AN ECONOMIC ANALYSIS OF THE CAPITAL INVESTMENT IN FARM MACHINERY IN THE OZARKS OF SOUTHEASTERN MISSOURI

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Master of Science

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by

Dale W. Wilson

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The undersigned, appointed by the Dean of the Graduate Faculty, have examined a thesis entitled

AN ECONOMIC ANALYSIS OF THE CAPITAL INVESTMENT IN FARM MACHINERY IN THE OZARKS OF SOUTHEASTERN MISSOURI

presented by

Dale W. Wilson

a candidate for the degree of

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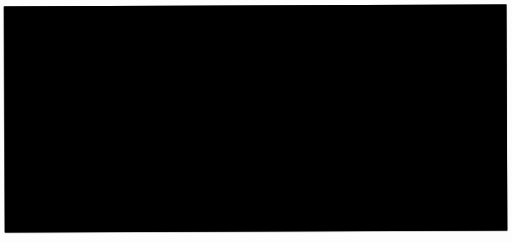
and hereby certify that in their opinion it is worthy of acceptance.



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INTRODUCTION

Need for the Study

An analysis of 1955 data obtained from 269 farm families in Economic Area 8 of the Ozarks in Southeastern Missouri showed that 32 percent of the respondents earned incomes of less than $1,000. The average household income to all farmers in the area was $2,042. Only 32 percent ($658) of this total came from farming. It was found that only 72 percent of the farmers met their operating costs, labor and capital receiving no reward. Furthermore, if capital had been rewarded at 5 percent interest, only 47 percent of the farm businesses would have returned anything to labor and management.[1] Livestock sales made up over 75 percent of the gross returns and crop sales approximately 20 percent. Farm machinery costs made up 41 percent of the total operating expenses as compared to only 28 percent for feed and other items for livestock. Investments in machinery and livestock were approximately the same. The average net farm income was $658 for all farms. About 90

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[1]Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Agriculture Experiment Station, Bulletin 661, March, 1958, p. 37.

percent of the farm businesses were too small for adequate levels of farm income (net farm incomes of more than $2,000 a year).

Most of the farm businesses in this area are very small. In 1954, the average acreage of cropland harvested was 25.3 acres.[2] Approximately 25 productive man work units were needed to take care of the crops and not enough livestock was kept to provide full employment for the family labor force. The farms were mechanized. Even in the lowest income class, where net returns were only $200 a year, 47 percent of the operators had tractors. In the highest income class about 90 percent had tractors.[3] Economic Area 8 is one of the roughest sections of Missouri. Steep slopes and small fields result in high operating costs for tractor drawn equipment. A major economic problem is that of lowering this cost. This analysis is directed at solutions of this problem. It deals with average fixed costs per unit of use and measures that can be employed in reducing the annual outlay for machinery and equipment. The

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[2]United States Bureau of the Census, U. S. Census of Agriculture, 1954, Vol. 1, Counties and State Economic Areas, Part 10, United States Government Printing Office, Washington, D. C., 1956, p. 193.

[3]Bird, Miller, and Turner, op. cit., pp. 53, 54, 55, 57, and 58.

procedures examined include alternative methods of ownership, custom hire, joint ownership and renting farm machinery. The discovery of methods of reducing average cost per unit of use is the major objective.

Obviously each farm unit cannot be fitted to a perfect pattern of need for and use of owned machinery. Timeliness of farm operations is important in getting crops planted, cultivated, and harvested. The quality of hay is best, if cut at the proper stage of maturity. Once cut, it must be put in the mow or stacked quickly to avoid deterioration from dew or rain. Sometimes a high cost per unit of use must be accepted to avoid a greater loss from quality deterioration or spoilage. However, there are certain general principles that can be used by farm operators as guides in planning their machinery investments. An effort is made to reveal these principles. By using recommended cropping systems, future needs for farm machinery in Economic Area 8 can be predicted, and investments on individual farms kept at a level that will prevent fixed costs from eliminating net income.

Objectives of the Study

The work has been guided by the following objectives:

1. To determine the potential need for farm machinery in Missouri Economic Area 8, with costs per unit of use maintained at reasonable

levels.

2. To outline systems of individual and cooperative ownership that will help farm operators to provide themselves with modern machinery at reasonable costs.
3. To set up guides for determining the most advantageous types of farm machinery ownership to use on individual farms.
4. To establish lower costs for use of farm machinery, and to use these data as a basis for recommending custom rates in Missouri Economic Area 8.

