A Study of the Cost of

Horse and Tractor Power

on Illinois Farms

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THE ACTUAL EXPERIENCE of some two thousand farm operators, as shown by financial records kept on 1,351 farms in 1930 and 1,599 farms in 1931, forms the basis for this economic study of the use and cost of horse and tractor power on Illinois farms. A number of detailed cost accounts have furnished data for special sections on truck, tractor, and horse costs. Neither the engineering aspects of the farm power problem, nor ways of making more effective use of the various types of power are considered in this study.

One of the principal questions which farmers ask with respect to the farm power problem is whether they can increase their net income by changing from horse to mechanical power or from standard tractors to general-purpose tractors. The horse-operated farms, the standard tractor farms, and the general-purpose tractor farms in this study were found in general to have the same net incomes when comparison was made between groups of farms comparable in size, altho the gross incomes were higher on the tractor farms. The tractor farms naturally had much higher costs for machinery and mechanical power than had the horse-operated farms, but these higher costs on the tractor farms were partly offset by lower horse costs and by very slightly lower labor costs. The combined labor, horse, and machinery costs were slightly lower on the horse-operated farms than on the tractor farms under the price relationships prevailing in 1930 and 1931. It is recognized that the relative advantages of these different types of power will change as price relationships change.

Judging by the experience of these farmers, there is no basis, so far as net income is concerned, for recommending any one type of power for any large group of Illinois farms. The problem still remains one for the individual farmer to decide in light of his abilities, his financial resources, and the particular conditions on his farm. The way in which size of farm and amount of livestock may influence costs on farms operated with different types of power are, however, made clearer by this study.

That many farmers can cut their operating costs without changing their type of power is indicated by the wide variation found in operating costs among farms similar in size and productive organization and operated with the same type of power. On the other hand it is doubtless true that many farmers have profited by changing their power organization and that still others would profit by doing so.

Because of its distinctive place on corn-belt farms, the general-purpose tractor is considered separately from the standard tractor in all analyses of tractor power made in this study.

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A Study of the Cost of Horse and Tractor Power on Illinois Farms

By P. E. Johnston and J. E. Wills[1]

OF THE MANY problems confronting farmers at the present time those dealing with various phases of farm power are among the most perplexing and among those of the greatest economic importance. The number of horses on farms continues to decline and the average age of horses to increase. Many farmers not already owning tractors are faced with the situation of having old and nearly worn-out horses as their only source of power. Their problem is to decide whether to purchase a tractor, and if to purchase one what type to purchase, or whether to obtain young work stock by purchase or by breeding.

The new models of tractors, particularly of the general-purpose type, have reached new peaks of efficiency and of adaptability to power needs. As a result they are intrinsically more attractive to farm operators; on the other hand, the low levels to which feed prices and the wage scale for farm labor have fallen have increased the competitive value of horse power. The necessity of reducing cash operating expenses to a minimum has induced even tractor farmers to consider the substitution of horses for tractors.

Many different kinds and combinations of power units are now used on Illinois farms. This variety is accounted for by a number of factors. Types of land, types of farming, and sizes of farms differ widely not only from one part of the state to another but within each part. Operators differ considerably in qualifications, preferences, and financial resources. Lastly, the types of power units available for farmers and the economic conditions under which they must be purchased and paid for have varied greatly within the past fifteen years.

Some Illinois farms are operated entirely with horses, many with horses and tractors, and a very few with tractors only. A number of farmers have also added a truck, a gas engine, or an electric motor. As they have gone over to machine power, some farmers have discarded all but two or three horses, whereas others have continued with the same number of horses they used before they acquired their tractors.

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Each farm presents a different power problem, and in the last analysis decisions concerning the power organization must take into consideration the kind of crops grown and the influence of power on crop yields, the kind of livestock produced and the influence of power on its efficiency, as well as the personal qualifications of the operator and the cost of the power.

The present study will be confined to those aspects of the power problem which concern the farmer as an individual, leaving out of consideration those broader phases of the problem which have a bearing on the farming industry as a whole and on farmers as a class. Many writers have pointed out that the prices of farm products, particularly of oats and hay, have declined because farmers have substituted mechanical power for horse power. The data assembled in this analysis, however, shed no light on this problem; and since farmers usually make their decisions entirely on the basis of the effect on their own business, it seems logical to analyze the power problem from the point of view of the individual farmer.

PRESENT POWER EQUIPMENT ON ILLINOIS FARMS

The extent to which farmers of the state have selected their power organizations to meet varying physical and economic conditions is indicated in part by a study, from the 1930 Census, of the distribution of various kinds of power in the eight farming-type areas of Illinois (Table 1 and Fig. 1).

Horses and mules, it will be noted, are fairly evenly distributed over the state, the smallest number per 100 acres being 2.7 in Area 8 and

TABLE 1.—PERCENTAGE OF ILLINOIS FARMS HAVING VARIOUS TYPES OF POWER UNITS, GROUPED BY FARMING-TYPE AREAS, 1929
(Data from 1930 U. S. Census)

Farming-type areas	Percentage of farms using—					Horses and mules[a] per farm	Horses and mules[a] per 100 acres	Acres per farm
	Automobiles	Trucks	Tractors	Motors	Gas engines			
Area 1	87.5	41.6	45.3	11.9	48.6	3.7	2.9	129.5
Area 2	90.3	27.5	36.4	7.1	49.5	4.4	2.8	155.3
Area 3	86.1	19.7	34.8	7.4	34.2	4.5	2.9	155.2
Area 4	90.4	21.9	48.0	6.8	51.0	5.2	3.0	172.5
Area 5	79.1	9.9	32.0	2.2	25.0	4.0	3.0	134.8
Area 6	77.5	12.9	26.9	3.3	23.9	4.5	2.8	162.2
Area 7	76.0	14.8	19.4	1.9	22.1	3.9	3.0	129.6
Area 8	59.8	6.8	10.4	.7	5.9	3.0	2.7	111.2
Average for state	79.5	18.1	30.8	4.9	31.1	4.1	2.9	143.1

[a]Horses and mules born before 1928.

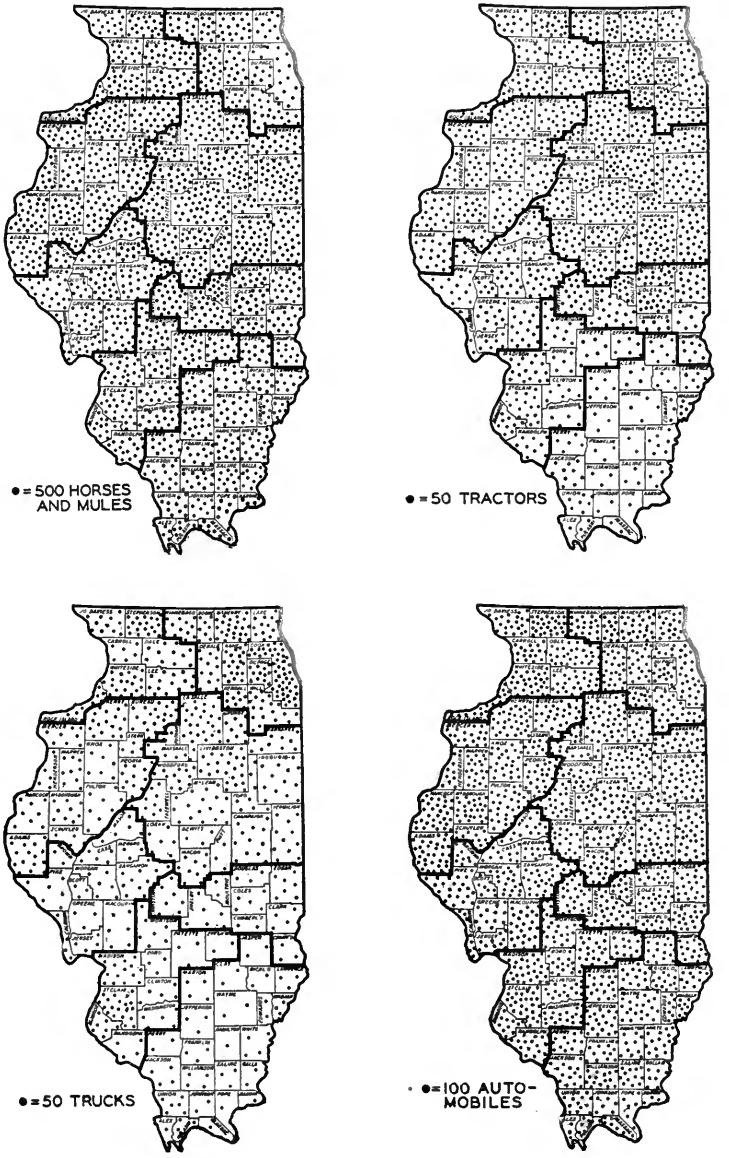

FIG. 1.—DISTRIBUTION OF VARIOUS TYPES OF POWER ON FARMS IN THE EIGHT FARMING-TYPE AREAS OF ILLINOIS, 1930 U. S. CENSUS

Horses and mules and farm automobiles are fairly well distributed over the state. The smaller and less productive farms of southern Illinois furnish less opportunity for the use of tractors than the large, level farms found farther north. Farm trucks show the highest concentration in areas producing large quantities of whole milk, livestock, or fruits and vegetables.

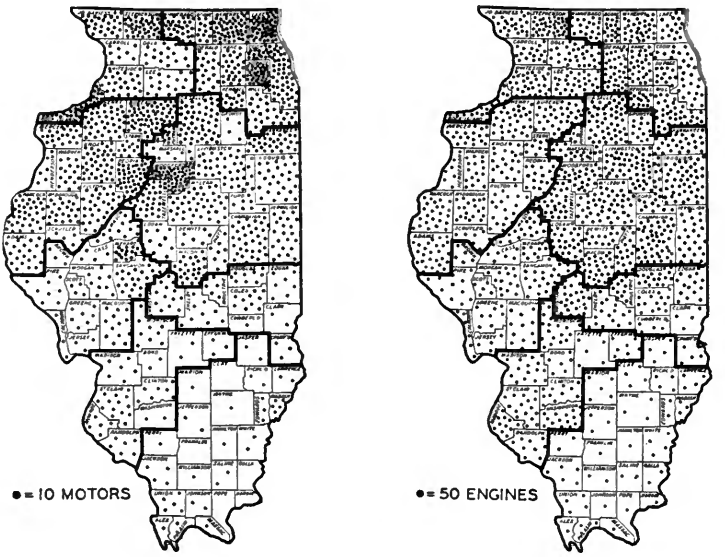

FIG. 2.—DISTRIBUTION OF ELECTRIC MOTORS AND GAS ENGINES ON FARMS

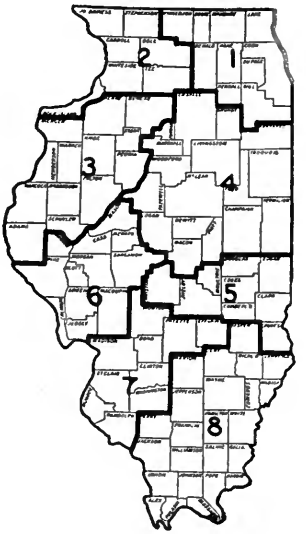

FIG. 3.—LOCATION OF FARMING-TYPE AREAS IN ILLINOIS

Area 1 consists predominantly of dairy farming; *Area 2,* of mixed livestock farming; *Area 3,* beef cattle and hog production, with corn the principal grain crop; *Area 4,* cash grain farming; *Area 5,* general farming, with corn the principal crop; *Area 6,* general farming, with wheat and corn the principal crops; *Area 7,* wheat production and dairy farming; and *Area 8,* mixed farming.

the largest 3.0 in Areas 4, 5, and 7. There is, however, more variation from section to section in the number of horses and mules per farm than there is in the number per 100 acres.

Altho there appears to be a uniform distribution of farm automobiles over the state, there is considerable variation among the different areas in the percentage of farms having automobiles. In Areas 2 and 4 cars are used on about 90 percent of all farms; in Area 8 they are used on only 60 percent of the farms.

There is considerably more variation in the distribution of tractors than of automobiles and there are not nearly so many tractors. Almost half the farms in Area 4 use tractors while only one-tenth of the farms in Area 8 use them. The smaller and less-productive farms of southern Illinois have not furnished the same opportunity for the use of tractors as the larger, level farms found farther north in the state.

Of the 69,628 tractors found on Illinois farms in 1930 (Table 42, Appendix) a large percentage were of the standard type, altho from 1927 to 1930 the general-purpose[1] type of tractor was increasing in popularity. Twenty-two percent of all tractors on accounting farms in central Illinois in 1931 were of the general-purpose type.

Farm motor trucks have their highest concentration in the Chicago area; with large numbers also in other areas producing large quantities of whole milk, livestock, or fruits and vegetables. In Area 1, 41.6 percent of all farms have trucks while in Area 8 only 6.8 percent of the farms use them.

Electric motors have a very interesting distribution and one that is marked by its lack of uniformity (Fig. 2). Here again the influence of larger cities is to be noted. Motors for the most part are used only where power lines have been installed and these lines radiate out from the urban centers.

Gasoline engines are found on about half the farms in Areas 1, 2, and 4, and on about one-third of the farms in Area 3; on one-fourth of the farms in Areas 5, 6, and 7; but on only one-sixteenth of the farms in Area 8.

Thus while there is considerable variation within every area in the power organizations found on farms, there are also, as noted above, clearly recognizable differences between areas in the extent to which use is made of various types of power and equipment. There is no doubt that physical and economic conditions have been important factors influencing the type of power organization generally adopted in these areas.

[1]The term "general-purpose tractor" is used in this study to include only those tractors used for cultivating corn.

POWER EQUIPMENT ON ACCOUNTING FARMS AND FACTORS INFLUENCING POWER COSTS

Practically all farmers in Illinois use some horses in operating their farms even tho motor power has replaced many horses in the last ten years. According to the 1930 U. S. Census, in Area 4 (east-central Illinois) 48 percent and in Area 3 (west-central Illinois) 35 percent of all farmers used tractors in addition to horses; while in the same areas 22 and 20 percent respectively used farm trucks (Table 1). These types of motor power replace not only horse labor but man labor also. It follows, therefore, that labor, horse, and machinery costs must all be considered in any attempt to compare the cost of operating comparable farms with different types of power.

In following the cost analyses made in this study it is necessary to keep in mind that, with three exceptions, the data have been compiled from what are known as "farm financial records," not from detailed cost accounts. Note:

Man labor costs include the cash cost of all hired labor and a charge for the labor of the operator and unpaid members of his family. No charge is made for the operator's management.

Horse costs include net depreciation in the value of horses and a charge for all feeds fed to horses. They include no charge for interest on the investment in horses, none for labor used in feeding and caring for the horses, none for shelter, none for harness, and none for veterinary services.

Machinery costs include net depreciation in the machinery and equipment account, including tractors and trucks, and cash costs of repairs and fuel. A part of the net depreciation and cash expense of the farm automobile are also included, usually one-half. The machinery and equipment account also includes such livestock equipment as milking machines, cream separators, and feed grinders. No interest on investment is included, no charge for shelter, and no charge for farm labor used in repairing or servicing.

Income from custom work is credited to labor and machinery, thus reducing man labor and machinery costs.

Combined man labor, horse, and machinery costs will be spoken of as *operating costs.*

The three instances in which detailed cost accounts have been used and in which, therefore, the above explanations do not apply are the analysis of farm motor truck costs (page 293), the special study of tractor costs (page 317), and the detailed horse cost analysis (page 323).

Types of Power on Accounting Farms

In order to determine the influence of different types of power on the cost of operating farms, a study was made of 1,351 central Illinois farms for 1930 and 1,599 farms for 1931. These farms were divided

into three groups: (1) those operated with horses; (2) those operated with horses and standard-type tractors; and (3) those operated with horses and general-purpose tractors. These groups will be referred to as *horse farms, standard tractor farms,* and *general-purpose tractor farms.* Only those tractors actually used in cultivating corn were

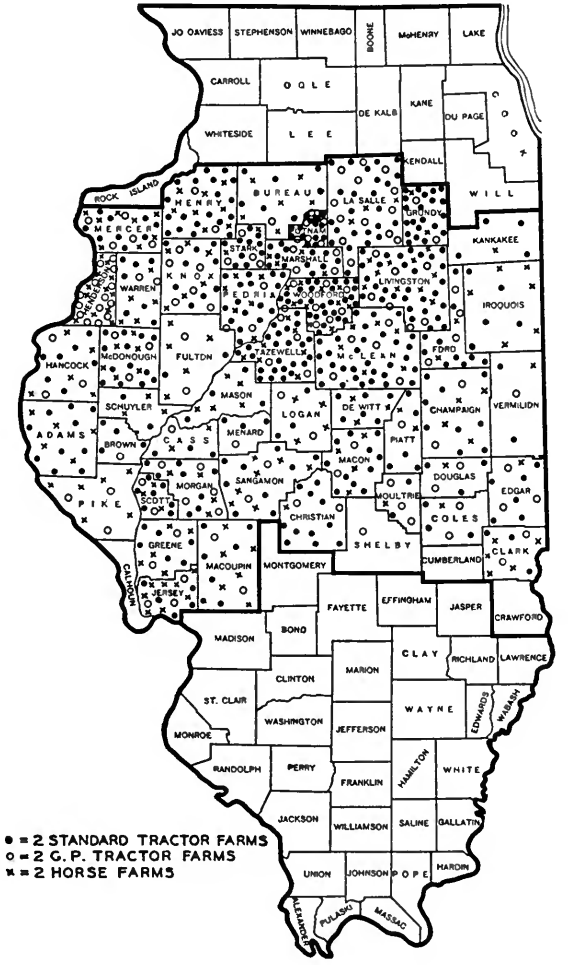

FIG. 4.—DISTRIBUTION OF STANDARD TRACTOR FARMS, GENERAL-PURPOSE TRACTOR FARMS, AND HORSE-OPERATED FARMS INCLUDED IN 1931 STUDY

Four hundred seventeen farms were operated with horses exclusively, 929 were operated with horses and standard tractors, and on 253 farms general-purpose tractors were used. In 1931, 1,599 farms were included in the study; in 1930, 1,351 farms.

