn	53	Deferred-fed calves	45 head	5,056 bu. purchased	Land	$3,479
	Oats	24				Hog space	
	Hay‡	113	Calves on pasture	66 head		Cattle space	
	Permanent pasture	50				Feed grain	
			Spring hog system	16 litters		Sept.-Oct.-Nov. labor	

* Proportions of various crops and yields from Iowa Farm Census data for 1949-53.

† Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

‡ Includes rotation pasture.

TABLE 15. OPTIMUM PLANS FOR A 240-ACRE FARM, ASSUMING IMPROVED TECHNIQUES AND ABOVE-AVERAGE MANAGEMENT.

Operating capital	Cropping plan — Soil class	Rotation	Acres	Crop acreage — Crop	Acres	Livestock — Type	Number	Corn purchased or sold	Limiting resources	Net income*
(1) 50% less than benchmark capital = $6,300	I	CCSb$_2$	40	Corn	61	2-litter hog system	18 litters	1,568 bu. sold	Soils I, II	$3,612
	II	CSbCOM$_2$	83	Soybeans	30				Capital	
	III	Cropland rented out†	67	Oats	16	Deferred-fed calves	10 head		Hog space	
		Permanent pasture	50	Hay‡	16					
(2) 25% less than benchmark capital = $9,450	I	CCSb$_2$	40	Corn	64	2-litter hog system	18 litters	518 bu. sold	Soils I, II	$5,146
	II	CSbCOM$_2$	83	Soybeans	30				Capital	
	III	COM$_2$	11	Oats	20	Deferred-fed calves	34 head		Hog space	
	III	Cropland rented out†	56	Hay‡	20				Hay	
		Permanent pasture	50							
(3) Benchmark capital = $12,600	I	CCSb$_2$	40	Corn	82	2-litter hog system	18 litters	772 bu. sold	Soils I, II, III	$6,087
	II	CCOMM$_2$	83	Soybeans	14				Capital	
	III	COM$_2$	67	Oats	39	Deferred-fed calves	51 head		Hog space	
		Permanent pasture	50	Hay‡	55				Hay	
(4) 25% greater than benchmark capital = $15,750	I	CCSb$_2$	40	Corn	82	2-litter hog system	18 litters	282 bu. purchased	Soils I, II, III	$6,929
	II	CCOMM$_2$	83	Soybeans	14				Capital	
	III	COM$_2$	67	Oats	39	Deferred-fed calves	18 head		Hog space	
		Permanent pasture	50	Hay‡	55				May-June labor	
						Calves on pasture	57 head		Feed grain	
									Hay	
(5) 50% greater than benchmark capital = $18,900	I	CCSb$_2$	40	Corn	82	2-litter hog system	4 litters	929 bu. purchased	Soils I, II, III	$7,231
	II	CCOMM$_2$	77	Soybeans	15				Capital	
	II	CSbCOM$_2$	6	Oats	39	Deferred-fed calves	31 head		Hog space	
	III	COM$_2$	67	Hay‡	54				May-June labor	
		Permanent pasture	50			Spring hog system	11 litters		Sept.-Oct.-Nov. labor	
						Calves on pasture	64 head		Feed grain	
									Hay	
(6) Nonlimitational capital = $20,669	I	CCSb$_2$	5	Corn	74	Spring hog system	15 litters	1,517 bu. purchased	Soils I, II, III	$7,252
	I	CSbCOM$_2$	28	Soybeans	7				May-June labor	
	I	CCOM$_2$	7	Oats	46	Deferred-fed calves	34 head		July-Aug. labor	
	II	CCOMM$_2$	83	Hay‡	63				Sept.-Oct.-Nov. labor	
	III	COM$_2$	67			Calves on pasture	70 head		Hog space	
		Permanent pasture	50						Feed grain	
									Hay	

* Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

† Cropland rented out at $6 per acre.

‡ Includes rotation pasture.

commensurate with the security offered. Farmers lacking the required security are forced to adopt only "noncapital using" improvements in techniques, even though returns on additional capital would be high. Reluctance by credit agencies to base loans on potential productivity, rather than on security, has recently diminished in some areas. Still, many farmers with high potential returns cannot obtain sufficient capital. Thus, the benchmark farmer may be restricted to adoption of proven low-cost techniques as immediate means of raising income. With capital accumulation, additional funds may be obtained, resulting in further income increases. A few farmers may refuse to borrow capital—even though it is available—for productive purposes because of uncertainty or community attitudes. Education may help in overcoming such obstacles to improvements in the level of farm income.

AGGREGATIVE IMPLICATIONS OF GREATER USE OF CAPITAL AND IMPROVED TECHNOLOGY

The preceding results indicate that southern Iowa farm incomes can be increased through greater capital use, improved technology or both. Reorganization of southern Iowa farms along the lines indicated in this study would increase aggregate farm output relatively little. However, widespread adoption of new technology throughout the farm economy may increase output substantially. With an inelastic demand for farm products, total returns to the agricultural sector decrease with greater output. Hence, what is the justification for encouraging courses of action which would, if generally adopted, decrease aggregate farm income? First, the information presented in this study is of importance for low income families in southern Iowa. An increase in the level of living for low income families is apparently desired by society. Second, society indicates a desire for economic progress. Technological developments which allow the same or greater agricultural production from fewer resources contribute to economic progress by releasing other resources for production of nonsubsistence goods. Thus, economic progress may result in lower returns to the farm sector of the economy. Recognition by society that one sector of the economy may suffer in the process of general economic progress is evident from recent legislation designed to support farm incomes. A more comprehensive discussion of the role of agricultural research and education in economic growth is presented elsewhere and will not be undertaken here.[13]

OPTIMUM "FAMILY-SIZE" FARM IN THE SHELBY-GRUNDY-HAIG SOIL AREA

Census data indicate that consolidation of farms into larger, more efficient units has been taking place continuously for several decades. This section is devoted to analysis of the optimum, or most profitable, farm size when plans are restricted to labor of the family alone. This restriction is used since most farms will, in the near future, be limited by the family labor supply. Too, comparison of farm and nonfarm income opportunities best apply to this group. Larger farms using hired labor are not uncommon in this area. Operators on these units generally have larger incomes than farmers restricted to the family labor supply and are less likely to be concerned with opportunities of shifting between occupations. Hence, in this section, land restrictions are lifted for 160- and 240-acre farms. The optimum farm size when restricted only by family labor is then determined.