Method of Analysis

The investigation was restricted to Missouri Economic Area 8, which includes St. Francois, Madison, Wayne, Ripley, Oregon, Shannon, Reynolds, Iron, Carter, and Dent Counties. Physical and economic data, land use, farm machinery costs, equipment performance rates, and custom rates were taken from secondary data. The age distribution of farm machinery and vehicles was taken directly from primary data obtained in the 1956 survey conducted by members of the Agricultural Research Service, USDA, and the University of Missouri staffs.[4]

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[4]Unpublished data obtained by Bird, Miller, and Turner.

Prices and operating costs of farm machines were obtained from dealers and other sources in order to determine the cost of owning and operating the equipment. By use of this information, it was possible to calculate the number of acres necessary for relatively low-cost operation of each machine or combination of equipment. The data were used to outline alternative methods of owning machinery that would give the farm operator relatively low cost per unit of use.

The number of harvested crop acres was used in the analysis since a part of the cropland in the area usually is left idle or in pasture. This information made it possible to compute the number of farms that were large enough to justify ownership of full sets of equipment and the number that needed to work out patterns of cooperative ownership or to get work done on a custom basis. The investment in and the present age of equipment in the area were taken from the field schedules obtained in the 1956 survey. It was then possible to estimate the amount of equipment required for the area and to determine the adequacy of existing equipment for the needs. The findings are reported in Chapter IV.

SUMMARY OF RELATED LITERATURE

Modern machinery and equipment have made it possible for farmers to expand their output per man very greatly.

In 1930, the index of farm output stood at 116. In 1958, it was 197--an increase of 69.8 percent (1910-14 = 100). Man hours of farm work declined from an index of 134 in 1930 to 80 in 1958, while output per man hour rose from 54 to 152 (1947-49 = 100). In 1930, each farm worker turned out enough products for 9.75 people. In 1957, he supported 23.55 people. Improved technology, largely in the form of machinery have made these advances possible.[5] However, to obtain these benefits the farmer has found it necessary to increase his investment in equipment and to enlarge his acreage in order to avoid materially higher unit costs. These changes have made custom hiring, joint ownership, and leasing of farm machinery essential practices on commercial farms. The following studies have dealt with the adjustment problem.

Farm Machinery Costs

Machinery costs make up a high percentage of farm expenses. Some of the costs such as fuel, labor and lubricants are variable; others such as depreciation, interest on investment, taxes, insurance and shelter, are fixed.

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[5]United States Department of Agriculture, Agricultural Outlook Charts, 1959, A Report Prepared by the Agricultural Marketing and Research Service, United States Government Printing Office, Washington, D. C., November, 1958, pp. 64, 65, and 66.

An inventory study by Bird, Miller and Turner showed that the charges for operating farm machinery and for machine hire made up 29 percent of the farm operating expenses in 1955.[6] Hoover's studies in 1954 indicated that machinery costs were 33 percent of all expenses on Kansas farms.[7]

Fenton and Fairbanks found that depreciation was the largest part of fixed ownership costs. Their studies showed that the straight line method was the most practical way to calculate depreciation on farm machinery. The second largest cost item was interest on the investment. Taxes, insurance and shelter made up the other fixed costs of ownership.[8]

The variable costs include wages for labor which usually is the largest item of cost in operating a farm machine. This fact has led to a trend toward larger machinery units. As wages have advanced it has been necessary to get more work accomplished per hour or per day.

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[6]Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Agriculture Experiment Station, Bulletin 661, March, 1958, p. 54.

[7]L. E. Hoover, Farm Machinery--to Buy or not to Buy, Kansas State College Agricultural Experiment Station, Bulletin 379, March, 1956, p. 3.

[8]F. C. Fenton and F. E. Fairbanks, The Cost of Using Farm Machinery, Kansas Engineering Experiment Station Bulletin 74, September, 1954, pp. 25, 48.