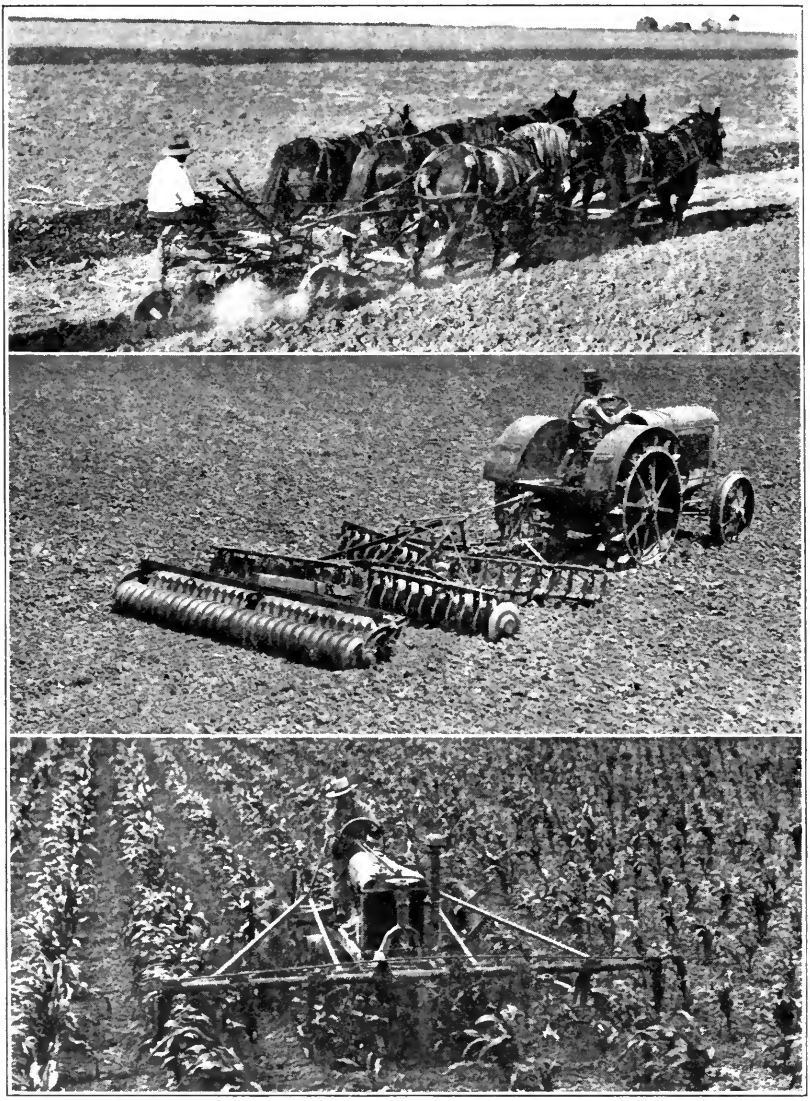

FIG. 5.—THE THREE TYPES OF DRAWBAR POWER FOUND ON ILLINOIS FARMS

Above: Six horses hitched three and three to a gang plow. On approximately 25 percent of the accounting farms in 1930 and 1931 horses furnished the only source of drawbar power. *Center:* A standard tractor being used in preparing ground for corn. About 60 percent of the farms used a tractor of the type pictured here. *Below:* A general-purpose tractor being used in cultivating corn. Approximately 15 percent of the accounting farms in this study employed one of these tractors.

TABLE 2.—NUMBER AND PERCENTAGE OF ILLINOIS ACCOUNTING FARMS HAVING VARIOUS TYPES OF POWER, 1930 AND 1931[a]

Type of power	1930		1931	
	Number of farms	Percent of total	Number of farms	Percent of total
Horses	342	25.3	417	26.1
Standard tractors	830	61.4	929	58.1
General-purpose tractors	179	13.3	253	15.8
Total	1 351	100.0	1 599	100.0
Percentage of farms with tractors	....	74.7	....	73.9

[a]Includes all accounting records from Areas 3, 4, 5, and 6. These records were obtained partly thru statewide accounting projects carried on by the division of Farm Management in cooperation with the county farm bureaus, and partly thru a special project known as the Farm Bureau Farm Management Service.

classed as general-purpose. On 18 percent of the general-purpose tractor farms there was also a standard tractor. The number and percentage of accounting farms using the different types of power are shown in Table 2.

It is to be noted that about 74 percent of these accounting farms, both in 1930 and in 1931, used tractors. This is a higher percentage than found for all the farms in these areas (Table 1). The greater use of tractors on these accounting farms was due in part to their larger size. In Area 4, for instance, the average size of all farms in 1930 was 172 acres, in Area 3 it was 155 acres, while the accounting farms in this study averaged 231 acres that year.

Variations in Size of Accounting Farms

For further analysis each of the three groups of farms was divided into eight size-groups according to the number of acres in crops. A study of the distribution of the farms on this basis brings out clearly the fact that the horse farms tended to be smaller than the farms operated with horses and tractors (Table 3).

Of the horse farms 77.1 percent had less than 160 acres in crops, as compared with but 40.5 percent of the standard tractor farms and 29.6 percent of the general-purpose tractor farms. In 1930 the horse farms averaged 179 acres in size, as compared with 243 acres for standard tractor farms and 279 acres for general-purpose tractor farms (Table 4). The average numbers of crop acres for these three groups were 124, 187, and 217. In 1931 the farms averaged slightly larger, there being 182 acres per farm in the horse farms, 245 acres in the standard tractor farms, and 292 acres in the general-purpose

TABLE 3.—DISTRIBUTION, BY POWER TYPE AND SIZE, OF CENTRAL ILLINOIS ACCOUNTING FARMS; 2,950 ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms				Standard tractor farms			
	Number			Percent of total	Number			Percent of total
	1930	1931	Total		1930	1931	Total	
40– 79	79	83	162	21.3	32	29	61	3.4
80–119	100	131	231	30.4	109	128	237	13.5
120–159	93	100	193	25.4	203	212	415	23.6
160–199	34	54	88	11.6	177	213	390	22.2
200–239	19	27	46	6.1	140	161	301	17.1
240–279	8	9	17	2.3	79	85	164	9.3
280–319	6	7	13	1.7	43	48	91	5.2
320 and over	3	6	9	1.2	47	53	100	5.7
Total	342	417	759	100.0	830	929	1 759	100.0
Crop acres per farm	General-purpose tractor farms							
40– 79	4	2	6	1.4	....	....	....	.....
80–119	15	18	33	7.6	....	....	....	.....
120–159	36	53	89	20.6	....	....	....	.....
160–199	36	37	73	16.9	....	....	....	.....
200–239	30	41	71	16.4	....	....	....	.....
240–279	22	40	62	14.4	....	....	....	.....
280–319	11	16	27	6.3	....	....	....	.....
320 and over	25	46	71	16.4	....	....	....	.....
Total	179	253	432	100.0	....	....	....	.....

tractor farms; the crop acres for these groups were 129, 188, and 231 respectively.

It is clear that any comparison of costs of different types of power should be based on costs within comparable size-groups. Unless the comparison is limited in this way, the smaller size of the horse farms puts them at an unwarranted disadvantage, since larger farms, whether operated with horses, standard tractors, or general-purpose tractors, can be operated with lower labor, horse, and machinery costs per acre than smaller farms. Influence of size of farm on operating costs will be discussed more fully in a later section.

Number of Horses per Farm

The average number of horses per farm varied from 2½ on the general-purpose tractor farms that had fewer than 80 crop acres per farm to 13 horses on the horse farms that had 320 crop acres or more each (Table 5).

The number of horses on farms in the same size-groups averaged smallest for general-purpose tractor farms. Most size-groups of all three power types showed slightly fewer horses per farm in 1931 than

TABLE 4.—AVERAGE TOTAL ACRES AND CROP ACRES IN FARMS WITH DIFFERENT TYPES OF POWER UNITS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

	1930		1931	
	Acres per farm	Crop acres per farm	Acres per farm	Crop acres per farm
Horse farms	178.7	124.3	182.5	129.1
Standard tractor farms	242.6	187.2	244.9	187.7
General-purpose tractor farms	278.8	217.4	291.5	230.6

in 1930. The decline in numbers, however, was least for horse farms, some groups of horse farms even showing an increase. At the present time colts are not being raised in large enough numbers to replace normal death losses.

TABLE 5.—NUMBER OF WORK HORSES[a] PER FARM ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	4.2	4.2	3.5	3.3	2.5	2.5
80–119	5.7	5.4	4.1	4.0	2.7	2.7
120–159	7.0	6.5	5.1	4.8	3.8	3.5
160–199	8.0	7.8	6.0	5.8	4.4	4.1
200–239	9.7	8.6	6.5	6.2	4.4	4.2
240–279	10.4	9.9	7.3	7.1	5.8	4.4
280–319	11.2	12.3	8.0	8.0	4.1	3.9
320 and over	12.7	13.0	9.9	9.7	7.1	6.6

[a]The term "work horse" includes all horses and mules over two years of age that were available for farm work. The number is an average for the year.

Increasing Ages of Horses on Illinois Farms.—A study of the ages of horses on Illinois farms indicates clearly that farm operators must either replace more horses with mechanical power, raise more colts, or purchase horses. The extent to which the ages of horses on two groups of Illinois farms have increased is indicated by the data in Table 6.

In 1926, 17.5 percent of the horses on these farms were under four years of age as compared with 12.5 percent in 1932. In 1926, 4.2 percent of the horses were twenty years of age or over, while in 1932 the number at this age had increased to 6.3 percent of the total. The number of colts born on these farms is still on the decline, as indicated

TABLE 6.—AGES OF FARM HORSES ON TWO GROUPS OF ILLINOIS FARMS, 1926 AND 1932
(From January 1 inventories)

Age groups, years	Horses on 858 farms, 1926[a]		Horses on 1,157 farms, 1932[a]	
	Number of horses	Percentage of total	Number of horses	Percentage of total
Under 4	1 163	17.5	871	12.5
4 to 7	1 600	24.0	1 372	19.8
8 to 11	1 878	28.2	1 591	22.8
12 to 15	1 213	18.2	1 651	23.6
16 to 19	528	7.9	1 046	15.0
20 and over	278	4.2	442	6.3
Total	6 660	100.0	6 973	100.0
Horses per farm	7.8	....	6	....

[a]Includes all the records from the statewide accounting project on which ages of horses were recorded.

by the fact that on the 1,157 farms in 1932 there were 155 colts under one year of age, 180 yearlings, 244 two-year olds, and 292 three-year olds. At the rate of 155 births a year and not allowing for any deaths at all, there would be at the end of a twenty-year period only 3,100 horses under twenty-one years of age on these farms.

Declining Numbers of Work Horses.—The extent to which Illinois farmers have been eliminating horses thru allowing deaths to exceed births or sales to exceed purchases is indicated in Table 7. Data are based on the numbers on hand in the beginning and closing inventories of groups of accounting farms.

While the horse farms of several size-groups showed increases in the number of horses in 1930 or in 1931, all size-groups of the standard tractor and general-purpose tractor farms showed decreases in both years.

A greater elimination of horses occurred on the general-purpose tractor farms than on the standard tractor farms, and the least elimination occurred on the horse farms. During the two-year period from January 1, 1930, to December 31, 1931, there was a decrease of 28 horses per 100 horse farms, a decrease of 70 horses per 100 standard tractor farms, and a decrease of 126 horses per 100 general-purpose tractor farms.[1] The greater decline in the number of horses on the farms where general-purpose tractors were used was probably due to the fact that more of the general-purpose tractors were new and their

[1]Calculated from Table 7 by dividing the total decreases in number of horses for the two years by the average number of accounting farms divided by 100.

TABLE 7.—DECREASE IN NUMBER OF WORK HORSES ON ACCOUNTING FARMS[a] IN CENTRAL ILLINOIS DURING 1930 AND 1931
(Figures are calculated from beginning and ending inventories)

Crop acres per farm	Horse farms				Standard tractor farms				General-purpose tractor farms			
	1930		1931		1930		1931		1930		1931	
	Number of farms	Decrease in horses[b]	Number of farms	Decrease in horses[b]	Number of farms	Decrease in horses	Number of farms	Decrease in horses	Number of farms	Decrease in horses	Number of farms	Decrease in horses
40– 79	18	4	15	+6	16	7	15	0	1	0	0	..
80–119	30	6	38	9	52	24	60	13	4	0	8	1
120–159	26	+4	25	3	110	42	121	31	8	5	25	10
160–199	17	+1	20	8	86	19	119	56	8	3	15	10
200–239	8	5	11	11	55	21	86	25	13	3	17	15
240–279	1	+1	2	0	42	22	41	4	6	12	17	16
280–319	0	...	3	+4	22	14	20	7	4	0	8	6
320 and over	0	...	1	0	18	16	19	7	8	5	24	19
Total farms and decreases	100	9	115	21	401	165	481	143	52	28	114	77

[a]Includes only records from Farm Bureau Farm Management Service. [b]The plus sign (+) is used to indicate an increase.

owners were just in the process of adjusting the number of their horses to their changed needs.

It may be noted that the number of standard tractor farms whose operators kept accounts increased from 401 to 481 between 1930 and 1931, while the number of general-purpose tractor farms whose operators kept accounts increased from 52 in 1930 to 114 in 1931.

Number of Crop Acres per Horse

The number of work horses employed on a farm in relation to the number of crop acres in the farm is a rather rough measure of the efficiency with which the horses are used, whether comparison is made among farms using horses as the sole source of drawbar power or among farms using horses to supplement mechanical power.

TABLE 8.—CROP ACRES PER HORSE ON FARMS OPERATED WITH DIFFERENT TYPES OF POWER; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
	Crop acres per horse[a]					
40– 79	14.3	14.6	18.8	19.6	26.8	27.4
80–119	17.3	18.4	25.0	25.7	36.7	38.0
120–159	19.6	21.2	27.3	28.6	37.5	39.2
160–199	22.0	22.6	30.1	31.0	40.9	43.6
200–239	22.6	25.3	33.7	35.1	49.3	51.5
240–279	24.9	25.6	35.3	36.5	45.3	58.5
280–319	26.8	24.2	37.2	37.2	73.7	76.9
320 and over	32.5	29.1	40.1	39.7	56.2	59.9
Average	22.5	22.6	30.9	31.7	46.0	49.4

[a]The average number of work horses for the year was used in making these calculations.

On the horse-operated farms in this study the efficiency with which the horses were used increased markedly with size of farm. On horse farms consisting of 40 to 79 crop acres there was one horse to about 15 crop acres, while on farms with 320 crop acres or more there was one horse to about 30 crop acres.

For the general-purpose and the standard tractor farms the same principle held true. On the standard tractor farms the number of crop acres per horse ranged from 20 in the group of smallest farms to 40 in the group of largest farms. On the general-purpose tractor farms the range was from 30 crop acres in the group of smallest farms to 65

crop acres in the group of largest farms. The greater replacement of horses by the general-purpose tractor, as compared with the standard tractor, results from the fact that the general-purpose tractor can be used in cultivating row crops, which is not true of the standard tractor.

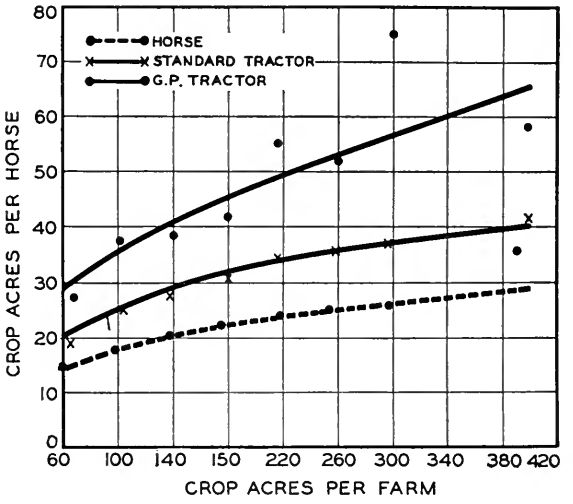

FIG. 6.—AVERAGE NUMBER OF CROP ACRES PER HORSE ON FARMS OF DIFFERENT SIZE OPERATED WITH DIFFERENT TYPES OF POWER; AVERAGE FOR YEARS 1930 AND 1931

With all three types of power, the number or crop acres per horse increased as size of farm increased. On the general-purpose tractor farms the number of crop acres per horse was larger than on the standard tractor farms. This difference was due to the fact that a general-purpose tractor has a wider range of adaptability than has the standard tractor.