The method used for estimating the optimum, or most profitable, farm size for plans restricted to the family labor supply consists of assuming an owned farm of fixed size, then permitting farm size to expand through rental of additional land. Using the linear programming technique, additional land is permitted to be rented only if this is the most profitable use of limited labor and other resources. The two basic farm situations used in predicting the optimum farm size for a family labor supply are as follows:

(1) The basic farm acreage (either 160 or 240 acres) is owned and operated under above-average management and improved technology. Additional land may be rented at $8.90 per acre; this land has the same proportions of soil classes I, II, III and permanent pasture land as the owned land. At the outset, the operator has a benchmark quantity of operating capital, but can borrow additional capital at 5 percent. The optimum farm plan is limited mainly by two resources: (a) operator and family labor and (b) livestock buildings available on the basic farm acreage (i.e., on the 160- or 240-acre farm).[14]

(2) This situation parallels that in (1) above, except that building space for livestock is nonlimitational. Thus, family labor forms the main restriction of farm size.[15]

Optimum Farm Size With Family Labor and Building Space Restrictional

Linear programming was used in determining the optimum farm size (with either 160 acres or 240 acres at the outset) given the restrictions of family labor and building space. Table 16 shows that, starting from an owner-operated 160-acre farm, the optimum farm size is 261 acres of cropland and permanent pasture, 101 acres of which are rented. In addition to the benchmark level of operating capital, $7,571 is borrowed to allow operation of the rented 101 acres and expansion of the beef enterprises. Labor supplies in several

[13] See: Heady, Earl O. Adaptation of extension education and auxiliary aids to the basic economic problems of agriculture. Jour. Farm Econ. 39:112-27 Feb. 1957.

[14] Of course, forage grown on the farm is also limitational; feed grain and land are limitational in the sense that they will be purchased or rented, respectively, only if these are profitable procedures.

[15] Same as footnote 14.

months, along with limited forage supplies and hog space, restrict farm size and profits. Existence of a dependable market for hay would allow farm size and profits to further expand. Larger farms also could be obtained by hiring labor; however, farm size is determined here in terms of optimum size for a family labor supply.

Table 16 indicates that the optimum farm size differs little when 240 acres rather than 160 acres are owned at the outset. Three more litters of hogs are produced starting from 240 acres because of greater hog building space; otherwise the crop and livestock plans are practically identical. Less capital is borrowed starting from 240 acres and, as expected, income is greater. The family labor supply ultimately limits farm size and profits in both situations. Hence, farmers with relatively large family labor supplies, or farmers who make very efficient use of labor, could expand farm size profitably beyond 260 acres, given the other resource restrictions. Optimum farm size as derived here also relates to the size or scale of farm machinery used. For instance, substitution of machinery for labor should allow farm size to expand.

Table 16 shows that farmers with a benchmark quantity of operating capital ordinarily maximize profits through expansion of farm size, if funds may be borrowed and land is available for rental. These results indicate that the trend toward larger farm units will probably continue in the soil area studied, forcing migration of some farm workers to other types of employment. A later section treats this subject more fully.

Optimum Farm Size Using Only Family Labor, With Building Space Nonrestricting

The plans of table 16 were limited mainly by family labor and livestock building space. For other farms of the area, even livestock buildings may not be a limitational resource. Thus, the plans of table 17 are derived with building restrictions lifted, leaving only labor as a limiting resource. That is, optimum farm size and profits are given where all resources except labor are variable. With only labor restrictional, however, maximum profits result from intensification of livestock production on the given farm acreage (either 160 or 240 acres) rather than from renting additional land. Production of spring pigs expands to 110 and 85 litters for the 160- and 240-acre situations, respectively, because hog building restrictions are removed.

With labor the main restriction, incomes are maximized with the plans of table 17. However, many farmers undoubtedly would prefer acreage expansion rather than intensification of hog production to the extent shown. Relatively few farmers can manage successfully a swine enterprise of this size—problems of disease and feeding are greatly magnified. Too, all hogs produced under the spring system are marketed at about the same date; low fall hog prices would greatly de-

TABLE 16. OPTIMUM FARM SIZE AND FARM PLANS WITH ONLY FAMILY LABOR AVAILABLE WHERE (1) 160 ACRES ARE OWNED AND ADDITIONAL LAND MAY BE RENTED, AND (2) 240 ACRES ARE OWNED AND ADDITIONAL LAND MAY BE RENTED.*