Fuel, lubricants, repair costs, and supplies make up the other components of operating cost. Repair costs depend on the value of the machine and the amount of use.[9] Supplies such as baling twine and spray material should also be considered as variable costs by the farmer. However, in figuring custom costs, these supplies may be provided by the owner of the equipment or custom operator.[10]

Estimates of the various items that make up all farm operating costs showed that expenditures for motor vehicles and machinery constituted two percent more of the total in 1957 than in 1949.[11]

Gregory's studies in Alabama indicated that the way in which the labor and machinery were managed greatly effected harvesting costs. Workers or machines can be added or taken off the job in relation to the percentage changes in harvesting costs and output per hour.[12]

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[9]Fenton and Fairbanks, op. cit., pp. 25, 26, and 48.

[10]Hoover, op. cit., p. 7.

[11]United States Department of Agriculture, The Farm Cost Situation, A Report Prepared by the Agriculture Research Service, Annual Release 43-87 (FCS-25) United States Government Printing Office, Washington, D.C., November 1958, p. 6.

[12]W. F. Gregory, Silage Making Costs and Practices, Agriculture Experiment Station of the Alabama Polytechnic Institute, Bulletin 310, December 1957, p. 29.

Miller, Ruden and Smith showed that fixed costs per rated drawbar horsepower varied inversely with the number of hours a tractor was used annually. Variable costs per drawbar horsepower increased as the tractor load decreased from its rated capacity. These studies showed an inverse relationship between total cost per acre or hour and annual use.[13] Jones and Day's study showed that an increase in annual use from 400 to 1800 hours brought about a 58 percent reduction in fixed costs per unit of use.[14]

Purchasing used equipment may be a method of lowering machinery costs according to studies by Tucker, Walker, and Jeffery.[15] Higher operating costs and lower capacity could be expected but lower fixed costs gave a definite advantage to used equipment on small acreages.

Kansas studies indicated that three methods could be used to reduce machinery cost. First, the annual use could be increased by expanding the acreage through custom work

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[13]Frank Miller, W. L. Ruden, and C. W. Smith, Cost of Tractor Power on Nebraska Farms, Nebraska Agriculture Experiment Station, Bulletin 324, November, 1939, pp. 9, 18.

[14]C. L. Day and M. M. Jones, Farm Tractor Costs, University of Missouri Agriculture Experiment Station, Bulletin 662, October, 1955, p. 7.

[15]E. A. Tucker, O. L. Walker, D. B. Jeffery, Custom Rates for Farm Operations, Oklahoma A & M College Experiment Station, Bulletin B-473, July, 1956, p. 78.

or by joint ownership; second, a longer useful life could be obtained by giving each machine good care; and third, by reducing the investment through careful selection of equipment of proper size for the job and through judicious purchase of used equipment.[16]

Farm Machinery Investment

The value of farm machinery is a major item in the total farm capital. Mechanization of farms has given increased output and convenience, but at a much larger capital outlay per farm.

Analysis of 1955 data shows that the investment in machinery in Economic Area 8 is exceeded only by the value of real estate. It is further indicated that most of the farms are mechanized. Seventy percent of all farm operators had power equipment.[17]

Frick, Weeks, and Fellows showed that the investment in machinery on 28 New Hampshire farms was equal to the value of livestock. Also the machinery investment was about one-half as large as the investment in land and buildings.[18]

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[16]Fenton and Fairbanks, op. cit., pp. 39-42.

[17]Bird, Miller, and Turner, op. cit., pp. 55 and 59.

[18]G. E. Frick, S. B. Weeks, I. F. Fellows, Adjustments in the Organization of Machinery and Equipment, Agriculture Experiment Station, University of New Hampshire, Bulletin 407, May, 1954, p. 3.

The machinery investment on Kansas farms increased by 58 percent from 1940 to 1950. A part of the increase was due to price change, but there was a tremendous advance in the amount of equipment per farm.[19]

The wholesale price index of farm machinery went up 50 percent between 1949 and 1957. However, expenditures for farm machinery decreased 2 percent during this period.[20]

Darley and Suter in 1951 reported that as the size of a Missouri farm business increased the average investment in machinery and equipment also increased. A further conclusion was that renters had an average of 41.5 percent of their total capital invested in machinery as compared to 15 percent for full owners.[21]

Miller and Ruden indicated in their Nebraska cost studies that the machine should be large enough for the available labor force to do each job in its proper season. Also, that the power unit should be matched in size with the expensive pieces of equipment to get low operating cost

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[19]Fenton and Fairbanks, op. cit., p. 8.

[20]United States Department of Agriculture Research Service, op. cit., pp. 6 and 10.