Horses Displaced per Tractor

The average number of horses displaced by each standard tractor increased as the size of the farm increased, in 1930 ranging from .6 horse on farms of less than 80 crop acres to 3.4 horses on farms of 320 crop acres and over; and in 1931 ranging from .7 to 3.3 horses (Table 9). The displacement of horses by the general-purpose tractors ranged from 1.7 to 4.7 in 1930 and from 1.8 to 5.2 in 1931. In both years the general-purpose tractor displaced more horses in each size-groups than did the standard tractor (Fig. 7). This is accounted for by the fact that the general-purpose tractors are used for cultivation, which is the work that normally determines on central Illinois farms the number of horses that must be kept in addition to a standard tractor.

TABLE 9.—HORSES DISPLACED PER TRACTOR ON STANDARD TRACTOR AND GENERAL-PURPOSE TRACTOR FARMS; 1,687 CENTRAL ILLINOIS ACCOUNTING RECORDS,[a] 1930 AND 1931

Crop acres per farm	Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931
	Horses displaced per tractor[b]			
40– 79	.6	.7	1.7	1.8
80–119	1.5	1.9	2.4	3.1
120–159	2.0	2.0	3.5	3.2
160–199	2.2	2.6	3.7	3.8
200–239	2.8	3.2	4.3	4.3
240–279	3.0	3.3	3.8	4.1
280–319	3.1	3.1	4.7	5.2
320 and over	3.4	3.3	4.3	4.9

[a]Records from the Farm Bureau Farm Management Service are not included here.
[b]Number of horses displaced was calculated by subtracting the number of horses on tractor farms from the number on horse farms of the same size, and dividing the difference by the number of tractors.

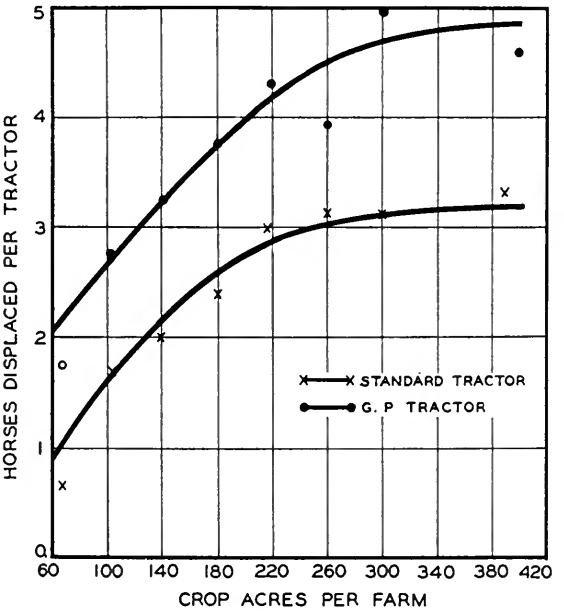

FIG. 7.—DISPLACEMENT OF HORSES BY GENERAL-PURPOSE TRACTORS AND BY STANDARD TRACTORS; CENTRAL ILLINOIS ACCOUNTING FARMS, 1930 AND 1931

More horses were displaced by general-purpose tractors than by standard tractors, and the number displaced increased as the size of farm increased.

More horses were displaced per tractor in 1931 than in 1930, as is further shown in Table 9. This displacement was accomplished largely thru actual sales (Table 26), but also thru deaths. Horses that died were not replaced either by the purchasing of stock or by the rearing of colts. The necessity of rigid economy in operation, combined with the relatively high position of horses in the general price level, no doubt encouraged a greater sale of horses on tractor farms than would ordinarily be expected, altho in many cases the sales would doubtless have been advisable even under normal economic conditions.

Amounts of Productive Livestock

Since the amount of productive livestock on a farm influences the operating costs, data were obtained on the average amounts of productive livestock per crop acre carried on farms of various sizes. The amounts of productive livestock were measured, in this study, by the value of the feed fed.[1]

It is evident that irrespective of the type of power employed there is a much higher concentration of livestock per acre on the small farms than on the large ones (Table 10). The fact that the value of the feed fed per crop acre was considerably higher in 1930 than in 1931 was due entirely to the higher market price of farm feed.

Altho frequently there were substantial differences in the average value of the feed fed per crop acre between the farms of one power type and the farms of another within the same size-group, there was

TABLE 10.—VALUE OF FEED FED PER CROP ACRE TO PRODUCTIVE LIVESTOCK ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$24.03	$15.16	$27.32	$16.24	$27.29	$24.65
80–119	20.19	12.13	21.31	12.16	16.10	9.91
120–159	13.30	8.76	16.25	10.73	16.25	10.88
160–199	12.79	9.17	17.13	9.85	12.37	9.05
200–239	13.68	8.49	13.04	8.36	11.89	5.84
240–279	12.28	7.18	11.92	7.08	14.42	8.03
280–319	9.68	10.11	10.74	6.85	12.52	8.77
320 and over	3.94	4.28	9.76	5.71	12.88	7.41

[1]This value included the value both of farm-grown and of purchased feeds fed to all livestock other than horses. Since costs for the productive livestock found on these farms were largely feed costs or other costs closely associated with the feeding operation, the value of the feed fed should serve as a very good index to the amount of such livestock kept on these farms.

no sustained tendency for more or less feed to be fed on farms of one power type than on the farms of other types (Fig. 8). Farms of each power type were highest in the value of feed fed in some size-groups and lowest in some.

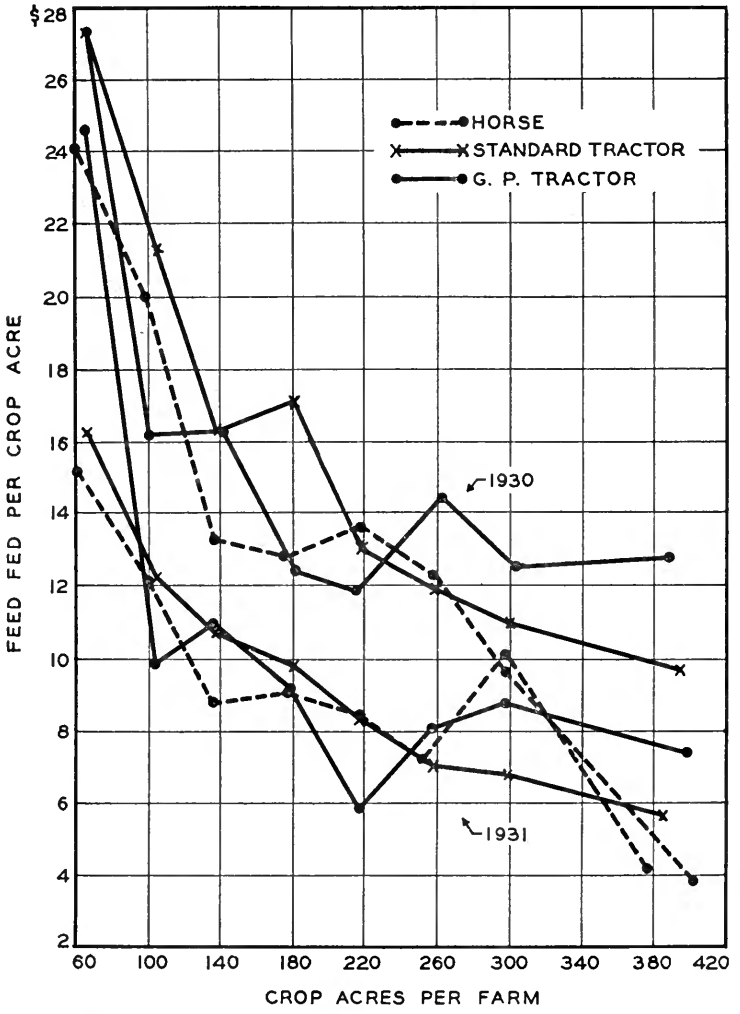

FIG. 8.—AMOUNTS OF LIVESTOCK CARRIED ON FARMS OF DIFFERENT SIZES OPERATED WITH DIFFERENT TYPES OF POWER; CENTRAL ILLINOIS ACCOUNTING FARMS, 1930 AND 1931

The larger farms had less livestock per crop acre (measured by worth of feed fed) than did the smaller farms. On the basis of type of power there were no significant differences among these farms in the amounts of livestock kept.

As pointed out earlier (page 278), there is a tendency for operating costs per crop acre to decline as the size of farm increases. If costs per crop acre also increase materially with the addition of livestock, then the cost will be much higher on the small farm than on the large farm due to the joint action of these two factors. The relationships between size of farm and operating costs, and between amount of livestock and operating costs, will be discussed in a later section.

Machinery Investment

The investment in machinery per farm was almost twice as large on the general-purpose tractor farms as on the horse farms, with the investment on standard tractor farms falling between these extremes (Table 11). Investment per farm naturally increases with an increase in size of farm, altho the increase is not in proportion to the increase in size.

TABLE 11.—MACHINERY INVESTMENT PER FARM ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$ 811	$ 791	$1 239	$1 130	$1 591	$1 474
80–119	983	920	1 693	1 629	1 913	1 808
120–159	1 121	1 101	1 866	1 887	1 906	2 140
160–199	1 257	1 226	2 135	2 106	2 172	2 242
200–239	1 239	1 112	2 377	2 342	2 401	2 422
240–279	1 544	1 396	2 423	2 365	2 792	2 824
280–319	1 365	1 402	2 742	2 747	3 197	3 532
320 and over	1 709	1 634	2 915	2 674	3 833	3 584

Inventory values for machinery tended to be less in 1931 than in 1930 except on the general-purpose tractor farms, where on the whole inventories in 1931 were higher than in 1930.

Number of Tractors per Farm

The higher investment in machinery on tractor farms was due in part to the fact that some of the farms had more than one tractor. This tendency to own more than one tractor was much more pronounced among the general-purpose tractor farms than among the standard tractor farms (Table 12), only 1.9 percent of the standard tractor farms having two tractors, while 18.4 percent of the general-purpose tractor farms had two.

TABLE 12.—NUMBER OF FARMS AND NUMBER OF TRACTORS ON FARMS OF DIFFERENT SIZES OPERATED WITH DIFFERENT TYPES OF POWER; 1,142 CENTRAL ILLINOIS ACCOUNTING RECORDS,[a] 1930 AND 1931

Crop acres per farm	Standard tractor farms		General-purpose tractor farms	
	Number of farms	Number of tractors	Number of farms	Number of tractors
40– 79	30	30	5	5
80–119	125	125	21	22
120–159	183	185	56	57
160–199	185	190	50	53
200–239	160	161	41	51
240–279	81	81	39	49
280–319	49	53	15	21
320 and over	63	68	39	57
Total	876	893	266	315
Percentage of farms with two tractors	...	1.9	...	18.4

[a]Records from the Farm Bureau Farm Management Service are not included here.

There were no records to indicate the extent to which each tractor was used on the general-purpose tractor farms, and it may be possible that there will be a reduction in number of tractors on these farms when the standard tractors have worn out. That there is duplication of tractor investment and expense on many farms is evident.

More Trucks on Tractor Farms

Further cause for the larger machinery investment on tractor farms may be found from a study of the number of trucks on them (Table 13 and Fig. 9). On the standard tractor farms there were about twice

TABLE 13.—PERCENTAGE OF HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS WITH TRUCKS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
40– 79	17.7	18.1	37.5	34.5	75.0	100.0
80–119	16.0	15.3	36.7	34.4	33.3	33.3
120–159	17.2	21.0	34.5	44.8	33.3	37.7
160–199	32.4	24.1	47.5	44.6	55.6	51.0
200–239	26.3	14.8	51.4	41.6	53.3	43.9
240–279	12.5	33.3	40.5	37.6	45.4	55.0
280–319	16.7	28.6	44.2	43.7	45.4	62.5
320 and over	0	16.7	48.9	39.6	68.0	60.9
Average	17.3	21.5	42.6	40.1	51.2	55.5

as many trucks as on the horse farms, and on the general-purpose tractor farms about three times as many trucks as on the horse farms.

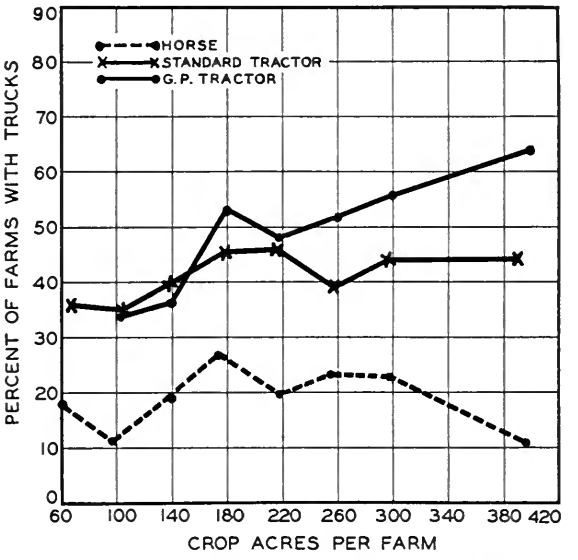

FIG. 9.—PERCENTAGE OF CENTRAL ILLINOIS ACCOUNTING FARMS HAVING MOTOR TRUCKS; AVERAGE 1930 AND 1931

More motor trucks were found on the farms operated with general-purpose tractors than on either the standard tractor farms or on the horse-operated farms. It was only on the general-purpose tractor farms that the number of trucks increased markedly with size of farm.

Tractor-Operated Equipment on Tractor Farms

The comparatively large machinery investment on tractor farms is accounted for not only by the addition of a second tractor on many farms and by a higher concentration of trucks, but by the addition of mechanical corn pickers, combines, and other tractor-operated equipment, which calls for relatively large investments. On a group of farms where special records were obtained on general-purpose tractors, 34 percent of the corn was harvested by mechanical pickers and 26 percent of the small grain by combines. On farms with both general-purpose and standard tractors these percentages were 56 and 53 respectively.

Duplication of Equipment on Tractor Farms

Observation indicates that besides the tractor equipment on tractor farms a set of horse-drawn equipment is usually found. Especially is

TABLE 14.—COMBINED INVESTMENT PER FARM IN HORSES AND MACHINERY ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS, 1930 AND 1931[a]

Crop acres per farm	Horse farms				Standard tractor farms				General-purpose tractor farms			
	1930		1931		1930		1931		1930		1931	
	Number of farms	Investment	Number of farms	Investment	Number of farms	Investment	Number of farms	Investment	Number of farms	Investment	Number of farms	Investment
40– 79	18	$1 423	15	$1 462	16	$1 462	15	$1 547	1	$1 473	..	$.....
80–119	30	1 556	37	1 488	52	2 203	60	2 211	4	2 133	8	2 207
120–159	26	1 721	25	1 766	110	2 474	122	2 489	8	2 274	25	2 677
160–199	17	2 033	20	2 196	86	2 821	119	2 874	8	2 883	15	2 608
200–239	8	2 002	11	1 987	55	3 188	86	3 267	13	3 183	17	3 088
240–279	1	2 136	2	3 806	42	3 323	41	3 261	6	3 492	17	3 799
280–319	..	.....	3	2 840	22	3 642	20	3 982	4	3 424	8	4 527
320 and over	..	.....	1	3 540	18	3 849	19	3 657	8	5 578	24	4 628

[a]Data are from Farm Bureau Farm Management records only.

this true of general-purpose tractor farms, where both tractors and tractor equipment have, as a rule, been but recently acquired.

Where new equipment is added to a farm to take the place of machines that are not yet worn out, and the old equipment is not sold, the use-value of the old equipment must be added to the purchase price of the new in order to get a true comparison of costs. For example, a horse-drawn cultivator which could have been used for another five years has perhaps a third of its entire usefulness left, yet may not be salable. If this machine were replaced by a motor cultivator and the horse-drawn machine retained, then one-third of the initial value of the horse cultivator must be added to the cost of the new machine in comparing the costs of horse and motor cultivation.

Combined Investment in Horses and Machinery

Tho the machinery investment was of course much higher on the tractor farms studied than on the horse farms, the investment in horses was much less on the former. The question logically arises whether the total investment in horses and machinery was greater on the tractor farms than on the horse farms of corresponding size. That it was is evident from a study of Table 14.

Differences in combined investments were particularly noticeable between the larger horse-operated and tractor-operated farms. The combined investment in horses and machinery was about the same on general-purpose tractor and standard tractor farms of the same size-groups. It is evident at once that where horses were replaced with tractors, the saving in capital invested in horses was more than offset by the added investment in tractors and in additional operating equipment.

OPERATING COSTS ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS

Horse Costs

As already shown, there were fewer horses on the general-purpose tractor farms than on the standard tractor farms and, of course, fewer horses on the standard tractor than on the horse farms. It is logical to expect that the cost per crop acre for horse labor would vary largely with the difference in number of horses. That this was true is shown in Table 15.

It is also evident from Table 15 that the cost for horse labor per crop acre was much less on the large farms than on the small ones,

TABLE 15.—HORSE COSTS[a] PER CROP ACRE ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$4.11	$2.87	$3.10	$2.09	$1.36	$1.29
80–119	3.58	2.50	2.46	1.92	2.00	1.31
120–159	3.16	2.20	2.23	1.75	1.73	1.17
160–199	2.64	2.05	2.18	1.62	1.35	1.08
200–239	2.41	1.95	1.90	1.29	1.37	.98
240–279	2.41	1.95	1.72	1.31	1.40	.83
280–319	2.33	1.77	1.71	1.40	.85	.72
320 and over	1.60	1.91	1.73	1.28	1.17	.81

[a]The horse costs include a charge for the value of all feed fed to horses and an allowance for net gains or net losses in the horse account.

ranging in 1930 from $4.11 on the small horse farms to $1.60 on the large horse farms, and from $3.10 on the small standard tractor farms to $1.71 on the large ones. The range on the general-purpose tractor farms was from $2 to 85 cents per crop acre. Costs were less in 1931 than in 1930 but the same ratios were found to apply.