Operating capital		Optimum combinations of enterprises											
		Cropping plan							Livestock				
Owned capital	Borrowed capital†	Soil class	Rotation	Total acreage		Owned acreage		Rented acreage‡	Type	Number	Corn purchased or sold	Limiting resources	Net income§
(1) Benchmark capital = $8,400	$7,571	I	$CCSb_2$	44	=	27	+	17	2-litter hog system	15 litters	103 bu. sold	May-June labor Sept.-Oct.-Nov. labor Hog space Hay	$6,450
		II	$CSbCOM_2$	90	=	55	+	35					
		III	COM_2	73	=	45	+	28	Deferred-fed calves	25 head			
		Permanent pasture		54	=	33	+	21					
Total = $15,971		Total acreage		261	=	160	+	101	Calves on pasture	55 head			
(2) Benchmark capital = $12,600	$3,466	I	$CCSb_2$	43	=	40	+	3	2-litter hog system	18 litters	65 bu. purchased	May-June labor Sept.-Oct.-Nov. labor Hog space Hay	$6,912
		II	$CSbCOM_2$	89	=	83	+	6					
		III	COM_2	72	=	67	+	5	Deferred-fed calves	24 head			
		Permanent pasture		53	=	50	+	3					
Total = $16,066		Total acreage		257	=	240	+	17	Calves on pasture	54 head			

* Assumes above-average management and use of improved technology, family labor supply and building space for benchmark situations.
† Interest rate is 5 percent.
‡ Land is rented for $8.90 per acre.
§ Net income = gross farm income — (variable costs + taxes + insurance + building repairs + depreciation on machinery + depreciation on buildings).

TABLE 17. OPTIMUM FARM SIZE AND FARM PLANS WITH ONLY FAMILY LABOR AVAILABLE AND ASSUMING NONLIMITATIONAL LIVESTOCK BUILDING SPACE WHERE (1) 160 ACRES ARE OWNED AND ADDITIONAL LAND MAY BE RENTED AND (2) 240 ACRES ARE OWNED AND ADDITIONAL LAND MAY BE RENTED.*

Operating capital		Optimum combinations of enterprises									
		Cropping plan					Livestock				
Owned capital	Borrowed capital†	Soil class	Rotation	Total acreage	Owned acreage	Rented acreage‡	Type	Number	Corn purchased or sold	Limiting resources	Net income§
(1) Benchmark capital = $8,400	$20,276	I	$CCSb_2$	27	27	0	Spring hog system	110 litters	7,264 bu. purchased	Sept.-Oct.-Nov. labor Hay	$9,714
		II	$CSbCOM_2$	55	55	0	Beef cow herd	4 head			
		III	COM_2	45	45	0					
		Permanent pasture		33	33	0					
Total = $28,676		Total acreage		160	160	0					
(2) Benchmark capital = $12,600	$10,645	I	$CCSb_2$	40	40	0	Spring hog system	85 litters	2,956 bu. purchased	Sept.-Oct.-Nov. labor Hay	$10,357
		II	$CSbCOM_2$	83	83	0	Beef cow herd	16 head			
		III	COM_2	67	67	0					
		Permanent pasture		50	50	0					
Total = $23,246		Total acreage		240	240	0					

* Assumes above-average management and use of improved technology and family labor supply.
† Interest rate is 5 percent.
‡ Land is rented for $8.90 per acre.
§ Net income = gross farm income — (variable costs + insurance + building repairs + depreciation on machinery + depreciation on buildings).

press farm incomes. Thus, while the plans of table 17 result in maximum average income, annual variability in income might be relatively high. Previous studies show that, for many farmers, low income variability may be more important than level of income.[16] Relatively high levels of borrowed capital also increase the risk associated with plans in table 17. However, farmers with low risk aversion, or those with high levels of operating capital, may prefer to intensify livestock production while maintaining the present farm size. For these farmers, the high mean income may be more important than greater variability in income.

Few farmers in the area studied are in a position where labor is the only restricting farm resource. Generally, limited capital and a relatively fixed building supply combine with labor restrictions to limit farm plans and profits. Hence, probably more farmers look toward expansion of farm size (table 16) rather than intensification of livestock production (table 17) as a method of increasing farm profits. Dissatisfaction with present farm income levels and pressure for increased farm size suggest a need for discussion of alternative employment opportunities.

OPTIMUM FARM PLANS FOR OPERATORS WITH OFF-FARM JOBS

Many farm families are dissatisfied with the level of income from farming alone and wish to supplement this income. Consequently, an increasing number of farm operators in the area studied are being employed off-farm on a part- or full-time basis. Some individuals will cease farming and shift to full-time urban employment at comparable incomes if such employment is available. Others require some premium for shifting to nonfarm work. The plans in this section concern that group which are employed off-farm, yet wish to continue living on the farm and use their remaining labor and other resources in farming. That is, the farm plans indicate optimum organization of the limited labor available for farming with capital and other resources. Plans are shown only for farms which ordinarily have excess labor (i.e., 80- and 160-acre farms). Returns from these plans will be used in later comparisons of alternative income opportunities for farmers of the area.

Optimum Farm Plans for Operators With Part-Time Off-Farm Jobs

A part-time off-farm job of 5.5 hours per day, 5 days a week (including commuting time) is assumed; the remaining labor supply is available for farm work as shown in table 2. Further de-

[16] See: Heady, Earl O., Hildreth, R. J. and Dean, Gerald W. Uncertainty, expectations and investment decisions for a sample of central Iowa farmers. Iowa Agr. Exp. Sta. Res. Bul. 447. 1957.

tails of the off-farm job are given later, since at this point emphasis is on the best possible farm plan, given that the operator has outside employment. Of course, other forms of part-time work are possible, such as off-farm employment only during winter months or in other seasons. Because of their diversity, however, such arrangements are not investigated.

Farmers on 80 acres, whether average or above-average managers, can hold part-time jobs as described above without restriction in farm plans or income. Sufficient labor exists in all months for both farming and part-time employment, even with nonrestrictional capital. Clearly, the 80-acre operator can increase total income by assuming a part-time off-farm job. His farm plans and farm income remain constant whether he works off-farm part-time or not. Optimum farm plans for this situation were presented in tables 10 and 11.