[21]R. D. Darley and R. C. Suter, Machinery Use and Investment on Missouri Farms, 1951, University of Missouri Agriculture Experiment Station, Bulletin 536, October, 1953, pp. 14, 41, and 42.

per unit of work accomplished.[22]

Increased mechanization does not always lower unit costs. The machine must be fitted to the job. The initial investment is only one factor; operating costs and the quantity and quality of product turned out by the machine are often more important.[23]

The Agricultural Research Service has shown that the volume of farm machinery and equipment purchased in a given year is determined largely by current and prospective incomes of farmers. The availability of farm machines is also a determining factor in sales. The data indicate that from 1948 to 1953 annual purchase of machinery equaled approximately 6 percent of the cash receipts of farm operators.[24]

Peak periods of labor requirement during the cropping season should be calculated to help determine the size of the equipment needed. Richey showed that the least margin

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[22]Frank Miller and W. L. Ruden, Cost of Operating Machinery on Nebraska Farms, Nebraska Agriculture Experiment Station, Bulletin 366, August, 1944, pp. 16 and 26.

[23]United States Department of Agriculture Research Service, op. cit., p. 9.

[24]Albert Brodell and M. R. Cooper, Power and Machinery of Farms, and Related Data, United States Department of Agricultural Research Service, Bulletin 43-46, United States Government Printing Office, Washington, D. C., April, 1956, pp. 8 and 30.

of safety is enough capacity to complete the work in the daylight hours of an average season, which would leave night hours available for a rush or abnormal season. Thus the margin of safety is the ratio of time available to time required during the cropping season.[25]

Ownership Methods of Farm Machinery

High machinery costs and low crop acreage per farm are valid reasons for considering the advantages of hiring machinery over ownership. Custom operation offers a way for small farmers to take advantage of mechanization. This type of operation also presents an opportunity for a small farmer who has good mechanical ability to increase the annual use of his machinery and lower the unit cost of operating it.

The practice of hiring the owners of farm machinery to do work on a cost per unit basis has increased greatly since 1949. In that year farmers spent $22,859,108 for machine hire in Missouri. In 1954, this charge amounted to $25,730,559.[26] This increase is a logical result of high

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[25]C. B. Richey, "American Society of Agriculture Engineers Data: Crop Machines Use," Agriculture Engineers Yearbook, American Society of Agriculture Engineers, 5th Edition, St. Joseph, Michigan, April, 1958, p. 80.

[26]United States Bureau of the Census, United States Census of Agriculture, 1954, Vol. 1, Counties and State Economic Areas, part 10, United States Government Printing Office, Washington, D. C., 1956.

priced equipment, small farms, and greater capacity to do work. It was estimated that 50 percent of the 1952 Kansas wheat crop was harvested by custom operators.[27]

Studies conducted in Missouri Economic Area 8 in 1955 also showed evidence of equipment being hired. The average expenditure for machine hire was $1 per crop acre.[28]

Operators of small farms can obtain benefits of mechanization by hiring all of their work done, and, at times, large operators can hire specialized equipment to an advantage.[29] An analysis of 1949 cost data from New England farms indicated that, regardless of size, most farmers can benefit by using custom work to some degree. The data showed that small operators benefited the most. These studies indicated that basic or foundational equipment such as a mowing machine, a tractor, a wagon and a manure spreader should be owned by the operator in most cases. This type of equipment is used for repetitive jobs and is often not readily available on a custom basis.[30]

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[27]Fenton and Fairbanks, op. cit, p. 48.

[28]Bird, Miller, and Turner, op. cit., pp. 54 and 58.

[29]United States Department of Agriculture Research Service, op. cit., p. 11.

[30]Frick, Weeks, and Fellows, op. cit., p. 39.

A farm operator with limited capital can profit by hiring neighbors who own machines to do certain farm jobs. By this procedure, the money invested in machinery may be used for better paying alternatives.[31]

Frick and Weeks showed that for certain tasks custom operators can obtain superior rates of production. If the custom operator can accomplish a given task with a similar machine in less time than the owner, then through custom hire, the owner would save more than an equal amount of fuel and labor.[32]

The use level of each machine should be calculated annually in acres or hours, and this figure used as a guide to determine whether the equipment should be owned or hired.[33]

Other factors than cost are important in deciding whether to own or hire machinery. The capital position of the farmer must be considered. Limited or excess capital often will be a determining factor. The timeliness of the operation is important because crops must be harvested

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[31]Tucker, Walker, and Jeffery, op. cit., p. 8.