Machinery Costs[1]

Machinery costs per crop acre on the general-purpose tractor farms in the smallest size-group averaged more than twice as high as on the horse farms in the same size-group. In the larger size-groups these costs on the general-purpose tractor farms averaged about three times as much as on the horse farms (Table 16). For most size-groups and for all power types these costs were lower in 1931 than in 1930. They included depreciation on all machinery and cash expenditures for repairs and supplies such as fuel and oil. Machinery costs per crop acre declined very rapidly as the farms increased in size, ranging in 1930

[1]The methods of closing the accounts on the farms studied prevent the machinery costs on horse and tractor farms from being exactly comparable. The tractor farms had more threshing machines, combines, and feed grinders than had the horse farms. Where these machines were owned on the farm, the expense of operating them was charged to the machinery account, whereas when their services were hired the expense was charged to the crops account or the feed account. The extent to which these differences influenced the computations for machinery costs on farms using different types of power is indicated by a comparison of crop expenses. A study of 1,599 records for 1931 showed that the average crop expense per crop acre was $1.08 on the horse farms, 99 cents on the standard tractor farms, and $1.05 on the general-purpose tractor farms. These differences in crop expenses, largely due to the method of accounting, are not sufficient to invalidate the results shown for machinery cost per crop acre.

TABLE 16.—MACHINERY COSTS PER CROP ACRE ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS,[a] 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$3.11	$2.70	$4.95	$4.04	$6.45	$7.71
80–119	2.29	1.96	3.80	3.18	4.18	3.50
120–159	1.87	1.70	3.38	2.70	3.99	3.40
160–199	1.69	1.60	2.96	2.45	3.70	3.11
200–239	1.34	1.11	2.83	2.43	3.29	2.48
240–279	1.33	1.31	2.64	2.14	3.59	2.65
280–319	.83	1.04	2.81	2.16	3.12	2.49
320 and over	.82	.84	2.42	1.88	3.02	2.39

[a]See footnote on page 292 concerning comparability of data for different type-of-power groups.

on the horse farms from $3.11 on the small farms to 82 cents on the large farms, on the standard tractor farms from $4.95 to $2.42, and on the general-purpose tractor farms from $6.45 to $3.02. The higher machinery costs on tractor farms were due not only to tractor costs but to heavier investments and expenses for other machinery.

A study of the cost records for farm trucks on some of the farms will show the extent to which trucks were responsible for the higher machinery costs on the tractor farms. As shown earlier (Table 13), there was a much higher percentage of tractor farms with trucks than horse farms with trucks.

Cost of Operating Farm Trucks

A detailed study of 43 farms in 1931 indicates that on the average the cost of operating a farm truck of the 1½-ton size, which was the typical size of truck found on these central Illinois farms, was $188 a year (Table 17). These trucks were driven an average of 2,813 miles a year. About one-third of their use was for doing miscellaneous jobs, one-third for hauling livestock and livestock products, and one-third for hauling crops, feed, and fertilizer.

Cash operating costs on these trucks averaged $101.95 a year.

Trucks are more frequently employed on tractor farms than on horse farms for a number of reasons. It is logical to assume that tractor farmers are more machinery-minded than are horse farmers, and for this reason more likely to own trucks. Tractor farmers are not so likely to have good road teams as are horse farmers. Tractor farmers are also more likely to own threshing machines, combines, and corn pickers, and trucks are used to good advantage in connection with these harvesting machines.

TABLE 17.—COST OF OPERATING FARM MOTOR TRUCKS ON 43 CENTRAL ILLINOIS ACCOUNTING FARMS, 1931

	Average of 43 trucks
Costs of operation	
Depreciation	$59.65
Interest on average investment at 5 percent	15.84
Insurance	5.55
License	20.00
Repairs	21.39
Tires and tubes	10.90
Value of farm labor making repairs	2.67
Gasoline	35.74
Motor oil	5.86
Grease	1.48
Use of building	8.31
Other costs	1.03
Total cost for 1931	$188.42
Cost per mile	.067
Miles per gallon of gasoline	11.12
Miles per quart of oil	77.2
Total miles truck was driven	2 813

Combined Horse and Machinery Costs

Combined horse and machinery costs were lowest on horse farms in all size-groups for both 1930 and 1931 (Fig. 10). The savings in machinery costs on horse farms were greater than the savings in horse costs on tractor farms.

Man Labor Costs

Man labor costs were considerably less in 1931 than in 1930 for farms of all power types and of all sizes (Table 18 and Fig. 10).

The cost per crop acre for man labor differed but little between

TABLE 18.—MAN LABOR COSTS[a] PER CROP ACRE ON HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$14.19	$11.54	$13.92	$9.98	$12.10	$10.28
80–119	10.28	8.33	9.96	7.80	9.72	7.56
120–159	8.06	6.64	8.55	6.58	8.16	6.23
160–199	7.56	6.12	7.37	6.18	6.81	5.49
200–239	6.91	5.45	6.69	5.27	6.69	4.94
240–279	6.70	4.70	6.31	5.00	6.02	4.86
280–319	5.38	4.85	5.77	4.86	5.36	4.14
320 and over	4.56	3.86	5.77	4.36	5.39	4.17

[a]The cost of man labor was calculated by adding together the cost of hired labor and the value of the family labor calculated at hired man's wages, and deducting money received for labor off the farm.

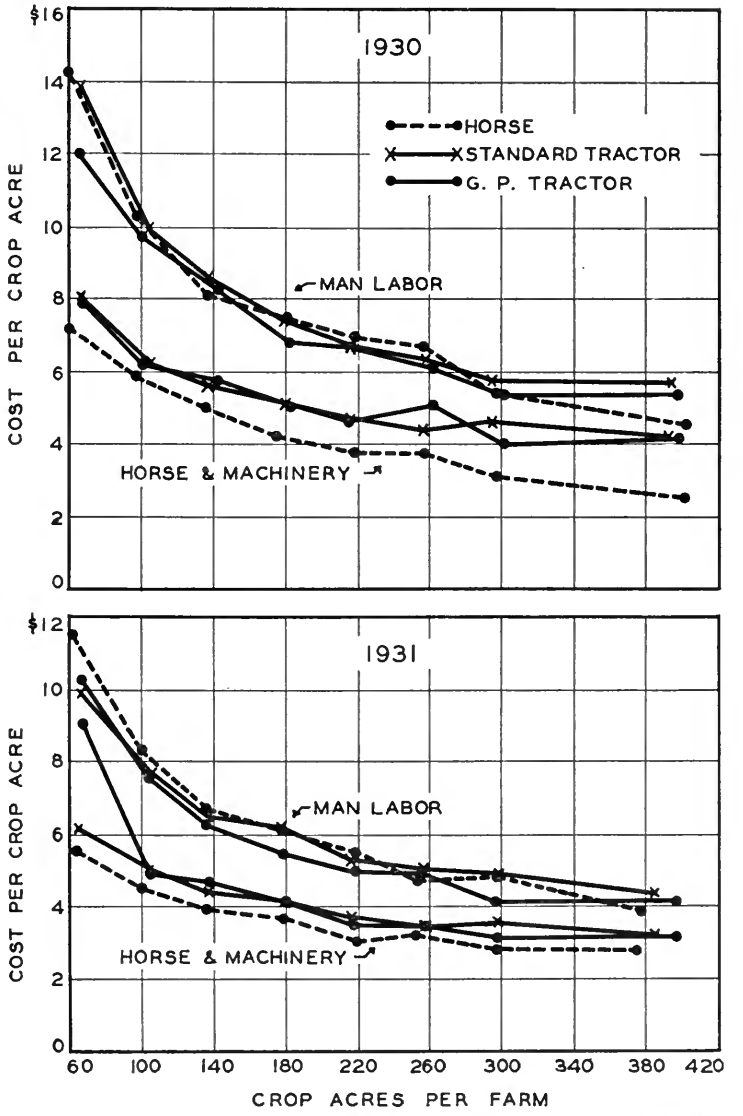

FIG. 10.—COSTS PER CROP ACRE FOR MAN LABOR AND FOR HORSES AND MACHINERY ON FARMS OF DIFFERENT SIZES OPERATED WITH DIFFERENT TYPES OF POWER

On the tractor farms the acre-cost for man labor was only slightly less than on the horse-operated farms. This may be explained partly by the fact that many farmers owning tractors had not yet made as thoro adjustment in their hired labor as was possible, and partly by the fact that much of the labor used on these farms was family labor. Total horse and machinery costs were consistently lower on the horse-operated farms. All these costs decreased with an increase in size of farm.

horse, standard tractor, and general-purpose tractor farms. General-purpose tractor farms, however, did tend to have slightly lower man-labor costs than the horse farms. In both 1930 and 1931 they had the advantage, altho only a very slight one, in six of the eight size-groups.

On the whole, these records indicate that there was no consistent relationship between the cost of man labor and the type of power employed on these farms, which is perhaps surprising in view of the fact that it has often been stated that the chief way in which tractors can reduce farm operating costs is by saving man labor. Undoubtedly one man and a tractor performed a specific field job on a tractor farm in less time than one man and the average size of team did a similar job on a horse farm, but this time saving was not reflected in a material reduction in the cost for man labor on the tractor farms. Apparently many farmers owning tractors had not made adjustments that would enable them to reduce the peak of labor requirements to the point where a smaller amount of hired labor would be needed.

In this connection it should be noted that a large part of the labor on these farms was performed by the operator and his family and thus did not represent any cash outlay. The problem of adjusting family labor when a tractor is added is more difficult than the problem of adjusting hired labor. In the records upon which this study was based a charge was made for the operators' time and for the time other members of the family worked on the farm.

In an Indiana study Lloyd and Hobson[1] found that men on horse farms cared for as many acres of crops per man as did men on tractor farms but spent an average of 14 more days in field work. The horse and tractor farms upon which this Indiana study was based were of practically the same size, but no farms using cultivation tractors were studied.

Results of studies purporting to show the saving of man labor effected by tractors vary significantly with the type of records on which the studies are based. Those based on statements of tractor operators unsupported by actual accounts consistently indicate greater savings than those based on accounts. The unreliability of conclusions that are not based on careful records was revealed in the course of the present study. A group of farmers who were using general-purpose tractors and who had kept records during the entire year were asked at the end of the year to estimate the number of months of hired labor

[1]Lloyd, O. G., and Hobson, L. G. Relation of farm power and farm organization in central Indiana. Purdue Univ., Agr. Exp. Sta. Bul. 332, pp. 6-9. 1929.

that they believed had been saved by the use of tractors. The estimates of 50 of these men showed an average saving of six and one-half months of hired labor, yet the analysis of their accounts and of the accounts for horse and standard-tractor farms of the same area showed practically the same labor costs for the farms of all three types.

Estimates of tractor operators concerning the savings they have effected in man labor by using tractors were very likely impaired also by the fact that farmers using horses have increased the efficiency of their operations, as have farmers who have changed from horses to horses and tractor. This increase in the efficiency with which labor is used on horse farms has been brought about by the practice of using bigger teams and implements of larger capacity and by better farm organization. It is also likely that not all adjustments have yet been made that can be made in the use either of horses or of man power on general-purpose tractor farms, these farms having acquired their tractors only within the past few years.

Combined Man Labor, Horse, and Machinery Costs

Total costs for man labor, horses, and machinery per crop acre averaged about the same for farms operated with the various types of power, as will be seen from Table 19 and Fig. 11.

TABLE 19.—MAN LABOR, HORSE, AND MACHINERY COST PER CROP ACRE ON FARMS OPERATED WITH DIFFERENT TYPES OF POWER; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$21.41	$17.11	$21.97	$16.11	$19.91	$19.28
80–119	16.15	12.79	16.22	12.90	15.90	12.37
120–159	13.09	10.54	14.16	11.03	13.88	10.80
160–199	11.89	9.77	12.51	10.25	11.86	9.68
200–239	10.66	8.51	11.42	8.99	11.35	8.40
240–279	10.44	7.96	10.67	8.45	11.01	8.34
280–319	8.54	7.66	10.29	8.42	9.33	7.35
320 and over	6.98	6.61	9.92	7.52	9.58	7.37

The slight saving in labor costs on tractor farms was offset by their higher combined horse and machinery costs.

The total costs were considerably lower in 1931 than in 1930, owing to changes in price-levels. Cheaper labor and lower prices for feed were the principal factors in this difference between the two years.

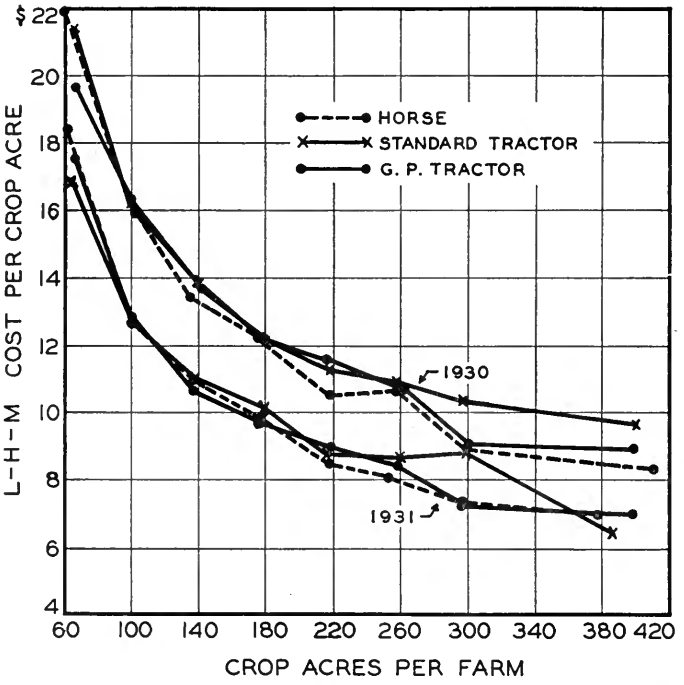

FIG. 11.—INFLUENCE OF SIZE OF FARM AND TYPE OF POWER ON TOTAL MAN LABOR, HORSE, AND MACHINERY COST PER CROP ACRE; CENTRAL ILLINOIS ACCOUNTING FARMS, 1930 AND 1931

The acre-cost for man labor and power was much less on large farms than on small farms. There was no significant difference in cost between farms operated with the different types of power indicated.

Combined Influence of Amount of Livestock and Size of Farm on Operating Costs

The tendency for a heavy concentration of livestock to be associated with the small farm was discussed in a previous section (page 285). Also, variations in combined labor, horse, and machinery cost with different sizes of farms and without reference to variations in the amount of livestock have been shown (Table 19 and Fig. 11). There remains to be shown the effect of different amounts of livestock on the operating costs of farms varying in size and type of power.

That there is a relationship between the amount of livestock and operating costs is shown in Table 20. Average costs on farms in the 120-to-159 crop-acre group ranged from $8.51 to $13.22 per crop acre with the amount of livestock kept. The increase in the operating cost

TABLE 20.—VARIATIONS IN TOTAL OPERATING COSTS ACCORDING TO AMOUNTS OF LIVESTOCK ON 365 FARMS RANGING FROM 120 TO 159 CROP ACRES, 1931

Value of feed fed per crop acre to productive livestock*	Number of farms	Labor, horse, and machinery cost per crop acre
$0.00–$1.99	13	$8.51
2.00– 3.99	47	8.95
4.00– 5.99	56	9.72
6.00– 7.99	51	9.93
8.00– 9.99	51	10.83
10.00–11.99	42	10.78
12.00–13.99	28	12.03
14.00–15.99	20	12.20
16.00–17.99	12	12.23
18.00–19.99	9	12.39
20.00 and over	36	13.22
Total number of farms	365	.....

*The value of the feed fed to productive livestock is used to measure the relative amounts of livestock on these farms.

per crop acre as the amount of feed fed increased was quite regular and indicates a definite relationship which must be taken into consideration in a study of this kind. It is also evident that the variation in average operating costs between size-groups, noted in Tables 15, 16, 18, and 19, is due to the combined influence of size of farm and amounts of livestock, and that an increase in the number of crop acres and a decrease in the amount of livestock per crop acre accompany each other and tend, separately and jointly, to reduce the operating cost per crop acre.

In order to measure the joint influences of the two variables—size of farm and amount of livestock—and to find the normal cost per crop acre for any combination of size of farm and amount of livestock, the data shown in Table 40, Appendix, were handled by the method outlined by Ezekiel[1] for determining the joint function of two independent variables. This method makes it possible to study the influence of the amount of livestock on operating costs for the various size-groups as well as the influence of the size of farm on costs where varying amounts of livestock are kept.

The influence of amount of livestock on operating costs per crop acre for farms of different sizes is shown graphically in Fig. 12. It is evident not only that costs per acre increase as the amount of livestock increases, but that the rate of increase grows less as the amount of livestock per acre becomes larger. It is also clear that operating costs per crop acre rise more on small farms than on large farms for identical increases in amounts of feed fed per crop acre.

[1]Ezekiel, Mordecai. Methods of correlation analysis. Chapter 20. J. Wiley and Sons, New York. 1930.

There was also a much greater decrease in operating costs per crop acre when the size of the farm was increased from 100 to 140 crop acres than when it was increased from 260 to 300 crop acres (Fig. 13).

The operating costs per crop acre decreased more rapidly (for a given increase in size of farm) on farms with large amounts of livestock than on farms with little livestock.