When farm size is 160 acres, some farm income must be sacrificed to allow part-time off-farm work (see table 18). Comparison of incomes in table 18 with those of tables 12 and 13 show that little decline in farm income results from the decrease in labor available for farming.[17] Shifts toward enterprises with lower labor requirements in restrictive months is indicated. For example, spring pigs, because of their low fall labor requirement, replace the 2-litter hog system. No other major shift in farm plans is required to accommodate the part-time off-farm job under either management condition of table 18. Again, most 160-acre farm operators can increase total income with a part-time job in addition to farming.

Optimum Farm Plans for Operators With Full-Time Off-Farm Jobs

Part-time work is not always available to farmers. Often the operator must take a full-time off-farm job or forego off-farm employment entirely. A full-time off-farm job is assumed for 40 hours per week plus commuting time. The labor remaining for farm work when the operator has a full-time off-farm job is presented in table 2.

Table 19 shows that, even on 80 acres, the farm labor supply becomes restricting in several months when the operator works off-farm on a full-time basis. However, adjustments in 80-acre farm plans allowing more efficient use of labor permit farm income to remain at nearly the same level as when the operator farms full-time. Part 1, table 19 may be compared with part 2, table 10 for changes in farm plans and incomes when an average manager of 80 acres takes a full-time off-farm job in addition to farming. With a full-time off-farm job, the livestock plan shifts toward enterprises which use labor more efficiently in restricting months. For example, spring pigs replace the 2-litter hog system, and beef cows enter the plan. However,

[17] Since the capital levels of tables 12 and 13 do not correspond exactly with those of table 18, precise comparisons are not possible. Close approximations can be made, however, by interpolation in tables 12 and 13.

TABLE 18. OPTIMUM FARM PLANS AND INCOME WHEN OPERATOR HOLDS A PART-TIME OFF-FARM JOB UNDER TWO SITUATIONS.

Farm situation	Optimum combination of enterprises: Cropping plan			Crop acreage		Livestock		Corn purchased or sold	Limiting resources	Net income*
	Soil class	Rotation	Acres	Crop	Acres	Type	Number			
(1) 160 acres Average management Nonlimitational capital = $12,735	"Typical" cropping pattern			Corn Oats Hay†	35 16 75	Spring hog system Deferred-fed calves Beef cow herd	13 litters 36 head 14 head	1,872 bu. purchased	Land Hog space Sept.-Oct.-Nov. labor Feed grain Hay	$1,446
(2) 160 acres Above-average management Nonlimitational capital = $11,346	I II III	$CCOM_2$ $CSbCOM_2$ COM_2 Permanent pasture	27 55 45 33	Corn Soybeans Oats Hay†	50 11 33 33	Spring hog system Deferred-fed calves Calves on pasture Beef cow herd	12 litters 10 head 42 head 2 head	253 bu. purchased	Soils I, II, III May-June labor Sept.-Oct.-Nov. labor Hog space Feed grain Hay	$4,098

* Net income = gross income — (variable costs + depreciation on machinery + depreciation on buildings + taxes + insurance + building repairs).

† Includes rotation pasture.

TABLE 19. OPTIMUM FARM PLANS AND INCOME WHEN OPERATOR HOLDS A FULL-TIME OFF-FARM JOB UNDER FOUR SITUATIONS.

Farm situation	Optimum combination of enterprises: Cropping plan			Crop acreage		Livestock		Corn purchased or sold	Limiting resources	Net income*
	Soil class	Rotation	Acres	Crop	Acres	Type	Number			
(1) 80 acres Average management Nonlimitational capital = $10,738	"Typical" cropping pattern			Corn Oats Hay†	18 8 37	Spring hog system Calves on pasture Deferred-fed calves Beef cow herd	11 litters 16 head 13 head 4 head	2,071 bu. purchased	Land July-Aug. labor Sept.-Oct.-Nov. labor Hog space Feed grain Hay	$ 695
(2) 80 acres Above-average management Nonlimitational capital = $6,447	I II II III	$CCSb_2$ $CCOMM_2$ $CCOM_2$ COM_2 Permanent pasture	13 19 9 22 17	Corn Soybeans Oats Hay†	28 4 14 17	Spring hog system Calves on pasture Deferred-fed calves	10 litters 14 head 12 head	404 bu. purchased	Soils I, II, III July-Aug. labor Sept.-Oct.-Nov. labor Hog space Feed grain Hay	$1,938
(3) 160 acres Average management Nonlimitational capital = $8,760	"Typical" cropping pattern			Corn Oats Hay†	35 16 75	Spring hog system Deferred-fed calves Beef cow herd	5 litters 8 head 28 head	364 bu. purchased	Land July-Aug. labor Sept.-Oct.-Nov. labor Hay	$ 533
(4) 160 acres Above-average management Nonlimitational capital = $6,427	I II II III III	$CCSb_2$ $CSbCOM_2$ $CSbCOM_2$ COM_2 Cropland rented out‡ Permanent pasture	17 10 55 17 28 33	Corn Soybeans Oats Hay†	43 19 19 20	Spring hog system Deferred-fed calves Beef cow herd	12 litters 1 head 12 head	1,584 bu. sold	Soils I, II May-June labor July-Aug. labor Sept.-Oct.-Nov. labor Hog space Hay	$2,394

* Net income = gross income — (variable costs + depreciation on machinery + depreciation on buildings + taxes + insurance + building repairs).
† Includes rotation pasture.
‡ Cropland rented out at $6.00 per acre.

income declines relatively little—from $836 to $695.

Part 2, table 19, compared with part 5, table 11, indicates shifts in farm plans and incomes when an above-average manager on 80 acres takes a full-time off-farm job. Here the major change in livestock plans is from calves fed on pasture to deferred-fed calves; the latter have higher returns to labor in all months. Again, income is maintained at high levels with the shift in plans. These results indicate that farmers on 80 acres, whether average or above-average managers, can assume a full-time off-farm job with little sacrifice in farm income if appropriate adjustments are made in farm plans.