[32]G. E. Frick and S. B. Weeks, When to Hire and When to Own Farm Equipment on New Hampshire Farms, Cooperative Extension Service of New Hampshire, Bulletin 136, September, 1956, p. 7.

[33]Darley and Suter, op. cit., p. 65.

during a certain definite period to prevent waste. The value of the labor saved is important, if it can be put to some other productive use. The advantages and disadvantages of custom operation must be weighed in addition to cash costs.[34]

Custom rates should be varied with operating conditions, wage rates, and changes in price of fuel, lubricants, and oil. Miller and Ruden showed that costs per unit varied only slightly, if similar machines of different sizes were adjusted to a per acre of capacity basis.[35]

Weeks and Frick showed that custom work offers many opportunities to make profitable adjustments in utilizing farm equipment. Off-the-farm work can be used to reduce equipment costs per unit to the individual owner by increasing the annual use of the machine.[36]

Joint ownership as an alternative procedure may not influence operating costs, but it can be used to reduce the amount of fixed machinery charge that must be carried by

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[34]Hoover, op. cit., pp. 9, 10, 11, and 12.

[35]Miller and Ruden, op. cit., pp. 19 and 22.

[36]S. B. Weeks and G. E. Frick, How to Make Money Doing Custom Work, The Agricultural Extension Service, University of New Hampshire, Extension Circular No. 303, July, 1951, p. 4.

each farm operator. However, the disadvantages of more travel for the equipment, less complete control over maintenance by the individual operator and more rapid depreciation because of wear may be factors to consider in this type of ownership. Because of lack of empirical data, evaluation of this alternative must be related to the particular circumstances that accompany each situation.[37]

The practice of leasing machinery to farmers may come into common use in the future. Phillips points out that the advantages of leasing equipment include tax savings, and conservation of working capital. Farm machinery companies are familiar with leasing industrial machinery. In a tight market situation where farmers have to give careful attention to costs and machinery companies are badly in need of markets there is more incentive to initiate programs of leasing farm equipment.[38]

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[37]Frick, Weeks, and Fellows, op. cit., p. 19.

[38]W. G. Phillips, "The Changing Structure of Markets for Farm Machinery" Journal of Farm Economics, pp. 1180 and 1181, Proceedings Number 5, Vol. 40, The American Farm Economics Association, Menasua, Wisconsin, December, 1958.

CHAPTER II

DESCRIPTION OF AREA

Location and Climate

The ten counties used in this study are located in the eastern Ozark plateau section of Missouri[1] (Figure 1). The eastern boundary begins 45 miles almost directly south of St. Louis and extends south another 60 miles, then west 25 miles, and then directly south 23 miles to the Arkansas border. The southernmost boundary extends westward along the Arkansas line about 55 miles. The western line extends north from this point about 85 miles. The northern border is about 85 miles across. The area of the ten counties is about 4.3 million acres.

The general slope of the land is approximately toward the south, with elevations varying from 1600 feet in the north to 200 feet above sea level in the south; but the topography is rough, as the plateau area is dissected deeply with large streams. The slope of most valley floors is also quite steep, and the streams often shift their channels. As a result, the soils in the narrow valleys contain a high percentage of gravel and stone. The pervious structure of the soils permits water to sink into the substratum rapidly.

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[1]The ten counties compose Missouri Economic Area 8.