The graph showing the changes in operating costs that accompany changes in the amounts of livestock can be used to adjust the data

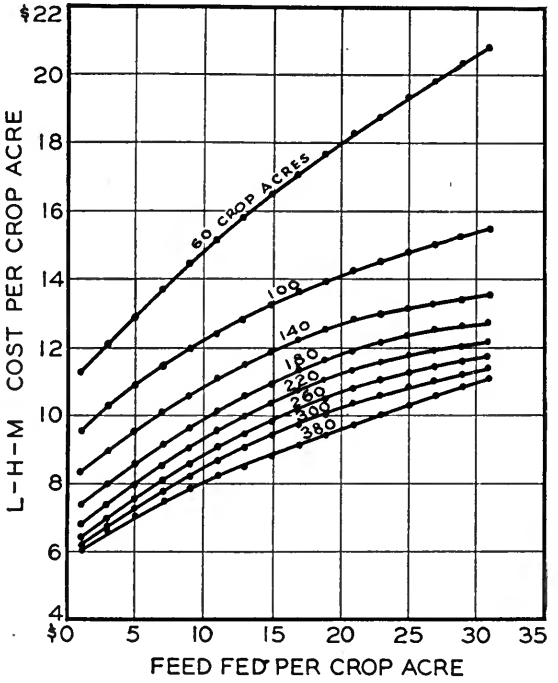

FIG. 12.—HOW AMOUNT OF LIVESTOCK CARRIED AFFECTED TOTAL MAN LABOR, HORSE, AND MACHINERY COST PER CROP ACRE ON EIGHT GROUPS OF FARMS OF DIFFERENT SIZES, 1931

As the amount of livestock increased, the costs increased on all sizes of farms, but they increased more rapidly on the small farms than on the large farms.

given in Table 19 for variations in the amount of livestock. This adjustment eliminates the influence of variations in the amount of livestock, so that a comparison of the operating costs on horse, standard tractor, and general-purpose tractor farms can be made under conditions more strictly comparable. To illustrate, the value of the feed fed to productive livestock during 1931 on farms of the 80-to-119 crop-

acres group was $12.13 per crop acre on horse farms, $12.16 on standard tractor farms, and only $9.91 on general-purpose tractor farms (Table 10). The operating costs per crop acre were $12.79, $12.90, and $12.37, respectively (Table 19). One reason why the cost on the general-purpose tractor farms was lowest was that these farms had

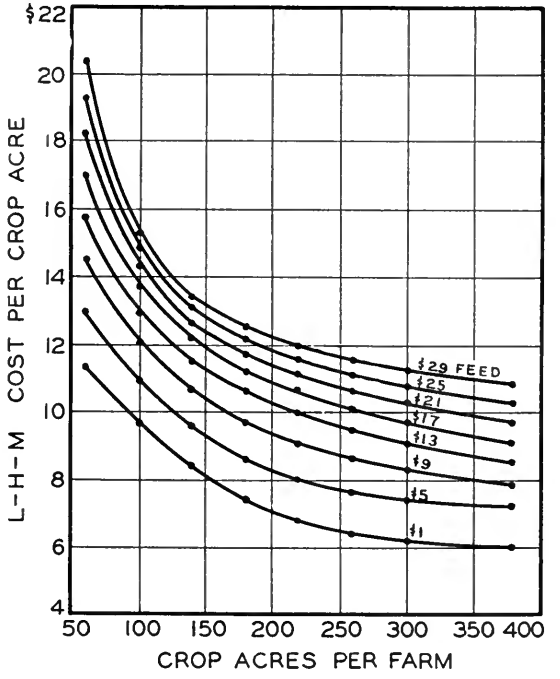

FIG. 13.—HOW VARIATION IN SIZE OF FARM INFLUENCED TOTAL LABOR, HORSE, AND MACHINERY COST PER CROP ACRE ON EIGHT GROUPS OF FARMS CARRYING DIFFERENT AMOUNTS OF LIVESTOCK, 1931

As the size of farm increased the power costs per crop acre decreased on all farms, but they decreased more rapidly on farms with considerable livestock than on farms with little livestock. This difference between the livestock and grain farms in power costs was marked only among the smaller sizes of farms. On the larger farms the amount of livestock carried had little effect on power costs. (This graph is drawn from the same data as Fig. 12; see Table 22.)

the least livestock to care for. The average amount of feed fed per crop acre in these three groups was $11.40. By referring to Fig. 12 we find that for the farms with 100 crop acres (where about $11.50 worth of feed was fed per crop acre) a change of $1 in feed fed per acre is accompanied by a change of 21 cents per crop acre in labor, horse, and machinery cost. Since on the general-purpose tractor farms

of this size-group $1.49 less feed per crop acre was fed than was fed as an average on all farms of this size-group, the cost for labor, horse power, and machinery on these farms should, for purposes of comparison, be increased by 31 cents ($1.49 × .21), making the adjusted cost $12.68 ($12.37 + .31) per crop acre. On the horse farms, on the other hand, 73 cents more feed was fed per crop acre than was fed as an average on all farms of this size-group, which fact necessitates a minus correction of 15 cents ($.73 × .21) per crop acre, making the adjusted cost $12.64 ($12.79 — .15).

Similar adjustments were made for all size-groups for 1930 and 1931 (Table 21). These data indicate what the operating expenses on the farms of the three power types would have been had they all had the average amounts of livestock for the respective size-groups.

TABLE 21.—ADJUSTED LABOR, HORSE, AND MACHINERY COST PER CROP ACRE FOR FARMS OF DIFFERENT SIZE AND OPERATED WITH DIFFERENT TYPES OF POWER, WITH AVERAGE AMOUNTS OF LIVESTOCK;[a] 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse farms		Standard tractor farms		General-purpose tractor farms	
	1930	1931	1930	1931	1930	1931
40– 79	$21.93	$18.17	$21.70	$16.84	$19.65	$17.49
80–119	16.02	12.64	15.95	12.74	16.30	12.68
120–159	13.41	10.85	14.00	10.89	13.72	10.63
160–199	12.09	9.82	12.06	10.13	12.12	9.75
200–239	10.49	8.25	11.38	8.77	11.56	8.88
240–279	10.56	8.02	10.87	8.54	10.68	8.18
280–319	8.81	7.31	10.34	8.82	9.01	7.31
320 and over	8.16	6.94	9.70	7.54	8.86	7.02

[a]The above figures are obtained by allowing for the effect on operating costs of variations in amounts of livestock on actual farms.

As will be seen, the elimination by this method of the influence of variations in the amounts of livestock revealed no very significant differences between the operating costs of farms which were of the same size but on which different types of power were employed (Table 21). However, these adjusted data do indicate that there was a tendency for costs to be lowest on the horse farms. Both in 1930 and 1931 costs were lowest on the horse farms in five of the eight size-groups.

Likewise, the data in Table 21 indicate that there was a tendency for costs to be highest on the standard tractor farms. In four of the size-groups in 1930 and in six size-groups in 1931 the costs were highest on the standard tractor farms. The advantage of general-purpose tractors over standard tractors appears to be in the fact that gen-

eral-purpose tractors offer greater opportunity to lower labor and horse costs than do standard tractors.

Costs on farms of all power types and of all sizes were lower in 1931 than in 1930.

Standards for Labor, Horse, and Machinery Costs

From Fig. 12 may be read the average labor, horse, and machinery cost per crop acre on farms of each size-group and with varying amounts of livestock. What the operating costs were in 1931 on the accounting farms in the various size-groups and in the various amount-of-livestock groups is shown in Table 22. These data indicate what may be expected on better than average central Illinois farms under the price conditions of 1931. Unfortunately price changes soon put standards of this kind out of date, and they can be made usable again only by being revised on the basis of current records or of percentage changes worked out from price indexes for labor, feed, machinery, and fuel. In a following section (page 310) standards for the use of man labor and horses are worked out on a physical basis.

Variations in Costs From Farm to Farm

So far the discussion of costs has been confined to the comparative costs on groups of farms differing in type of power, number of crop acres, or amounts of livestock. Variations in operating costs between individual farms using the same type of power and falling within the same size-group are also of interest. A study of this variation among farms in the 120-to-159 and the 160-to-199 crop-acre groups, for 1931, is shown in Table 23. Costs on these farms were not adjusted for deviations from group averages in the amount of livestock.

It will be noted from Table 23 that the range in operating costs was greatest on the standard tractor farms and least on the horse farms. On the standard tractor farms in the 120-to-159 crop-acre group these costs ranged from $3.50 an acre to $21.50, as compared with $5.50 to $16.50 an acre on the farms using horses. On the other hand, the standard deviation for the general-purpose tractor farms was greater than for either of the other groups, being $3.55 as compared with $2.70 for the standard tractor, and $2.40 for the horse farms. Since there were four times as many farms in the standard tractor group as in the general-purpose tractor group, the standard error of the mean was considerably less on the standard tractor farms.

It is apparent from the study of the standard errors of the mean

TABLE 22.—COMPUTED AVERAGE LABOR, HORSE, AND MACHINERY COST PER CROP ACRE ON FARMS OF VARIOUS SIZES AND WITH VARYING AMOUNTS OF LIVESTOCK;[a] 1,599 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1931

Crop acres per farm	Costs on farms where value of feed fed per crop acre to productive livestock was—															
	$1	$3	$5	$7	$9	$11	$13	$15	$17	$19	$21	$23	$25	$27	$29	$31
60	$11.30	$12.10	$12.90	$13.70	$14.45	$15.15	$15.85	$16.50	$17.10	$17.70	$18.30	$18.85	$19.40	$19.90	$20.40	$20.85
100	9.60	10.30	10.90	11.45	11.95	12.40	12.80	13.20	13.60	13.95	14.25	14.55	14.80	15.05	15.30	15.50
140	8.35	8.95	9.55	10.10	10.60	11.10	11.50	11.90	12.25	12.55	12.80	13.00	13.20	13.35	13.45	13.55
180	7.40	8.00	8.60	9.20	9.70	10.20	10.60	11.00	11.30	11.60	11.90	12.15	12.40	12.55	12.65	12.75
220	6.80	7.40	8.00	8.55	9.10	9.60	10.00	10.40	10.75	11.05	11.35	11.55	11.80	11.95	12.10	12.20
260	6.35	7.00	7.60	8.10	8.60	9.10	9.45	9.80	10.15	10.50	10.80	11.05	11.25	11.45	11.65	11.80
300	6.15	6.80	7.35	7.80	8.25	8.70	9.05	9.40	9.70	10.00	10.30	10.60	10.85	11.05	11.25	11.45
380	6.10	6.65	7.20	7.60	7.90	8.20	8.50	8.80	9.10	9.40	9.70	10.00	10.30	10.60	10.90	11.15

[a]See footnote to Table 21.

TABLE 23.—DISTRIBUTION OF HORSE, STANDARD TRACTOR, AND GENERAL-PURPOSE TRACTOR FARMS ACCORDING TO COST PER CROP ACRE OF COMBINED LABOR, HORSE, AND MACHINERY COST,[a] 1931

Labor, horse, and machinery cost per crop acre	Number of farms consisting of 120 to 159 crop acres			Number of farms consisting of 160 to 199 crop acres		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
$3.00– 3.99	..	2	..	..	..	..
4.00– 4.99	..	1	..	..	1	..
5.00– 5.99	2	..	2	2	3	1
6.00– 6.99	3	4	3	2	8	3
7.00– 7.99	14	13	10	11	24	6
8.00– 8.99	14	26	6	10	44	7
9.00– 9.99	16	40	7	10	34	7
10.00–10.99	16	34	5	6	33	5
11.00–11.99	11	30	4	5	25	3
12.00–12.99	11	22	4	2	20	2
13.00–13.99	6	16	2	4	12	1
14.00–14.99	1	7	2	2	3	..
15.00–15.99	5	9	4	..	..	1
16.00–16.99	1	4	1	..	1	..
17.00–17.99	..	..	..	..	2	1
18.00–18.99	..	2	..	..	1	..
19.00–19.99	..	..	3	..	2	..
20.00–20.99	..	1	..	..	..	..
21.00–21.99	..	1	..	..	..	..
Total	100	212	53	54	213	37
Mean	$10.54	$11.03	$10.80	$9.77	$10.25	$9.68
Standard deviation of sample	$ 2.40	$ 2.70	$ 3.55	$2.20	$ 2.81	$3.12
Standard error of mean	$ .24	$ .19	$ .49	$ .39	$ .19	$ .51

[a]Groupings in this table are according to costs and not adjusted costs; that is, no allowances were made for variations in amount of livestock.

operating costs for the various type-of-power groups that there are really no significant differences between the averages. Let us examine, for example, the difference between the average combined labor, horse, and machinery costs per crop acre on horse farms and on standard tractor farms for the 120-to-159 crop-acre group. Average operating costs on the horse farms of this group were $10.54 and on the standard tractor farms, $11.03—a difference of only 49 cents. The standard error of the difference between these two averages is 30 cents.

In order to indicate any certainty that operating costs were lower on horse than on standard tractor farms, the difference between the two means should be at least twice the standard error of the difference, and it will be noted that the observed difference of 49 cents is less than twice its standard error of 30 cents. The same lack of significant differences prevails also between the other size-groups. This leads to the conclusion that the differences noted in the average operating costs for the various types of power in the various size-groups do not necessarily indicate any significant differences in the actual cost of operating farms with horses or with standard or general-purpose tractors.

The wide range in operating costs that occurred on farms of approximately the same size and having comparable amounts of livestock (Table 24) indicates the opportunity that some farmers have for increasing the efficiency with which they use their labor and machinery.

TABLE 24.—VARIATIONS IN COMBINED LABOR, HORSE, AND MACHINERY COST PER CROP ACRE ON FARMS OF THE SAME SIZE AND WITH THE SAME AMOUNT OF LIVESTOCK

Labor, horse, and machinery cost per crop acre		Crop acres per farm	Value of total feed fed per crop acre to livestock	Number of farms
Range	Average			
$6.00 to $7.99	$7.01	179	$4.97	8
8.00 to 9.99	8.96	181	4.91	17
10.00 to 11.99	10.77	181	4.98	5

Of 30 farms of approximately the same size and having about the same amounts of livestock per crop acre, 8 had average operating costs per crop acre of $7.01, whereas 5 had average operating costs of $10.77. The rest had operating costs between these extremes. The major portion of the difference in operating costs on these farms was due to variations in amounts of labor and power and to differences in the efficiency with which they were used.[1]

Comparison of Low-Cost Farms

Further light is shed on the problem of economical operation by comparing the power organization and the operating costs on the 10 low-cost horse farms with those on the 10 low-cost general-purpose tractor farms in the 160-to-199 crop-acre group (Table 25.)

The farms of the two types averaged about the same number of crop acres per farm but they differed considerably in organization. The horse farms had an average of $796 worth of machinery, 7.3 work horses, and absorbed 18 months of man labor. The tractor farms had an average machinery investment of $1,932 and used 3.4 horses and 16.5 months of man labor. More feed was fed to productive livestock on the tractor farms than on the horse farms.

[1]This study has been limited chiefly to a consideration of differences in labor, horse, and machinery costs which accompany differences in the size and organization of farms. While it has been possible to suggest many of the reasons for differences in costs when size and organization of the farms are the same, there is an evident need for further studies in agricultural engineering, animal husbandry, and farm management in order to determine in detail what practices account for these variations in labor, horse, and machinery efficiencies.

TABLE 25.—COMPARISON OF LOW-COST HORSE FARMS AND LOW-COST GENERAL-PURPOSE TRACTOR FARMS HAVING 160 TO 199 CROP ACRES PER FARM, 1931

	Average of 10 low-cost *horse* farms	Average of 10 low-cost *general-purpose tractor* farms
Acres per farm	221	218
Crop acres per farm	179	182
Machinery investment per farm	$796	$1 932
Number of work horses per farm	7.3	3.4
Months of man labor	18.0	16.5
Number of trucks on 10 farms	1	3
Value of feed fed per farm	$757	$929
Returns per $100 of feed fed	$115	$117
Yield of corn per acre, bushels	45.7	46.4
Yield of oats per acre, bushels	37.5	42.8
Labor, horse, and machinery costs per crop acre		
Horse costs	$1.50	$ .66
Machinery costs	1.02	2.11
Man labor cost	4.76	4.29
Total	$7.28	$7.06

Machinery costs per crop acre were lower on the horse farms, but the increased costs for horses and labor on these farms made the total costs for labor, machinery, and horses about equal to the total costs for these items on the tractor farms. The total crop-acre costs when adjusted to average amounts of livestock were $7.39 on the horse farms and $6.94 on the tractor farms.

Net Cash Expenditures for Horses, Machinery, and Labor

As has been pointed out, there was but little difference in operating costs per crop acre between farms of the three power types. Operating expenses, however, are only in part cash expenses. The fact that horses are fed from home-produced feed, whereas the fuel for tractors has to be purchased, is one important factor favoring lower cash costs on horse farms. Other cash expenditures, such as those for labor, have also to be considered. In a period such as 1930 and 1931, when farm earnings were very low and credit was hard to obtain, the volume of cash outlay necessary to operate a farm becomes a matter of great importance.

Cash expenditures for horses, machinery, and labor for each 100 crop acres were lowest, both in 1930 and in 1931, for horse farms and highest for general-purpose tractor farms (Table 26). In 1930 net cash expenses per 100 acres of crops were $401 on the horse farms, $582 on the standard-tractor farms, and $690 on the general-purpose tractor farms. The corresponding figures for 1931 were: $280, $343,

and $355. The net cash expenses by size-groups are shown in Appendix Table 41. It is apparent at once that cash outlays were much reduced in 1931 as compared with 1930. It is also apparent that the horse-operated farms required a much lower outlay of cash than the tractor farms.