Comparison of part 3, table 19, and part 1, table 12, indicates changes in farm plans and income when an average manager of 160 acres takes a full-time off-farm job. The results are similar to those for 80 acres: By shifting toward enterprises with high returns to labor, farm income is nearly maintained. Part 4, table 19, compared with part 2, table 13, shows changes in farm plans and income when a 160-acre farmer with above-average managerial ability has a full-time off-farm job. Again, a shift occurs toward livestock enterprises with low labor requirements. However, an important difference is noted between this and previous situations: A sizable sacrifice in farm income results from using labor off-farm. Hence, the off-farm wage rate becomes important because it must be sufficiently large to compensate for sacrifices in farm income. Detailed comparisons of incomes from various alternatives are discussed below.

ALTERNATIVE INCOME OPPORTUNITIES FOR FARMERS IN THE SHELBY-GRUNDY-HAIG SOIL AREA

Many farm families in the soil area studied are faced each year with the task of increasing, or sometimes maintaining, relatively low incomes. Three broad employment alternatives exist for these families: (1) devote full-time to farming, (2) work part- or full-time in nonfarm employment and use remaining labor for farming or (3) sell the farm and move to full-time nonfarm employment. A decision among these alternatives is clear-cut on economic grounds alone: Simply select the occupation, among those available, with the highest real income. However, economic forces alone ordinarily do not determine the choice of employment. Closeness to friends and relatives, church affiliation and preference for farm living are among noneconomic forces retarding transfer of farmers to higher-paying nonfarm occupations. Such factors must be weighed, along with income, by individual farm families in making decisions regarding employment.

Comparison of Incomes From Farming and Nonfarming Opportunities

In making employment decisions, many farmers

TABLE 20. COMPARISON OF FARM AND NONFARM "REAL" INCOMES FOR VARIOUS FARM SITUATIONS AND NONFARM WAGE RATES.[a]

Farm size (acres)	Management	Operating capital used[b]	Farm net income[c]	Home used produce[d]	Annual salary at various hourly wage rates[e]			Housing[f]	Interest on capital[g]	"Real" nonfarm income at various hourly wage rates[h]			"Real" farm income[i]
					$1.35	$1.90	$2.45			$1.35	$1.90	$2.45	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
80	Average	$ 4,200	$ —139	$ 464	$ 2,808	$ 3,952	$ 5,096	$ 960	$ 815	$2,663	$3,807	$4,951	$ 325
80	Average	10,738	836	464	$ 2,808	$ 3,952	$ 5,096	960	1.077	2,925	4,069	5,213	1,300
80	Above-average	2,100	591	464	$ 2,808	$ 3,952	$ 5,096	960	731	2,579	3,723	4,867	1,055
80	Above-average	3,150	1,178	464	$ 2,808	$ 3,952	$ 5,096	960	773	2,621	3,765	4,909	1.642
80	Above-average	4,200	1,536	464	$ 2,808	$ 3.952	$ 5,096	960	815	2,663	3,807	4,951	2,000
80	Above-average	5,250	1,803	464	$ 2,808	$ 3,952	$ 5,096	960	857	2,705	3,849	4.993	2,267
80	Above-average	6,300	1,991	464	$ 2,808	$ 3,952	$ 5,096	960	899	2,747	3.891	5,035	2,455
80	Above-average	9,292	2,349	464	$ 2,808	$ 3,952	$ 5,096	960	1,019	2,867	4,011	5,155	2,813
160	Average	8,400	571	490	$ 2,808	$ 3,952	$ 5,096	960	1.515	3,363	4,507	5.651	1,061
160	Average	19,117	2,340	490	$ 2,808	$ 3,952	$ 5,096	960	1.943	3,791	4,935	6,079	2,830
160	Above-average	4,200	1,948	490	$ 2,808	$ 3,952	$ 5,096	960	1,347	3,195	4,339	5,483	2,438
160	Above-average	6,300	3,032	490	$ 2,808	$ 3,952	$ 5,096	960	1,431	3,279	4,423	5,567	3,522
160	Above-average	8,400	3,667	490	$ 2,808	$ 3,952	$ 5,096	960	1,515	3,363	4,507	5,651	4,157
160	Above-average	10,500	4.199	490	$ 2,808	$ 3,952	$ 5,096	960	1,599	3,447	4,591	5,735	4,689
160	Above-average	12,600	4,554	490	$ 2,808	$ 3,952	$ 5,096	960	1,683	3,531	4,675	5,819	5,044
160	Above-average	17,129	5,015	490	$ 2,808	$ 3,952	$ 5,096	960	1,864	3,712	4,856	6,000	5,505
240	Average	12,600	1,633	430	$ 2,808	$ 3,952	$ 5,096	960	2,208	4,056	5,200	6,344	2,063
240	Average	24,287	3,479	430	$ 2,808	$ 3,952	$ 5,096	960	2.675	4.523	5,667	6,811	3,909
240	Above-average	6,300	3,612	430	$ 2,808	$ 3,952	$ 5,096	960	1,956	3,804	4.948	6,092	4,042
240	Above-average	9,450	5,146	430	$ 2,808	$ 3.952	$ 5,096	960	2.082	3,930	5,074	6,218	5,576
240	Above-average	12,600	6,087	430	$ 2,808	$ 3,952	$ 5,096	960	2,208	4,056	5,200	6,344	6,517
240	Above-average	15,750	6,929	430	$ 2,808	$ 3,952	$ 5,096	960	2.334	4,182	5,326	6,470	7,359
240	Above-average	18,900	7,231	430	$ 2,808	$ 3,952	$ 5,096	960	2.460	4,308	5,452	6,596	7,661
240	Above-average	20,669	7,252	430	$ 2,808	$ 3,952	$ 5,096	960	2,531	4,379	5,523	6,667	7,682

[a] Farm situations correspond, in order, to those in tables 10, 11, 12, 13, 14 and 15. "Real" income is defined in subsequent footnotes.