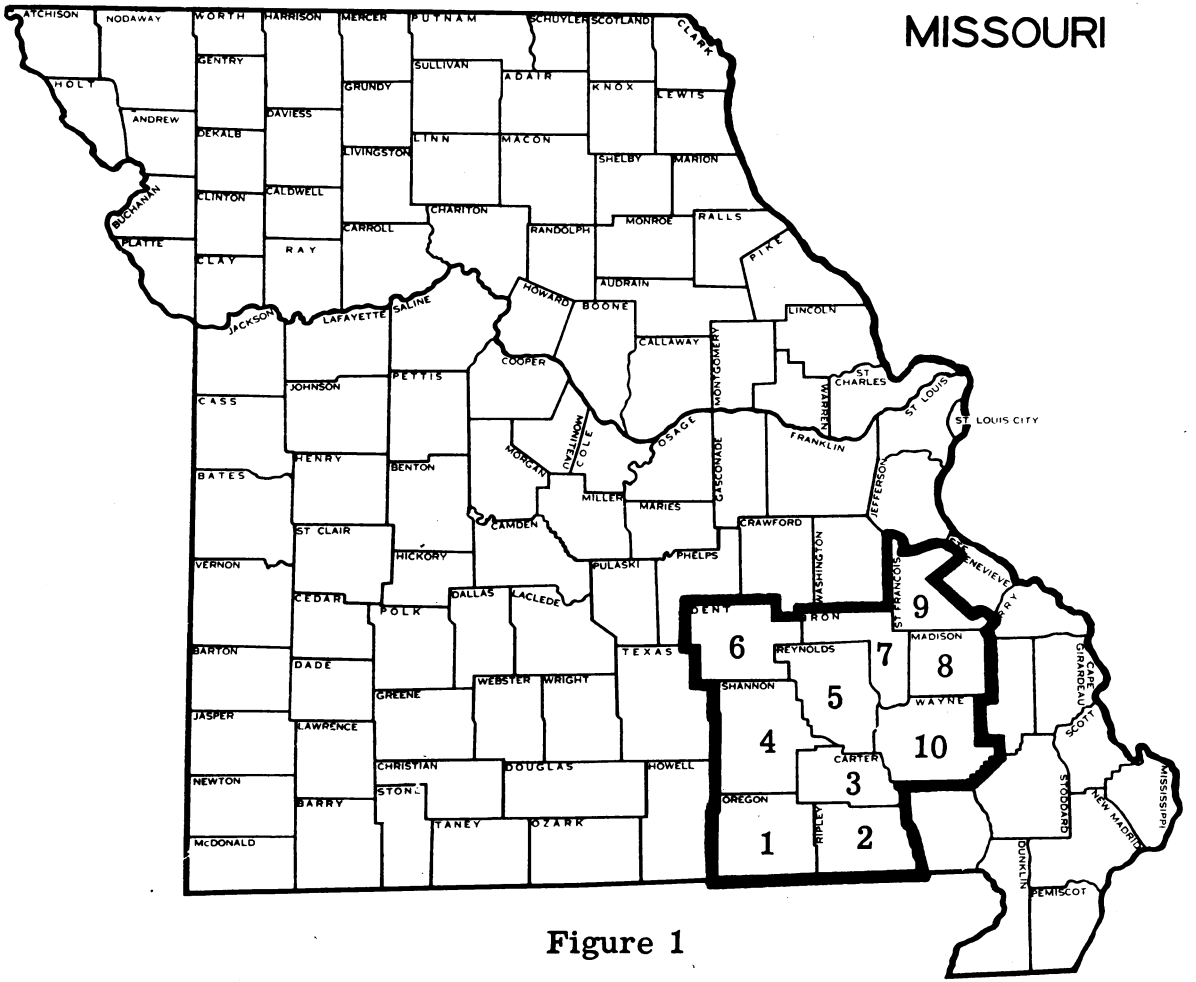

Figure 1

Location of Economic Area 8

This fact and the steep slopes which cause the water from rains to run off rapidly often lead to drouth conditions during the summer months. The larger streams are fed by springs that remove much of the rainfall by underground drainage.

The area has a continental climate. Temperatures move through a wide range with frequent abrupt changes (Table I). January is the coldest month, and July the hottest. January temperatures show the most extreme variations. Readings below zero are not common, and when they occur, usually last only one or two days. During July the temperature has ranged from 47 to 114 degrees Fahrenheit. The average at the various stations has been between 77.5 and 79.3 degrees Fahrenheit.

The average length of the growing season varies from 169 to 205 days. The last killing frost in the spring comes about April 21 at Greenville in Wayne County and April 7 at Koshkonong in Oregon County. In the fall, the first killing frost occurs about October 11 at Greenville and October 29 at Koshkonong. The average length of the growing season is 183 days. The data summarized in Table I show the various ranges of temperature and frost free dates by counties.