The difference in cash outlay for machinery between the horse-operated farms and the tractor farms was particularly noticeable. In 1930 the general-purpose tractor farms required $576 per 100 crop

TABLE 26.—CASH RECEIPTS AND EXPENSES FOR HORSES, MACHINERY, AND LABOR FOR EACH 100 ACRES OF CROPS ON FARMS[a] OPERATED WITH DIFFERENT TYPES OF POWER, 1930 AND 1931

	Horse purchases	Horse sales	Machinery purchases	Machinery sales and income	Labor hired	Income from labor	Cash decrease total
1930							
Horse farms	$50	$50	$214	$21	$247	$39	$401
Standard tractor farms	23	37	457	96	276	41	582
General-purpose tractor farms	12	35	576	131	312	44	690
1931							
Horse farms	30	41	165	21	185	38	280
Standard tractor farms	19	24	243	65	202	32	343
General-purpose tractor farms	7	29	322	106	201	40	355

[a]Includes only records from Farm Bureau Farm Management Service.

acres as compared with $214 for the horse farms. On the other hand, the income from machinery was much higher on the general-purpose tractor farms, but it was not enough higher to offset the difference in cash outlay.

Cash expenditures for machinery were much less on all groups of farms in 1931 than in 1930. Expenditures continued to be lower on horse farms, but reductions, actually and proportionally, were greater on tractor farms, primarily because fewer tractors and other expensive machines were purchased, but also because of lower fuel prices. Reductions were greater on general-purpose tractor farms than on standard tractor farms.

Differences between the cash outlay for hired labor on horse-operated farms and on tractor farms were not so great as between the cash outlays for machinery on these farms, altho they were of some significance. Altho, as was shown earlier in Table 18, more man labor per year was used on horse farms than on general-purpose tractor farms, cash expenditures for man labor were less on horse farms than on general-purpose tractor farms. On the general-purpose tractor farms in 1930 the value of hired labor per 100 acres of crops was

$312 and on horse farms it was $247; in 1931 it was $201 on the general-purpose tractor farms as compared with $185 on the horse farms. The larger expenditures in cash for labor on the general-purpose tractor farms was due to the fact that tho on the average about the same amount of family labor was available on all farms, the general-purpose tractor farms were much larger than the horse farms and consequently a larger proportion of the labor which they used was hired.

The general-purpose tractor farms had the advantage in the balance between cash outlay and cash income from horses.

In 1930 horse purchases on general-purpose tractor farms were $12 per 100 crop acres and horse sales $35, while in 1931 purchases and sales were $7 and $29 respectively. In other words, horse sales on these farms were almost three times the purchases in 1930 and over four times the purchases in 1931. On the horse farms in 1930, horse sales and purchases balanced at $50, while in 1931 the purchases were $30 as compared with $41 for sales.

The excess of horse sales over horse purchases on the general-purpose tractor farms can, of course, continue only so long as adjustments in power equipments are being made on these farms. Once all the horses have been eliminated that can be replaced by the general-purpose tractor, purchases and sales will more nearly balance.

Further light on relative cash costs of power on farms of different power types is afforded by a study of detailed cost records for horses and tractors in 1931. Of the total cost of keeping horses on these farms in 1931, only 5.8 percent was made up of cash expenses and 18.9 percent was for depreciation. Of the total tractor costs, 55.7 percent was for cash items and 31.8 percent was for depreciation.[1] Whereas depreciation on a tractor represents a cash expenditure which was made at some previous time but which in the accounts is spread over the period when the machine is being worn out, much of the depreciation on horses does not represent an original cash outlay, since many of the horses were reared by the farm operators themselves. The fact that tractors require a relatively heavy cash outlay at one time accounts in part for the fact that few have been purchased since farm prices dropped so severely.

So long as total operating costs are about equal for the various types of power, and so long as prices of farm products are low compared with the prices of machinery, fuel, and oil, farmers will continue

[1]Calculated from detailed cost records for 1931 on farms in Champaign and Piatt counties.

to give considerable attention to cash costs. It is apparent that in 1930 and 1931 the lower cash costs on the farms operated with horses only gave their operators a decided advantage.

Standards for Number of Horses and Amount of Man Labor

Altho the combined input of labor, horses, and machinery on the accounting farms had to be measured in terms of dollars, the labor and horses used may also be measured individually by physical units. The accounts show both the months of man labor and the number of horses used per farm. By Ezekiel's method of joint correlation, employed earlier in this study (see page 299), it was possible to work out the average months of man labor and the average number of horses used on the accounting farms of various sizes, according to the amount of livestock[1] and the type of power employed.

Number of Horses.—The number of horses per farm averaged least on the general-purpose tractor farms and most on the horse farms in all size-groups when the amounts of livestock were approximately the same (Table 27). These data indicate that accounting farms in central Illinois on which general-purpose tractors are used are operated with about half as many horses as are accounting farms of the same size using horses only. Since these accounting farms were known to be more efficient than the average farm, it is logical to accept the numbers of horses used on them as approximate standards for well-organized farms of corresponding size, power type, and amount of productive livestock.

On the farms of the smallest size-group operated with horses or with standard tractors and horses, the number of horses declined as the amount of other livestock increased, which was contrary to the trend shown for the other size-groups. There are two reasons for this difference in trend on small farms: (1) The horse-operated and standard tractor farms in the 40-to-79 crop-acre group decreased in size as the amount of livestock increased, and hence fewer horses were needed on them. (The horse farms of this group feeding more feed than was produced averaged 56.2 crop acres whereas those feeding only 20 percent of the feed produced averaged 64.3 crop acres.) (2) The operators of farms on which all available feed was needed for productive livestock apparently made greater efforts than other operators to eliminate as many horses as possible.

[1]In this section the amount of livestock is measured by the proportion between the value of feed fed on the farm and the total value of feed produced on the farm. This method makes it possible to compare one year with another without adjusting the value of feed for price changes.

TABLE 27.—AVERAGE NUMBER OF HORSES PER FARM ON FARMS OF VARIOUS SIZES AND WITH VARYING AMOUNTS OF LIVESTOCK AS INDICATED BY AMOUNTS OF FEED FED; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Number of horses per farm on farms where—								
	20 percent of raised feed was fed			40 percent of raised feed was fed			60 percent of raised feed was fed		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
60	4.6	3.9	2.1	4.5	3.8	2.3	4.5	3.7	2.3
100	5.2	4.1	2.2	5.2	4.1	2.5	5.2	4.1	2.7
140	6.1	4.6	2.5	6.3	4.6	3.0	6.4	4.7	3.3
180	7.3	5.4	3.1	7.5	5.4	3.7	7.7	5.4	4.0
220	8.5	6.2	3.7	8.8	6.2	4.3	9.0	6.2	4.7
260	9.7	7.0	4.4	10.0	7.0	5.0	10.2	7.0	5.3
300	11.0	7.9	5.0	11.2	7.9	5.6	11.5	7.9	5.9
340	12.2	8.6	5.5	12.5	8.6	6.1	12.8	8.6	6.5
380	13.4	9.2	5.8	13.8	9.2	6.5	14.3	9.2	7.0

Crop acres per farm	80 percent of raised feed was fed			All raised feed was fed			Additional feed was bought		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
60	4.4	3.7	2.4	4.4	3.6	2.4	4.3	3.4	2.4
100	5.2	4.1	2.8	5.2	4.1	2.9	5.3	4.1	2.9
140	6.5	4.8	3.4	6.6	5.0	3.5	7.0	5.1	3.6
180	7.9	5.7	4.1	8.2	5.9	4.2	8.9	6.2	4.3
220	9.3	6.6	4.8	9.6	6.9	4.8	10.4	7.2	5.0
260	10.5	7.5	5.4	10.9	7.9	5.5	11.7	8.2	5.7
300	11.8	8.3	6.1	12.2	8.9	6.2	13.0	9.2	6.4
340	13.2	9.1	6.7	13.6	9.7	6.9	14.6	9.9	7.1
380	14.6	9.8	7.3	15.1	10.2	7.6	16.1	10.4	7.8

Months of Man Labor.—The saving in labor due to the use of the tractor was relatively small both on farms where standard tractors were used and on farms where general-purpose tractors were used (Table 28). The greatest saving effected by the use of general-purpose tractors was effected on the large farms that had but little livestock. There was no apparent saving on the large farms on which more feed was fed than was produced. These data confirm the results observed in the study of man-labor costs.

Differences in the amounts of livestock kept caused greater variations in the amount of man labor used than in the number of horses used. The small grain farms absorbed the time of one man, or 13 months of labor; while the small farms on which feed was bought absorbed the time of one and one-third men or about 16 months of man labor. On the 380 crop-acre grain farms about two and one-half men

were used, while on the farms of the same size but where more feed was fed than was produced from three to four men were used.

TABLE 28.—AVERAGE NUMBER OF MONTHS OF MAN LABOR USED PER FARM ON FARMS OF VARIOUS SIZES AND WITH VARYING AMOUNTS OF LIVESTOCK; 2,950 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Months of man labor used per farm on farms where—								
	20 percent of raised feed was fed			40 percent of raised feed was fed			60 percent of raised feed was fed		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
60	13.0	12.1	12.2	14.0	12.4	14.5	14.8	13.2	16.2
100	14.8	13.2	12.8	15.5	14.0	15.0	16.2	15.2	16.8
140	16.8	15.6	13.8	17.8	16.5	16.2	18.5	18.2	18.0
180	19.5	18.5	15.8	20.5	19.8	18.8	21.5	21.8	20.8
220	22.0	21.7	18.2	23.2	23.0	21.2	24.5	24.8	23.8
260	24.5	24.0	21.8	26.0	25.6	24.2	27.5	27.6	26.8
300	27.0	26.2	23.5	28.5	28.0	27.0	30.0	30.3	30.0
340	29.0	28.0	25.8	31.0	29.9	29.1	32.9	32.6	32.3
380	30.5	29.2	27.8	32.8	31.7	31.0	34.5	34.6	34.0

Crop acres per farm	80 percent of raised feed was fed			All raised feed was fed			Additional feed was bought		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
60	15.5	14.0	16.8	15.8	14.7	16.8	16.0	16.1	16.8
100	17.0	16.5	17.2	17.5	17.5	17.2	18.5	18.9	17.2
140	19.5	19.9	18.8	20.2	21.2	19.5	22.2	22.2	19.8
180	22.5	23.5	22.0	24.0	24.2	23.0	26.5	25.6	24.8
220	26.0	26.5	25.2	27.8	27.8	27.0	31.0	29.0	29.5
260	29.0	29.5	28.5	31.0	31.0	31.0	34.5	32.7	34.0
300	32.0	32.5	31.8	34.5	34.0	34.8	38.0	35.5	38.2
340	34.5	35.0	34.2	37.1	36.6	37.2	41.1	37.9	42.0
380	36.8	37.2	36.0	39.0	38.4	39.5	43.5	39.0	45.0

INFLUENCE OF TYPE OF POWER ON QUALITY OF WORK DONE AND ON FARM EARNINGS

The fact that tractors cover more ground in a 10-hour day than horse-drawn implements and the fact that they may be worked a greater number of hours a day are often given by farmers as important advantages of the tractor. However, the value of getting work done quickly is very difficult to measure and varies considerably from year to year and from farm to farm. If the getting of work done quickly is to have any influence on the net farm income, it must result in increased crop yields or increased livestock efficiency. It is quite clear

that for the quick performance of work the tractor will have its greatest advantage in years when field work has been so delayed by weather conditions that there is a rush to get a large amount of work done in a short time. The years 1930 and 1931 were quite favorable for getting field work done on scheduled time; hence there were but few rush periods. Had the data been gathered in years when field work was delayed by bad weather, the results of this study might have been different.

Study of All Records

A study of corn and oat yields, from 2,950 farm records for 1930 and 1931, indicated that yields were slightly higher on the tractor farms.

Corn yields for farms of all sizes averaged in 1930, 34.8 bushels an acre on the horse farms, 37.0 bushels on the standard tractor farms, and 37.0 bushels on the general-purpose tractor farms. The yields in 1931 were 44.3, 45.3, and 44.6 bushels respectively.

Oat yields in 1930 were 36.1 bushels an acre on horse farms, 38.2 on standard tractor farms, and 38.6 on general-purpose tractor farms. Comparable yields for 1931 were 42.6, 45.4, and 43.4 bushels an acre.

Tabulations made for the 2,950 farm records, when classified by type of power and by size of farm, failed to show any material advantage in farm earnings for any one of the three types of power.

Study of Matched Records

It was recognized that errors might have been introduced into the analyses in this section by unlike distributions of the farms of different power types. For example, a greater (or a lesser) proportion of the horse than of the tractor farms may have been located in those counties having relatively high acreage yields or relatively high earnings. In order to avoid errors that may have resulted from such unlike distributions, a special study was made using only records from all-tillable farms in east-central Illinois. In order further to increase the comparability of the records they were also matched as to size of farm and amount of feed fed per crop acre to productive livestock. By this process 35 records were obtained for each type of power in 1930 and 50 for each type in 1931 (Table 29).

The farms were almost exactly matched as to size and were matched very closely with respect to the amounts of feed fed per crop acre to productive livestock. The power and labor organizations were typical for all three power-type groups. Twice as many horses were on

TABLE 29.—COMPARISON WITH RESPECT TO CERTAIN SELECTED FACTORS OF FARMS OPERATED WITH DIFFERENT TYPES OF POWER; EAST-CENTRAL ILLINOIS, 1930 AND 1931

(Farms are matched in size, amount of livestock, and type of soil)

	1930: 35 farms in each type-of-power group			1931: 50 farms in each type-of-power group		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
Crop acres per farm	198	202	201	188	188	188
Total acres per farm	244	245	245	231	231	228
Feed fed per crop acre	$ 8.95	$ 8.86	$ 9.12	$ 5.94	$ 5.97	$ 6.17
Machinery investment	$1 285	$2 188	$2 423	$1 178	$2 153	$2 546
Number of horses	8.2	6.3	4.0	8.1	6.1	3.7
Months of man labor	21.7	21.1	21.4	20.4	20.9	19.9
Corn yield per acre, bushels	34.7	36.1	36.0	45.8	46.3	47.5
Oats yield per acre, bushels	34.5	39.2	36.8	43.2	48.3	48.3
Return per $100 feed fed	$136	$120	$125	$114	$128	$125
Cost per crop acre						
Man labor	$ 6.65	$ 6.35	$ 6.25	$ 5.20	$ 5.26	$ 5.26
Horse	2.05	1.67	1.03	1.95	1.36	.84
Machinery	1.45	3.04	3.44	1.35	2.36	2.83
Total	$10.15	$11.06	$10.72	$8.50	$8.98	$8.93
Rate earned	1.56%	1.05%	1.44%	−1.35%	−1.21%	− .55%

the horse-operated farms as were on the general-purpose tractor farms but the investment in machinery on the former was only half that on the latter. The months of man labor were slightly higher on the horse than on the tractor farms.

Crop Yields.—Average corn and oat yields were slightly higher on the tractor farms than on the horse farms for both 1930 and 1931. The standard tractor farms produced in 1930 1.4 bushels more corn to the acre and 4.7 bushels more oats to the acre than did the horse farms. In 1931 yields on the standard tractor farms were greater by .5 bushel of corn and 5.1 bushels of oats. The general-purpose tractor farms had in 1930 an advantage over the horse farms of 1.3 bushels of corn and 2.3 bushels of oats an acre. In 1931 the advantage was 1.7 bushels of corn and 5.1 bushels of oats an acre.

The significance or lack of significance of these differences in yield is clearly indicated by a study of the standard errors of the differences. The results of such a study are summarized at the top of the next page.

If twice the standard error is the limit of significance, it is clear that there is no statistical significance in the higher corn yields ob-

MEAN EXCESSES OF YIELDS ON TRACTOR FARMS OVER YIELDS ON HORSE FARMS[a]

	1930		1931	
	Standard tractor	General-purpose tractor	Standard tractor	General-purpose tractor
Corn.....	1.4 ± 1.74	1.3 ± 1.63	.5 ± 1.16	1.7 ± 1.24
Oats.....	4.7 ± 1.92	2.3 ± 2.69	5.1 ± 2.54	5.1 ± 2.18

([a]The standard errors of the differences were calculated by Student's method of determining the significance of differences in the means of paired samples. See Fisher, R. A., Statistical Methods for Research Workers, Chapter 5, 3rd ed. Oliver and Boyd. Edinburgh, 1930.)

served on the tractor farms. On the other hand, the observed oat yields on the tractor farms, except on the general-purpose tractor farms in 1930, were significantly greater than those on horse farms, tho this does not mean that the use of tractors was necessarily responsible for the greater yields.