[b] Includes capital required for variable costs. Does not include investment in machinery and equipment or the value of land and buildings. Investment in machinery and equipment is as follows: 80 acres—$3,585; 160 acres—$4,270; 240 acres—$4,800. Land and buildings are valued at $157 per acre.

[c] Farm net income determined by linear programming (see tables 10 through 15).

[d] From the "1955 Iowa Farm Record Summary" for southern Iowa pasture area.

[e] Estimates of hourly wage rates in Des Moines, Iowa obtained from the Iowa Employment Security Commission. Hourly wages of $1.35 are common as starting pay for male factory workers; wages of $2.45 per hour are common for union construction labor; wages of $1.90 are an intermediate level of earning. Annual salary based on a 40-hour week.

[f] The Iowa Employment Security Commission estimates rent on a 2-bedroom apartment at $80-$95 per month with all or part of the utilities paid. To approximate average rent without utilities, the lower figure of $80 per month was selected.

[g] Interest at 4 percent on capital formerly used in farming. Includes operating capital used in farming (col. 3) + value of machinery and equipment + value of land and buildings (see footnote b).

[h] "Real" nonfarm income (cols. 11, 12, 13) = annual salary (cols. 6, 7, 8) — housing cost (col. 9) + interest on capital (col. 10).

[i] "Real" farm income (col. 14) = farm net income (col. 4) + home used produce (col. 5).

rule out part-time farming as undesirable because of the commuting problem. Hence, the first comparison made is simply one of income in full-time farming versus urban income (see table 20). The optimum farm plans developed earlier (tables 10 through 15) are used in predicting farm incomes under various resource situations. These farm incomes, adjusted for the value of home-used products, are compared with three levels of urban income based, in turn, on wage rates of $1.35, $1.90 and $2.45 per hour.[18] The nonfarm incomes are adjusted for housing expenses and interest on capital formerly used in farming. Thus, income from labor and capital used in farming is compared with income from the same resources when employed in various nonfarm uses (see columns 11, 12, 13 and 14, table 20 for adjusted comparative incomes).

Table 20 shows that a farmer with only 80 acres will increase income by moving to nonfarm employment, even at a wage rate of only $1.35 per hour. This result holds even for operators with above-average managerial ability and a nonlimitational level of operating capital. Thus, 80-acre farmers must sacrifice income to remain in farming unless they do additional off-farm work; the amount of sacrifice depends on the operator's managerial ability and level of operating capital. Furthermore, average managers, regardless of farm size (80, 160 or 240 acres) or capital level, increase profits by moving to nonfarm employment, even at $1.35 per hour.

When 160 acres or more are operated under above-average management, the level of available operating capital determines whether higher profits are possible in nonfarm employment. For example, a 160-acre farmer with above-average managerial ability and 50 percent less than benchmark capital ($4,200) needs only $1.35 per hour to make nonfarm employment more profitable than farming. However, the same farmer with a benchmark level of operating capital ($8,400) requires $1.90 per hour before nonfarm income is higher; with nonlimitational capital, he needs $2.45 per hour to make urban work more profitable. When farm size is increased to 240 acres, an above-average manager with benchmark operating capital ($12,600) or above maximizes profits in farming, even with a possible nonfarm wage rate of $2.45 per hour. Thus, employment decisions by particular farmers depend not only on their managerial ability and resources used in farming, but also on their capabilities and opportunities in nonfarm jobs. An important factor influencing the employment decision may be that fewer total working hours per year are required on the nonfarm job compared with most of the farm situations studied.

These results show that farmers with average managerial ability obtain higher returns on labor and other resources in nonfarm employment, even at the unskilled wage rate of $1.35. Many of these farmers, however, reject nonfarm jobs which yield comparable or higher incomes. Lack of training often restricts nonfarm opportunities to jobs which, in the eyes of farmers, lack the prestige associated with farm entrepreneurship. Also, nonfarm jobs at any wage rate may be scarce. Unfortunately, farmers with the lowest incomes often cannot compete effectively with others for scarce nonfarm employment.

Comparison of Incomes From Farming, Nonfarm Work and Part-Time Farming

Earier discussion suggested part-time farming (i.e., combining off-farm work with farming) as a promising method for increasing farm family incomes in the soil area studied. Hence, incomes from this alternative are compared with incomes from farming alone and from full-time urban employment. The data and footnotes of table 21 give details of computing incomes from farming alone and from part-time farming alternatives; these incomes, and those from urban employment (see table 20), are summarized in table 22.