The extent to which cropping systems were similar for the three type-of-power groups is indicated in Table 30. It should be noted that the proportion of the total acreage in crops with high labor and power requirements tended to be larger on tractor farms than on horse-

TABLE 30.—COMPARISON OF LAND USE ON FARMS OPERATED WITH DIFFERENT TYPES OF POWER, EAST-CENTRAL ILLINOIS, 1930 AND 1931
(Farms are matched in size, amount of livestock, and type of soil)

Kind of crops	1930: 35 farms in each type-of-power group			1931: 50 farms in each type-of-power group		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
	acres	*acres*	*acres*	*acres*	*acres*	*acres*
Corn.....	102.1	101.7	108.6	102.2	102.4	102.4
Oats.....	50.5	45.5	42.9	43.4	44.5	32.3
Wheat.....	17.8	17.9	15.6	13.6	14.2	18.8
Barley.....	2.1	2.7	2.9	2.4	1.7	6.1
Soybeans.....	6.6	13.5	8.7	7.4	8.6	10.1
Other grain.....	.6	.1	1.0	1.2	.9	.9
Hay.....	16.8	14.3	13.9	14.9	14.0	13.3
Other crops.....	1.6	6.3	7.2	2.7	1.6	4.0
Total crops.....	198.1	202.0	200.8	187.8	187.9	187.9

operated farms. In 1930 the average acreage of corn was highest on the general-purpose tractor farms. In the same year the acreage of oats was lower on both standard tractor and general-purpose tractor farms than on horse farms, whereas the acreages of soybeans, and of "other crops" (mostly canning crops) was higher. In 1931 the general-purpose tractor farms had the lowest acreage of oats but the greatest acreages of wheat and barley and the greatest acreage of "other crops."

Both standard and general-purpose tractor farms averaged a slightly higher acreage in soybeans.

Livestock Efficiency.—The returns per $100 of feed fed to productive livestock were higher on the horse-operated farms than on tractor farms in 1930 and lower in 1931 (Table 29). Apparently no one type of power had a consistent advantage in livestock efficiency in these years.

Sources and Amount of Income.—The amount and sources of income for the type-of-power groups are shown in Table 31. There were some differences in the sources of income due to differences in kinds and efficiencies of livestock on the different groups of farms, but the most important differences were in the income from the feed and grain account. Particularly on the general-purpose tractor farms was the income from grain much greater than on the horse farms.

TABLE 31.—COMPARISON OF SOURCES AND AMOUNTS OF INCOME ON FARMS OPERATED WITH DIFFERENT TYPES OF POWER, EAST-CENTRAL ILLINOIS, 1930 AND 1931
(Farms are matched in size, amount of livestock, and type of soil)

Sources of income	1930: 35 farms in each type-of-power group			1931: 50 farms in each type-of-power group		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
Cattle	$ 261	$ 83	$ 293	$ 79	$117	$ 81
Hogs	1 118	1 178	1 085	579	577	594
Sheep	63	47	64	29	8	24
Poultry	121	47	73	69	86	54
Egg sales	208	150	184	90	109	102
Dairy sales	501	553	431	279	393	449
Feed and grain	1 146	1 440	1 694	426	573	915
Labor	35	34	93	30	62	91
Miscellaneous	27	14	...	29	4	45
Total	$3 480	$3 546	$3 917	$1 610	$1 929	$2 355

The difference in amount of income from grain can be explained to some extent by the fact that there were twice as many horses to feed on the horse-operated farms as on the general-purpose tractor farms. The higher yields observed on the tractor farms was also a factor. The differences in cropping systems, noted on page 315, would also result in slightly higher incomes from grain on the tractor farms.

These data indicate that even on farms of the same size, and with the same amount of feed fed to productive livestock, gross incomes averaged larger on tractor farms than on horse farms.

Operating Costs.—The combined man labor, horse, and machinery costs per crop acre were slightly less on the horse-operated farms than on either the standard tractor or general-purpose tractor farms for

both 1930 and 1931 (Table 29). In 1931 costs were less on the horse farms than on the standard tractor farms by 48 cents a crop acre, or $90 a farm. In 1930 the difference was 91 cents a crop acre, or $182 a farm.

It will be noted that this difference in combined operating costs agrees with the results of the analysis of all records (page 302).

Farm Earnings.—In 1930 farm earnings were higher on the horse-operated farms than on tractor farms, while in 1931 losses were greater on the horse farms (Table 29).

DETAILED TRACTOR COST STUDY

Altho, as has been shown, there was but little difference between the average costs per crop acre for labor, horses, and machinery on horse farms and on tractor farms, it should be helpful to study in more detail the cost per year and per hour for horse and tractor service as well as the amount of work which can be accomplished with these different types of power in a 10-hour day. The present section will be devoted to a study of tractor costs, and similar information concerning horse costs will be presented in a later section.

TABLE 32.—AVERAGE COSTS, YEAR BASIS, OF OPERATING TWO- AND THREE-PLOW STANDARD TRACTORS AND TWO-PLOW GENERAL-PURPOSE TRACTORS, 1931

	Two-plow standard[a]		Three-plow standard[a]		General purpose	
	Total	Per hour	Total	Per hour	Total	Per hour
Number of tractors	32	....	19	....	65	....
Cost items						
Fuel, oil, and grease	$101.80	$.265	$130.86	$.326	$126.25	$.246
Repairs	35.30	.092	34.39	.086	19.60	.038
Man labor (exclusive of driver)	6.38	.017	11.90	.030	10.50	.021
Miscellaneous	.15	....	.32	....	.....	....
Total operating costs	143.63	.374	177.47	.442	156.35	.305
Shelter	5.26	.014	4.21	.010	5.00	.010
Depreciation	70.58	.184	89.94	.224	97.23	.189
Interest	22.14	.058	33.55	.084	28.88	.056
Total overhead	97.98	.256	127.70	.318	131.11	.255
Total cost	$241.61	$.630	$305.17	$.760	$287.46	$.560
Hours of drawbar work	342		341		488	
Hours of belt work	41		61		26	
Total hours	383		402		514	
Crop acres per farm	202		262		220	

[a]The standard-tractor figures are based on detailed cost records extending over a five-year period (1927-1931), with fuel, oil, labor, and repair costs adjusted to 1931 prices.

The study of tractor costs is based on cost records for 65 general-purpose tractors for 1931 and on cost records for 32 two-plow and 19 three-plow standard tractors, extending over a five-year period, with fuel, oil, labor, and repair costs adjusted to 1931 prices.

The average annual cost (1931 figures) for the operation of tractors was $241.61 for two-plow standard tractors, $305.17 for three-plow standard tractors, and $287.46 for two-plow general-purpose tractors (Table 32). The average costs per hour of operation were 63 cents, 76 cents, and 56 cents respectively.

Tractor Operating Costs

The cost for fuel, oil, and grease averaged 26.5 cents an hour for the two-plow standard tractors, 32.6 cents for the three-plow standard tractors, and 24.6 cents for the general-purpose tractors. Fuel prices in 1931 were considerably lower than in previous years and these lower prices were an important factor in the costs of tractor operation.

Repair costs, including charges for parts and for pay to mechanics in making repairs, averaged $35.30 for the two-plow and $34.39 for the three-plow standard tractors but only $19.60 for the general-purpose tractors. This large variation in the cost of repairs was due to a difference in the average age of the three types of tractors. Of the 32 two-plow standard tractors, 10 were over eight years old and only 12 were under four years old. Of the 19 three-plow tractors, 6 were seven years old and 8 were under four years. None of the general-purpose tractors were over six years old and 42 were under four years. Differences in repair costs due to differences in the ages of the tractors are of particular importance in interpreting the cost of operating the general-purpose tractors. Many of these general-purpose tractors had had no major repairs at all, and the $19.60 average for repairs was lower than would have obtained had these tractors not been relatively new.

The charge for man labor included only the time spent by the operators in making repairs and adjustments and in servicing the tractors. This labor was charged against the tractors at the rate of 21 cents an hour.

Fixed or Overhead Costs

Depreciation was the largest item of expense other than fuel, oil, and grease, and averaged $70.58 for the two-plow standard tractors, $89.94 for the three-plow tractors, and $97.23 for the general-purpose tractors. The higher depreciation on general-purpose tractors than on

two-plow standard tractors was due to a larger initial investment and to a greater number of hours of usage a year. On the hourly basis the depreciation on these two types of tractors was practically the same. Greater yearly usage also accounts for the higher depreciation of general-purpose tractors than of three-plow standard tractors.

Interest on the investment amounted to $22.14 for the two-plow standard tractors, $33.55 for the three-plow standard tractors, and $28.88 for the general-purpose tractors. These differences were very largely the result of differences in the purchase prices of the tractors.

Hours Tractors Were Used

The total average number of hours of use for the general-purpose tractors was considerably higher than for the standard tractors (Table 32). The use of the general-purpose tractor for corn planting and cultivation explains the greater number of hours it was used at drawbar work. The three-plow standard tractors were used the greatest number of hours at belt work and the general-purpose tractors the least.

Variation in Hour Cost

There was wide variation in the hourly cost of operating tractors of similar type on different farms. In studying the reasons for this variation the cost records of the 65 general-purpose tractors were used because of the greater number of these records.

The total cost per hour of operating the 65 general-purpose tractors in 1931 varied from 41.7 cents to 95.7 cents but was below 70 cents an hour on 58 of the tractors (Table 33). Since fuel cost alone made up

TABLE 33.—VARIATION IN TOTAL COST OF OPERATION PER HOUR OF USE OF 65 GENERAL-PURPOSE TRACTORS, 1931

Cost per hour	Number of tractors
cts.	
40.0–49.9	19
50.0–59.9	26
60.0–69.9	13
70.0–79.9	3
80.0–89.9	3
90.0–99.9	1

approximately a third of the total cost of operating these tractors, variations in the average fuel consumption per day of work was one of the important factors causing variations in the total cost per hour. The average fuel consumption per 10-hour day by the 65 tractors was

19.6 gallons, but the rate of consumption varied greatly from tractor to tractor. Total costs per hour rose steadily with an increase in the amount of fuel required per day (Table 34). A part of the variation in amount of fuel used per day was probably due to the fact that some tractors were used more for the heavier jobs, such as plowing, than were others. However, it is evident that the different tractors varied greatly in the amounts of fuel used at the same kinds of work, and that this difference was one of the chief causes of variation in the cost of operating the tractors.

TABLE 34.—INFLUENCE OF AMOUNT OF FUEL CONSUMED ON COST OF OPERATION OF 65 GENERAL-PURPOSE TRACTORS, 1931

Fuel used per 10-hour day	Number of tractors	Average cost per hour
gals.		*cts.*
12.0–15.9	17	52.2
16.0–19.9	23	56.8
20.0–23.9	16	57.3
24.0 and over	9	70.4

Much of the variation in the average cost per hour of operating these tractors was due to variations in the number of hours a year that the tractors were used. The average cost per hour decreased steadily as the number of hours of use increased (Table 35). This decrease in total cost per hour is accounted for by the influence of the hours of use on the overhead costs of depreciation, interest, and shelter.

The depreciation charge per hour decreased with the increase in the number of hours of use but not at a proportionate rate (Table 35). The tractor owners in estimating the life of their tractors in years took into account the hours that the tractor was operated annually. Their estimates indicate, however, that a part of the depreciation of a tractor goes on regardless of the number of hours used. The per-

TABLE 35.—INFLUENCE OF TOTAL HOURS OF USE ON HOUR COST OF OPERATION OF 65 GENERAL-PURPOSE TRACTORS, 1931

Hours of use	Number of tractors	Total cost per hour	Depreciation per hour	Percent depreciation was of total cost	Interest per hour	Percent interest was of total cost
		cts.	*cts.*		*cts.*	
200–349	11	66.2	23.8	36.0	9.1	13.7
350–499	25	59.1	20.5	34.7	6.6	11.2
500–649	17	54.6	18.6	34.1	5.0	9.2
650–799	8	50.6	15.3	30.2	4.2	8.3
800 and over	4	46.3	15.0	32.4	3.2	7.0

centage that depreciation made up of the total cost decreased with the increase in hours of use.

Interest charges, while slightly higher per year on those tractors with greater use, were much more fixed than depreciation charges; consequently the interest charges per hour decreased relatively more rapidly than the depreciation charges as the hours of use increased (Table 35).

Variations in the initial cost of the tractors cause some variation in the charges made for depreciation and for interest. On these particular tractors, however, charges for depreciation and interest were not greatly affected, except in a very few cases, by variations in original costs. Of the 65 tractors 44 had an original cost of $875 to $925.

For the purposes of this study a fixed charge for shelter was made against all tractors. This shelter charge, however, was but a relatively small part of the total expense and hence variations in the hours of use caused only slight variations in the shelter charge per hour.

Since these tractors had been but recently acquired repair costs were small and caused only small variations in hour costs.

Accomplishments of the General-Purpose Tractor

The average acreages covered by general-purpose tractors in a 10-hour day at different operations are shown in Table 36. Only rates for those sizes of implements commonly used are given. The 14-inch gang plow and the 7-foot tandem disk were standard-size equipment used with the general-purpose tractors, altho several 8-foot tandem disks were also used. The most common sizes of harrows used were 15, 18, and 20 feet in width. The number of acres covered by the two-row and three-row cultivators, it will be observed, differed approximately according to the difference in number of rows. The accomplishments of the four-row cultivators are not shown, for the number of

TABLE 36.—AVERAGE ACCOMPLISHMENT OF 65 GENERAL-PURPOSE TRACTORS AT VARIOUS JOBS WITH VARIOUS SIZES OF IMPLEMENTS, 1931

Kind of implement	Size of implement	Total acres	Acres per 10-hour day
Plow	2-14-inch	6 954	7.8
Disk	7-foot-tandem	9 114	23.4
Harrow	20-foot	4 964	72.8
Planter	3-row	1 927	30.8
Rotary hoe	3-row	2 403	46.7
Cultivator	2-row	15 344	21.9
Cultivator	3-row	4 629	31.6
Binder	8-foot	2 439	19.7
Corn picker	2-row	2 076	13.1

records where the four-row cultivator was used was not considered large enough to give a significant average.

The accomplishments in acres covered per day at a large number of jobs indicate the adaptability of the general-purpose tractor to field work. The wide range in the adaptability of the general-purpose tractor is further shown by a comparison of the percentage of each operation done by horse power and by tractor power on another group of 65 farms employing general-purpose tractors and horses (Table 37). A certain amount of specialization in the use of horses and tractors is indicated. Horses, for example, were used very little for plowing and

TABLE 37.—PROPORTION OF DIFFERENT FIELD JOBS PERFORMED BY TRACTORS AND BY HORSES, 65 CENTRAL ILLINOIS FARMS EMPLOYING GENERAL-PURPOSE TRACTORS AND HORSES, 1931

Kind of work	Total acres	Percent of work done by general-purpose tractors	Percent of work done by horses
Plowing	8 555	94.0	6.0
Disking	18 871	94.8	5.2
Harrowing	15 850	76.3	23.7
Cultivating	20 992	73.9	26.1
Planting	6 994	16.7	83.3
Rotary hoeing	6 610	71.6	28.4
Grain binding	3 671	89.7	10.3

disking, whereas most of the planting was done with them. Many farmers used horses for the first cultivation when the corn was small or for cross cultivating on poorly checked rows where the tractor cultivator could not be used to good advantage. Of the third and fourth cultivations 85.3 and 89.3 percent, respectively, was performed by tractors. Hot weather encouraged the use of tractor power for the last cultivations while the increased size of the corn also favored motor cultivation.

Quality of Work Done by Tractor Cultivators

The general opinion of farmers using tractor cultivators was that the quality of work done by tractor cultivators was as good or better than the quality of work done by horse cultivators. Of 81 farmers expressing opinions, 25 thought that the tractor cultivators did the cultivating better than horse cultivators did, 50 that they did it just as well as horse cultivators or better, and only 6 that they did not do it so well.

Distribution of Belt and Custom Work

An average of 26 hours of belt work was performed by the general-purpose tractors. Of this amount grinding was the most frequent

operation with a total of 13 hours for the year. The remaining 13 hours were almost equally divided between wood-sawing, shelling, threshing, silo filling, baling, and pumping water.

Combining and corn husking made up over half the total hours of custom work performed by the general-purpose tractors. The peaks of custom work were therefore in the months of July, October, and November. However, except by a few farm operators, no major custom work was done. Custom work on 52 farms averaged 24 custom hours per tractor, but 12 was the largest number of farmers reporting custom work for any one month. The general adoption of tractors has greatly limited the amount of custom work that can be obtained unless some special machine such as a corn picker or a combine is also used.

DETAILED STUDY OF HORSE COSTS

In order to get a more detailed picture of horse costs and the amount of work that may reasonably be expected with horse-drawn equipment, detailed cost records were obtained for 35 central Illinois horse farms in 1931 (Table 38).

TABLE 38.—HOURS OF USE AND COST OF KEEPING HORSES ON 35 FARMS IN CENTRAL ILLINOIS, 1931

	Average of 35 farms where *no tractors* were used
Acres per farm	231
Crop acres per farm	189
Number of work horses per farm	8.2
Crop acres worked per horse	23.0
Amounts of feed fed	
Corn, bushels	22.8
Oats, bushels	38.5
Hay, tons	.9
Other roughage, tons	.3
Pasture days	198
Cost items per work horse	
Feed	$39.45
Labor	10.60
Interest	4.82
Depreciation	4.32
Shelter	4.83
Harness	2.74
Miscellaneous*	.81
Total cost for year	67.57
Manure credit	5.23
Net cost for year	62.34
Average hours horses were worked per horse	652
Horse cost per hour	.096

*The miscellaneous items consisted entirely of cash expenditures for veterinary services, medicines, and minor supplies.

Costs per Year, per Hour, and per Acre

On these farms the horses were worked an average of 711 hours a year each, at an average net cost of $62.34, making an hour-cost of 9.6 cents.