Table 22 indicates that 80-acre farmers with average management and benchmark operating capital ($4,200) would maximize income by moving to full-time nonfarm employment; at full-time off-farm wage rates of $1.35, $1.90 or $2.45 per hour their most profitable alternative is to direct all resources to nonfarm uses. However, 80-acre farmers with average managerial ability but nonlimitational capital ($10,738) would maximize income by combining a full-time off-farm job with farming. The latter result also follows for above-average managers on 80 acres with benchmark ($4,200) or nonlimitational operating capital ($9,-292). Of course, wage differentials might alter the income advantage. For example, an individual who lives in town and devotes full attention to a nonfarm job may advance more rapidly and command higher wages than if he holds the same job but maintains his major interest in farming.[19]

An average manager of 160 acres maximizes income by moving to nonfarm employment at any of the three wage rates shown in table 22. An above-average manager of 160 acres with nonlimitational operating capital ($17,129) maximizes income by combining farming with a full-time off-farm job if wages are $1.90 or $2.45 per hour. At wages of only $1.35 per hour on a full-time off-farm job, however, this operator obtains a higher

[18] Nonfarm wage rates in Des Moines, Iowa, were estimated by the Iowa Employment Security Commission. Hourly wages of $1.35 are common in Des Moines as starting pay for unskilled factory workers; wages range up to $2.45 per hour and more for construction labor. An hourly rate of $1.90 was selected as an intermediate wage level. These figures represent probable wages for farmers with different degrees of skill who move to nonfarm employment. Annual salaries at each wage rate are based on a 40-hour week.

[19] Wage differentials may decide the most profitable alternative as follows: Suppose an average manager of 80 acres with nonlimitational capital ($10,738) receives a full-time nonfarm hourly wage of $2.45 if he moves off the farm, but only $1.90 if he remains on the farm. His income is maximized in this case by moving to nonfarm employment (i.e., his total income is $5,213 instead of $4,498). However, if the full-time nonfarm hourly wage rate is $2.45 regardless of whether he lives in town or on the farm, he maximizes income by combining the full-time job with farming (i.e., his total income is $5,642 instead of $5,213).

TABLE 21. COMPARATIVE "REAL" INCOMES IN VARIOUS SITUATIONS FROM FARMING ALONE, FARMING WITH A PART-TIME JOB AND FARMING WITH A FULL-TIME JOB.[a]

		FARMING ALONE		PART-TIME NONFARM JOB AND FARMING						FULL-TIME NONFARM JOB AND FARMING							
Farm size (acres)	Management	Operating capital used[b]	Farm "real" income[c]	Net salary at two hourly wage rates[d]		Farm "real" income[e]	Interest on capital[f]	Total "real" income at two hourly wage rates[g]		Net salary at three hourly wage rates[d]			Farm "real" income[h]	Interest on capital[f]	Total "real" income at three hourly wage rates[g]		
				$1.25	$1.75			$1.25	$1.75	$1.35	$1.90	$2.45			$1.35	$1.90	$2.45
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
80	Average	$ 4,200	$ 325	$598	$1,118	$ 325	0	$ 923	$1,443	$2,106	$3,250	$4,394	$ 325	$ 0	$2,431	$3,575	$4,719
80	Average	10,738	1,300	598	1,118	1,300	0	1,898	2,418	2,106	3,250	4,394	1,199	49	3,354	4,498	5,642
80	Above-avg.	4,200	2,000	598	1,118	2,000	0	2,598	3,118	2,106	3,250	4,394	2,000	0	4,106	5,250	6,394
80	Above-avg.	9,292	2,813	598	1,118	2,813	0	3,411	3,931	2,106	3,250	4,394	2,402	114	4,622	5,766	6,910
160	Average	8,400	1,061	598	1,118	1,061	0	1,659	2,179	2,106	3,250	4,394	964	0	3,070	4,214	5,358
160	Average	19,117	2,830	598	1,118	1,283	387	2,268	2,788	2,106	3,250	4,394	1,023	414	3,543	4,687	5,831
160	Above-avg.	8,400	4,157	598	1,118	3,752	0	4,350	4,870	2,106	3,250	4,394	2,884	79	5,069	6,213	7,357
160	Above-avg.	17,129	5,505	598	1,118	4,588	231	5,417	5,937	2,106	3,250	4,394	2,884	428	5,418	6,562	7,706

[a] "Real" income is defined in subsequent footnotes.
[b] Includes capital required for variable costs. Does not include investment in machinery and equipment or value of land and buildings.
[c] Farm "real" income = farm net income + value of home used products.
[d] Estimates of wage rates for part-time work in Des Moines, Iowa obtained from the Iowa Employment Security Commission. Part-time job was assumed to be 20 hours per week, year-around. Transportation costs were assumed to be $2.70 per day, i.e., 90 miles of travel at 3 cents per mile. Net salary = total wages — transportation costs.
[e] Farm "real" income = farm net income using labor available when operator has a part-time off-farm job + value of home used products.
[f] Interest at 4 percent on capital available but not used for farm investments.
[g] Total "real" income = net salary + farm "real" income + interest on capital.
[h] Farm "real" income = farm net income using labor available when operator has a full-time off-farm job + value of home used products.

income from devoting full-time to farming alone. That is, the sacrifice in farm income from working off the farm in this case is greater than the gain in off-farm income. In contrast, farmers on 80 acres can increase incomes considerably through part-time off-farm work even at the low off-farm wage rates, although other alternatives give greater income.

Several general observations can be made from the previous income comparisons. Within the range of off-farm wages considered, above-average managers should, for maximum profits, take advantage of their entrepreneurial ability by staying in farming—at least on a part-time basis. Average managers, however, generally maximize income by moving to nonfarm employment. Again, the suggestions of this section are based on profit maximization as the farm family goal. Final decisions also rest on preferences and opportunities of the individual farm family.

OBSTACLES TO GREATER CAPITAL USE

Scarcity of operating capital limits profits in nearly all situations studied. In these situations, returns on added operating capital are relatively high, especially when the initial quantity of capital used is small. The following discussion attempts to explain why farmers fail to use additional operating capital, often at an obvious sacrifice in average income.

Use of funds in farming is restricted by either (1) rationing of credit to farmers by lending sources or (2) unwillingness by farmers themselves to use additional capital. A previous study in Iowa found that, of the two types of capital rationing, the self-imposed type appeared to be the major reason that added capital was not used.[20] A later investigation involving only central Iowa farmers supported this finding.[21]

In both studies, the great majority of farmers indicated that larger quantities of borrowed funds were available than were actually used; many of these same farmers stated that use of additional capital probably would have increased profits. Why, then, do farmers themselves restrict capital use? The principle reasons relate to risk and uncertainty, e.g., uncertainty with respect to prices and yields. Thus, while greater capital use would increase average income, the possibility of loss within the immediate year deters use of more funds. A general awareness by farmers of the principle of increasing risk helps explain their reluctance to expand use of capital through borrowed funds. As more borrowed funds are used and the percentage equity declines, the probability of loss and bankruptcy increases. Other farmers may refrain from borrowing because of the community attitude toward debt.

On the basis of the studies quoted, availability of credit is not a major obstacle to added capital

[20] See: Heady, Earl O. and Swanson, Earl R. Resource productivity in Iowa farming. Iowa Agr. Exp. Sta. Res. Bul. 388. 1952.

[21] Heady, Hildreth and Dean. op. cit.

TABLE 22. COMPARATIVE "REAL" INCOME IN VARIOUS SITUATIONS FROM FARMING ALONE, FROM FARMING WITH A PART- OR FULL-TIME JOB, AND FROM A NONFARM JOB ALONE.*

Farm size (acres)	Management	Operating capital used	Farming full-time	Part-time nonfarm job and farming: Off-farm hourly wage rates		Full-time nonfarm job and farming: Off-farm hourly wage rates			Full-time nonfarm job and not farming: Off-farm hourly wage rates		
				$1.25	$1.75	$1.35	$1.90	$2.45	$1.35	$1.90	$2.45
80	Average	$ 4,200	$ 325	$ 923	$1,443	$2,431	$3,575	$4,719	$2,663	$3,807	$4,951
80	Average	10,738	1,300	1,898	2,418	3,354	4,498	5,642	2,925	4,069	5,213
80	Above-average	4,200	2,000	2,598	3,118	4,106	5,250	6,394	2,663	3,807	4,951
80	Above-average	9,292	2,813	3,411	3,931	4,622	5,766	6,910	2,867	4,011	5,155
160	Average	8,400	1,061	1,659	2,179	3,070	4,214	5,358	3,363	4,507	5,651
160	Average	19,117	2,830	2,789	3,309	3,543	4,687	5,831	3,791	4,935	6,079
160	Above-average	8,400	4,157	4,350	4,870	5,069	6,213	7,357	3,363	4,507	5,651
160	Above-average	17,129	5,505	5,417	5,937	5,418	6,562	7,706	3,712	4,856	6,000

* Income figures taken from tables 20 and 21 and summarized here for ready comparisons.

use. Educational programs designed to reduce farmers' unwillingness to borrow funds appear as the most promising method of putting more capital into farming, resulting in increased incomes. Information on improved technology alone is inadequate, since added capital is often required for adoption of new practices. Thus, educational programs require a two-pronged attack with respect to capital use in farming. One aspect must be to remove barriers to greater capital use. The other must be to indicate the most profitable uses of this capital, whether for new practices (hitherto the principal area of concentration) or for other farm uses.

OBSTACLES TO LABOR MOBILITY

This study indicates that operators with only average farm managerial ability, especially those with small acreages, may increase monetary incomes substantially in one of two ways: (1) by working off-farm in addition to farming or (2) by selling the farm and equipment and moving to urban employment. In many cases, use of these alternatives may be required to bring family income to a satisfactory level. Adjustments along these lines are taking place—but more slowly than might be expected on the basis of comparative incomes. A partial explanation for this sluggishness is that nonfarm jobs are often scarce, and in some cases, impossible for the farmer applicant to obtain, given his skills. In other instances, the availability of jobs is unknown to farmers. Lack of knowledge concerning alternative opportunities is often a major obstacle to needed adjustments by farm families. The psychological and social factors mentioned earlier are also barriers to greater labor mobility.

Uncertainty by farmers concerning the stability of nonfarm work is frequently a reason for their reluctance to leave agriculture. For example, in a study noted earlier,[22] 78 percent of the farmers interviewed stated that farming was "less risky" than working in a factory. Again, this uncertainty is often related to insufficient knowledge about nonfarm employment.

Part- or full-time off-farm work in connection with farming may be a possible avenue for accelerating movement of labor off farms. First of all, a combination of farm and nonfarm work may allow substantial increases in income, as shown in the area studied. Secondly, uncertainty concerning nonfarm employment may be lessened, paving the way for a future transition to full-time nonfarm employment. One value of the present study may be in stimulating individual farmers to evaluate their own income opportunities. This information is prerequisite for making rational decisions concerning future employment.

[22] Heady, Hildreth and Dean. op. cit.

APPENDIX

TABLE A-1. FIXED COSTS FOR VARIOUS FARM SIZES IN SOUTHERN IOWA.*

Item	0-139 acres†			140-199 acres†			200-259 acres†		
	1955	1954	1953	1955	1954	1953	1955	1954	1953
Taxes, interest, insurance, building repairs	$ 626	$ 650	$ 751	$ 929	$ 967	$ 837	$1,143	$1,154	$1,207
Depreciation on machinery	636	591	674	824	750	651	851	863	747
Depreciation on buildings	222	249	241	372	374	290	411	407	410
Total fixed costs	$1,484	$1,490	$1,666	$2,125	$2,091	$1,778	$2,405	$2,424	$2,364

* Taken from "Iowa Farm Record Summary" for the southern Iowa pasture area, for the 3 years 1953, 1954 and 1955.

† The 1955 total fixed costs for the three farm-size ranges, 0-139, 140-199 and 200-259 acres, are used as estimates of total fixed costs for farms of 80, 160 and 240 acres.