That these farms were operated with greater efficiency than were even the average of the accounting farms which were operated with horses is indicated by a comparison of the horse, machinery, and man-labor costs on these farms with the 1931 costs for the same items on the 54 horse-operated farms previously studied ranging in size from 160 to 199 crop acres. These 35 farms averaged 189 crop acres per farm and had horse costs of $1.93 per crop acre, machinery costs of $1.39, and man labor costs of $5.17, making a total labor, horse, and machinery cost of $8.49 per crop acre. The 54 horse farms considered earlier in this study had, as noted in Tables 15, 16, 18, and 19, costs of $2.05, $1.60, $6.12, and $9.77, respectively, for comparable items.

The very low cost for horse labor on these large farms suggests that men who still operate large farms with horses are probably as a class particularly efficient in the use of horses, since it is on large farms that the tractors seem to be best adapted to power needs.

Rate at Which Field Work Was Done

Daily records were obtained from the 35 horse farms to show the kind of work that was done each day, the number of horses used, and the acreage covered. The fact that tractors cover more ground in a

TABLE 39.—AMOUNT OF WORK DONE PER DAY WITH HORSE-DRAWN IMPLEMENTS ON 35 CENTRAL ILLINOIS HORSE-OPERATED FARMS, 1931

Kind of implement	Size of implement	Number of horses	Total acres covered	Acres per 10-hour day
Plow	2-14-inch	5	556	5.6
Disk (single)	10-foot	6	2 863	22.2
Disk (tandem)	8-foot	8	474	19.8
Harrow	20-foot	4	3 083	39.5
Planter	2-row	2	3 491	17.1
Cultivator	1-row	2	4 277	7.9
Cultivator	2-row	3	2 361	15.0
Cultivator	2-row	4	1 208	16.8
Binder	8-foot	4	2 001	15.2

10-hour day than horses do is evidenced by a comparison of the data in Table 39 with that in Table 36.

Many more power combinations, it should be observed, are possible with horse-drawn implements than with tractor-drawn, with the result

that there is greater difficulty in getting sufficient data on amounts of work performed with horses to provide representative averages. Power combinations were particularly diversified for plowing on these 35 horse farms. Teams with four and five horses were used with plows having two 12-, 13-, or 14-inch bottoms; occasionally teams of six and seven horses were used with plows having two 14-inch bottoms; eight-, nine-, and ten-horse teams were used with plows having three 14-inch bottoms. Not enough acres were plowed by any one power combination with a particular size plow to provide really reliable averages. The five- and six-horse teams on the 14-inch gangs, however, plowed more acres than any other combination.

On these 35 farms the five-horse teams with 14-inch gangs plowed 5.6 acres in a 10-hour day, which is at a rate slightly higher than usually reported. In comparison, general-purpose tractors on 65 farms (Table 36) plowed 7.8 acres with the same size of plow. Six horses on 10-foot disks averaged 22.2 acres a day, while eight horses on 8-foot tandem disks averaged 19.8 acres a day, as compared with 27.0 acres for general-purpose tractors pulling implements of the same size. In harrowing, four horses covered almost 40 acres with 20-foot harrows, whereas tractors covered about 73 acres with implements of the same size.

The horse-drawn planters lacked 3 acres a day of planting 20 acres, which is considered by many farmers to be an exceptionally good day's planting. Three-row tractor-drawn planters covered about 31 acres. With three horses on the two-row cultivators 15 acres of corn were covered in 10 hours, as compared with 22 acres where motor cultivators were used. Horses on 8-foot binders were able to average 15 acres a day, whereas tractors on 8-foot binders covered 20 acres.

These data indicate the approximate amount of land which a farmer should cover in a 10-hour day with various power combinations. It is apparent at once that one man with a tractor will do more field work in a day than a man with the average-sized team.

SUMMARY AND CONCLUSIONS

Variation in Power Organizations on Illinois Farms.—The character of the power organizations found on farms in different sections of Illinois varies greatly from section to section. Power organizations also vary greatly from farm to farm within each area.

The variations that exist are in large part consistent with good practice and have, as a rule, been brought about by the efforts which

farmers have been making to adjust their power organizations to their individual needs. Individual needs for power vary between farms because of differences in size, type of land, and the kind of production for which the farm is organized, and because of differences in the skill and other qualifications of the operators.

Variations in the power organization, however, are in part due to differences in the personal preferences and financial resources of the operators, and to the many changes within the past fifteen years in the types of power units available for farmers and in economic conditions.

An analysis of 1930 and 1931 records from a group of central Illinois accounting farms indicates clearly that farms operated with tractors and horses are considerably larger than those operated with horses only. The amount of livestock per acre was much greater on small farms than on large farms. Horse and tractor farms comparable in size carried approximately the same amounts of productive livestock.

Numbers of Horses and Horse Costs.—On the farms studied, which were typical of well-managed corn-belt farms, general-purpose tractors had a distinct advantage over standard tractors in reducing the number of horses and horse costs. However, many tractor farms have retained more horses than are necessary to meet the power requirements of the farm. Numbers of horses in the years covered by this study were declining on horse-operated farms as well as on tractor farms, altho much less rapidly on the former. On the tractor farms this decline usually represented a planned adjustment toward a more efficient power organization, altho an unplanned excess of deaths over births and purchases was also a factor.

Machinery Investments and Costs.—The much higher machinery costs on tractor farms than on horse-operated farms were due not only to much greater operating expenses for machinery but also to a much higher machinery investment. This higher investment was due to the cost of the tractors themselves, to more motor trucks, and to more combines, corn pickers, and other machines that require rather large investments. The investment required in the purchase of a tractor and tractor equipment is an important factor in preventing their adoption on many farms, especially in years when prices for farm products are relatively low.

The higher investment in machinery on the tractor farms than on the horse-operated farms was only in part offset by a lower investment in horses. Combined machinery and horse investments and also combined machinery and horse costs were higher on the tractor farms than on the horse-operated farms.

Amounts of Man Labor and Man-Labor Costs.—On the tractor farms slightly less labor was used than was used on comparable horse farms, with general-purpose tractor farms having a slight advantage over the standard tractor farms. The greatest saving in amount of man labor was effected by the general-purpose tractors on the large grain farms.

Likewise, the cost of man labor was slightly lower on the tractor farms than on the horse-operated farms, altho tractor owners whose records are analyzed in this study had apparently not taken full advantage of the opportunity their tractors afford for reducing man labor costs.

Combined Operating Costs.—The combined labor, horse, and machinery costs averaged lowest on the horse-operated farms and highest on the standard tractor farms. However, the differences were slight, and the variation was great within each power-type group. Because of such wide intragroup variations it cannot be concluded with certainty that horse farms in general are operated with lower costs than are tractor farms.

The wide variation in the operating costs on farms of the same size, type, and power organization indicates that many farmers have an opportunity to reduce operating costs without changing their type of power. Some farmers, however, would profit by making a change in power type.

Cash Operating Expenses.—On these central Illinois farms cash operating expenses were higher on the farms operated with tractors than on farms operated with horses only. Whether such a difference is of general significance depends on the relation between the prices of things farmers have to sell and the things they purchase. When prices of farm products are relatively low, as they were in 1930 and 1931, farmers are at a disadvantage when they exchange them for such items as machinery, motor fuel, and labor. Often the difficulty of obtaining credit on satisfactory terms is also a disadvantage when large cash expenses are involved.

Relation of Type of Power to Livestock Efficiency, Crop Yields, and Net Earnings.—In a study of the present kind on the influence of type of power on crop yields, livestock efficiency, and farm earnings, it is very difficult to hold constant or to allow adequately for factors other than power which have an influence on the items studied. It is impossible to account completely for all such factors. It is certain, however, that by the methods of analysis used in this study no marked

superiority in any one of these respects was demonstrated for any one type of power.

The type of power used on these farms had no relation to the amount of productive livestock found on them. It is sometimes pointed out that, by reducing the time required at field work, a tractor enables a farmer to care for more livestock or to give his livestock better care. This opportunity undoubtedly exists but the present study does not show that central Illinois farmers have in general taken advantage of it.

The yields of corn and oats averaged slightly higher on the tractor farms than on the horse-operated farms during the two years of this study, but the differences were neither great enough nor consistent enough to warrant a conclusion that this relationship was due to the type of power used.

Gross incomes were higher on the tractor farms than on the horse-operated farms, the difference being largely due to differences in income from grain, but the higher gross income on the tractor farms was offset by higher expenses, the net earnings on tractor-operated and horse-operated farms being about the same.

If it could be demonstrated that higher net incomes as a rule accompany the use of tractor power, there would yet remain the problem of ascertaining whether the use of tractors resulted in the higher net income or whether the higher net income resulted in the purchase of tractors. It probably is true, for example, that operators who obtain higher net returns from their farms thru high crop yields and efficient livestock production will be most apt to have the money with which to purchase tractors and power-operated equipment should they so desire.

Probably the safest generalization that can be made from the data concerning relative earnings on the tractor and the horse-operated farms is that the type of power used had as little influence on average farm earnings as it did on average combined labor, horse, and machinery costs, which, as already shown, was not much. Nevertheless it does not follow that what would be true for Illinois farmers as a whole would be true for individual operators. There can be but little doubt that some farmers have increased their net income by changing from horses to tractors or from standard tractors to general-purpose tractors, while others have reduced their net income by the same change. It is logical to expect that for the most part those operators who have not changed are the ones who would profit least by so doing. The fact that horses tend to be concentrated on small livestock farms lends some weight to this conclusion.

Tractor Costs.—In 1931 costs per hour of operation averaged 63 cents for two-plow standard tractors, 76 cents for three-plow standard tractors, and 56 cents for two-plow general-purpose tractors. The average hours of use were 383, 402, and 514 respectively. (Table 32.)

Variations in total hours of tractor use and in the amount of fuel used per hour of operation were the chief factors accounting for the variation in the hour cost of tractor operation.

Horse Costs and Accomplishments With Horses.—In 1931 the net cost of keeping a work horse on a group of 35 central Illinois horse-operated farms averaged $62.34. Each horse was worked an average of 652 hours, at an average cost of 9.6 cents per hour. (Table 38.)

From a study of the average rates at which tractors and horses performed certain field jobs it is apparent that one man with a tractor will do more field work in a given number of hours than a man with the average-sized team. However, almost as many months of man labor were used during a year on farms operated with both tractors and horses as on farms of the same size and with the same amount of livestock but operated with horses only. The men who used horses only made up for the longer time it took to perform field work by working a greater number of days during the year than the men did who used tractors.

Tractors Make Possible More Leisure or an Expansion of the Farm Business.—Since there is no particular difference in average costs between operating with horses and operating with tractors, the leisure time which tractors make possible may be sufficient to cause many operators to prefer them. On the other hand, it must be remembered that cash operating costs are much higher with the tractors than with the horses.

It must also be kept in mind that the individual farmer who plans his work well so that he can utilize the time saved by using tractors to farm more land or to care for more productive livestock has an opportunity to increase his net income over that of the farmer who operates with horses only or who uses for leisure the time he saves thru operating with tractors. Averages for a large number of farms indicate, however, that tractor farmers as a whole have not taken advantage of this opportunity to increase their incomes.

The influence of labor and power efficiency on the standard of living is difficult to measure, and the records analyzed in this study throw no light on the subject. We may say, however, that to the extent that time saved is used in making the farm a better place on which to

live, such saving of time may be entirely justified even tho it is not reflected in a reduction of total labor costs or in higher earnings.

Future Trends in Power Organization.—Many factors will doubtless influence the future trends in the organization and use of farm power. So long as prices of farm products are relatively low there will be a particular need for farmers to operate with low costs. Relative prices of such items as hired labor, horses, horse feeds, mechanical power units, and motor fuels will be of importance in determining trends in the use of particular types of power. The extent to which mechanical power units are made more efficient will also be an important factor. With respect to the possibility of increasing the relative importance of horses as sources of farm power it must be recognized that the breeding of horses has declined to the point that any increase in their numbers could take place but slowly.

Each Farm an Individual Problem.—One point that stands out clearly in this study is the impossibility of making any general recommendation in favor of any particular type of power for Illinois farms. Each farm is an individual problem. What power set-up is most desirable depends on money resources, the physical characteristics and setting of the farm, the preference of the operator for a given combination of power and machinery and his ability to utilize it. In large measure the success that an operator will have with any particular type of power equipment and organization will depend upon his own ability to handle it and his interest in it.

APPENDIX

TABLE 40.—LABOR, HORSE, AND MACHINERY COSTS PER CROP ACRE FOR FARMS OF DIFFERENT SIZES AND WITH DIFFERENT AMOUNTS OF LIVESTOCK; 1,599 CENTRAL ILLINOIS ACCOUNTING RECORDS, 1931

Value of feed fed per crop acre to livestock[a]	40–79 crop acres		80–119 crop acres		120–159 crop acres		160–199 crop acres		200–239 crop acres		240–279 crop acres		280–319 crop acres		320 crop acres and over	
	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre	Number of farms	Cost per crop acre
$0.00–$1.99	2	$11.22	7	$ 9.62	13	$ 8.51	10	$7.13	20	$7.79	15	$6.48	7	$5.78	15	$5.86
2.00– 3.99	8	14.93	16	10.74	47	8.95	40	8.51	41	7.50	33	7.65	15	6.69	24	6.83
4.00– 5.99	12	12.37	34	10.95	56	9.72	58	9.10	49	7.96	24	7.88	17	8.16	22	7.10
6.00– 7.99	3	13.06	28	11.50	51	9.93	41	9.25	40	8.46	24	8.00	6	7.69	18	7.40
8.00– 9.99	13	14.97	40	11.74	51	10.83	44	9.87	16	9.68	5	8.53	6	9.40	10	8.43
10.00–11.99	7	14.72	33	12.31	42	10.78	30	9.78	20	9.08	10	9.11	6	9.00	4	8.12
12.00–13.99	10	17.61	29	12.85	28	12.03	18	10.77	13	10.51	7	9.77	3	8.87	6	8.69
14.00–15.99	10	16.09	21	13.35	20	12.20	15	12.14	9	10.22	3	10.09	5	9.86	2	7.96
16.00–17.99	8	16.26	24	15.33	12	12.23	13	11.52	6	9.89	3	12.09	3	8.08	1	12.14
18.00–19.99	8	18.87	10	13.98	9	12.39	15	12.89	4	10.47	4	9.94	..	....	..	....
20.00 and over	33	21.67	35	14.81	36	13.22	20	12.62	11	11.94	6	11.80	3	9.85	3	9.88
Total	114	.....	277	.....	365	.....	304	.....	229	.....	134	.....	71	.....	105	.....

[a]Value of feed fed is used here as a measure of the amount of livestock kept. See footnote, page 285.

TABLE 41.—NET CASH EXPENSES PER 100 CROP ACRES FOR HORSES, MACHINERY, AND LABOR ON FARMS[a] OPERATED WITH DIFFERENT TYPES OF POWER; CENTRAL ILLINOIS ACCOUNTING RECORDS, 1930 AND 1931

Crop acres per farm	Horse expenses per 100 crop acres on—			Machinery expenses per 100 crop acres on—			Labor expenses per 100 crop acres on—		
	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms	Horse farms	Standard tractor farms	G. P. tractor farms
1930									
40– 79	$+27[b]	$+14	$ 0	$299	$682	$1 345	$ 57	$ 21	$ 9
80–119	2	+15	+26	278	446	462	198	78	102
120–159	+ 9	+19	+46	175	399	540	210	197	106
160–199	5	+ 3	+10	151	351	576	219	221	188
200–239	18	+ 9	+ 5	102	368	357	320	258	249
240–279	35	+27	+56	116	307	536	121	261	177
280–319	..	+13	+10	...	315	513	...	247	248
320 and over	..	+13	+26	...	294	351	...	408	439
Average	0	+14	+23	193	361	445	208	235	268
1931									
40– 79	$ 50	$ 10	$ ..	$221	$254	$...	$ 98	$176	$...
80–119	+ 2	+ 4	+ 3	187	213	177	197	59	57
120–159	+18	+ 4	+16	121	208	230	70	113	85
160–199	+41	+10	+28	145	180	277	172	193	96
200–239	+18	+ 5	+40	111	148	159	130	172	91
240–279	+ 7	+ 3	+26	88	149	164	336	218	177
280–319	33	+ 5	+17	122	197	195	149	221	133
320 and over	+22	+ 5	+16	70	165	247	111	231	240
Average	+11	+ 5	+22	144	178	216	147	170	161

[a]Includes only records from the Farm Bureau Farm Management Service. [b]The plus sign (+) is used to indicate a net cash increase.

TABLE 42.—NUMBERS OF POWER UNITS ON ILLINOIS FARMS IN DIFFERENT FARMING-TYPE AREAS, 1930 U. S. CENSUS

	Horses and mules	Automobiles	Trucks	Tractors	Electric motors	Stationary gas engines	Number of farms	Acres in farms
								thousands
Area 1	75 903	20 933	8 949	9 829	3 467	12 266	20 294	2 630
Area 2	70 586	16 759	4 516	6 004	1 654	9 450	15 981	2 482
Area 3	140 705	31 075	6 330	11 359	3 528	12 578	31 210	4 841
Area 4	209 108	42 647	9 129	20 474	4 288	24 490	40 454	6 985
Area 5	76 434	16 728	1 979	6 540	596	5 688	19 278	2 597
Area 6	96 049	18 583	2 865	6 112	1 069	6 095	21 425	3 411
Area 7	89 654	19 080	3 557	4 643	545	5 787	23 208	3 007
Area 8	126 621	27 068	3 046	4 667	410	2 946	42 647	4 742
Total for state	885 060	192 873	40 371	69 628	15 557	79 300	214 497	30 695

12-33—8000—4189
5-34—8000—5711