Most of the rainfall is received during April, May and June. From the standpoint of moisture for crop

TABLE I

JANUARY AND JULY AVERAGE TEMPERATURES, AVERAGE KILLING FROST DATES, AND AVERAGE LENGTH OF GROWING SEASON IN EACH COUNTY OF MISSOURI ECONOMIC AREA 8 1/

County	Station	Temperatures				Killing Frost Average Dates			
		Length of Record	January Average	July Average	Maximum	Minimum	Length of Record	Last in the Spring	First in the Fall	Growing Season 2/
Carter 3/										
Dent	Salem	35	32.2	77.4	112	-28	36	Apr. 20	Oct. 19	128
Iron	(Arcadia	40	32.6	76.4	113	-33	40	Apr. 26	Oct. 13	170
	(Goodland	39	33.3	76.2	111	-31	40	Apr. 26	Oct. 12	169
Madison 4/										
Oregon	Koshkonong	38	37.0	79.3	112	-17	39	Apr. 7	Oct. 29	205
Reynolds 5/										
Ripley	Doniphan	34	35.6	79.3	114	-18	35	Apr. 12	Oct. 20	191
Shannon	Birch Tree	40	35.0	77.5	111	-32	40	Apr. 13	Oct. 20	190
St. Francois	Farmington	24	34.3	78.4	114	-22	23	Apr. 21	Oct. 20	182
Wayne	Greenville	28	35.2	77.5	113	-32	28	Apr. 21	Oct. 11	173

1/ United States Department of Agriculture, Climate and Man, Yearbook of Agriculture, 1946, United States Government Printing Office, Washington, D.C., 1941, pp. 945-947.

2/ Length of Growing Season is minimized by the number of days between the last killing frost in Spring and first in the Fall.

3/ No records were available for Carter County. Conditions there are best represented by the station at Doniphan in Ripley County.

4/ No records were available for Madison County. Conditions were best represented by the station at Arcadia in Iron County.

5/ No records were available for Reynolds County. Conditions there are best represented by the station at Goodland in Iron County.

production, July usually is the critical month. The average rainfall has been 3.70 inches (Table II). Average amounts of rainfall obscure the variations that occur. For example, in 25 percent of the years, the July precipitation has been less than 2 inches, and more than 50 percent of the time it has been less than 3 inches.[2] These small amounts occurring during the period of highest temperature have a very important bearing on yields of crops. The distribution of rainfall during the critical period of growth becomes extremely important. Because of its unevenness, farmers are confronted with dry periods that cause considerable damage to feed and cash crops. As a result, the supply of home grown feed is highly variable. This is especially true of pastures.

Topography

One of the limiting factors in the use of farm equipment in this area is the steep topography. Serious erosion problems often develop where the land is cultivated. Differences in elevation as indicated by the local relief show the ruggedness of the terrain. Figure 2 indicates the abrupt changes in elevation. Surface drainage is excessive

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[2]W. Decker, Monthly Precipitation in Missouri, University of Missouri Experiment Station, Bulletin 650, March, 1955.

TABLE II

AVERAGE, MONTHLY AND YEARLY RAINFALL IN EACH COUNTY OF MISSOURI ECONOMIC AREA 8 1/

County	Station	Length of Record	Average Precipitations Jan.	Feb.	Mar.	Apr.	May	June
Carter 2/								
Dent	Salem	34	2.83	2.18	3.70	4.50	4.69	4.63
Iron	Arcadia	40	3.02	2.42	3.87	4.74	4.27	4.09
	Goodland	39	2.74	2.27	3.66	4.83	4.51	4.05
Madison	Fredericktown	15	3.66	2.27	3.81	4.18	3.84	4.33
Oregon	Koshkonong	38	3.73	2.79	4.00	4.87	4.56	4.44
Reynolds 3/								
Ripley	Doniphan	35	4.23	3.03	4.41	4.98	4.27	4.56
Shannon	Birchtree	40	3.24	2.51	3.72	4.65	4.35	4.57
St. Francois	Farmington	23	2.70	2.23	3.56	4.42	5.60	4.04
Wayne	Greenville	28	3.50	2.66	4.32	4.69	3.95	4.56
	Leeper	14	4.18	2.42	3.82	4.62	4.43	4.54
	Williamsville	15	4.39	2.54	3.86	4.54	4.00	5.18
Average	All Stations		3.47	2.48	3.88	4.64	4.41	4.45

1/ United States Department of Agriculture, Climate and Man, Yearbook of Agriculture, 1941, United States Government Printing Office, Washington, D.C., 1941, pp. 945-947.

2/ No records were available for Carter County. Conditions there are best represented by the station at Doniphan in Ripley County.

3/ No records were available for Reynolds County. Conditions there are best represented by the station at Goodland in Iron County.

TABLE II CONTINUED

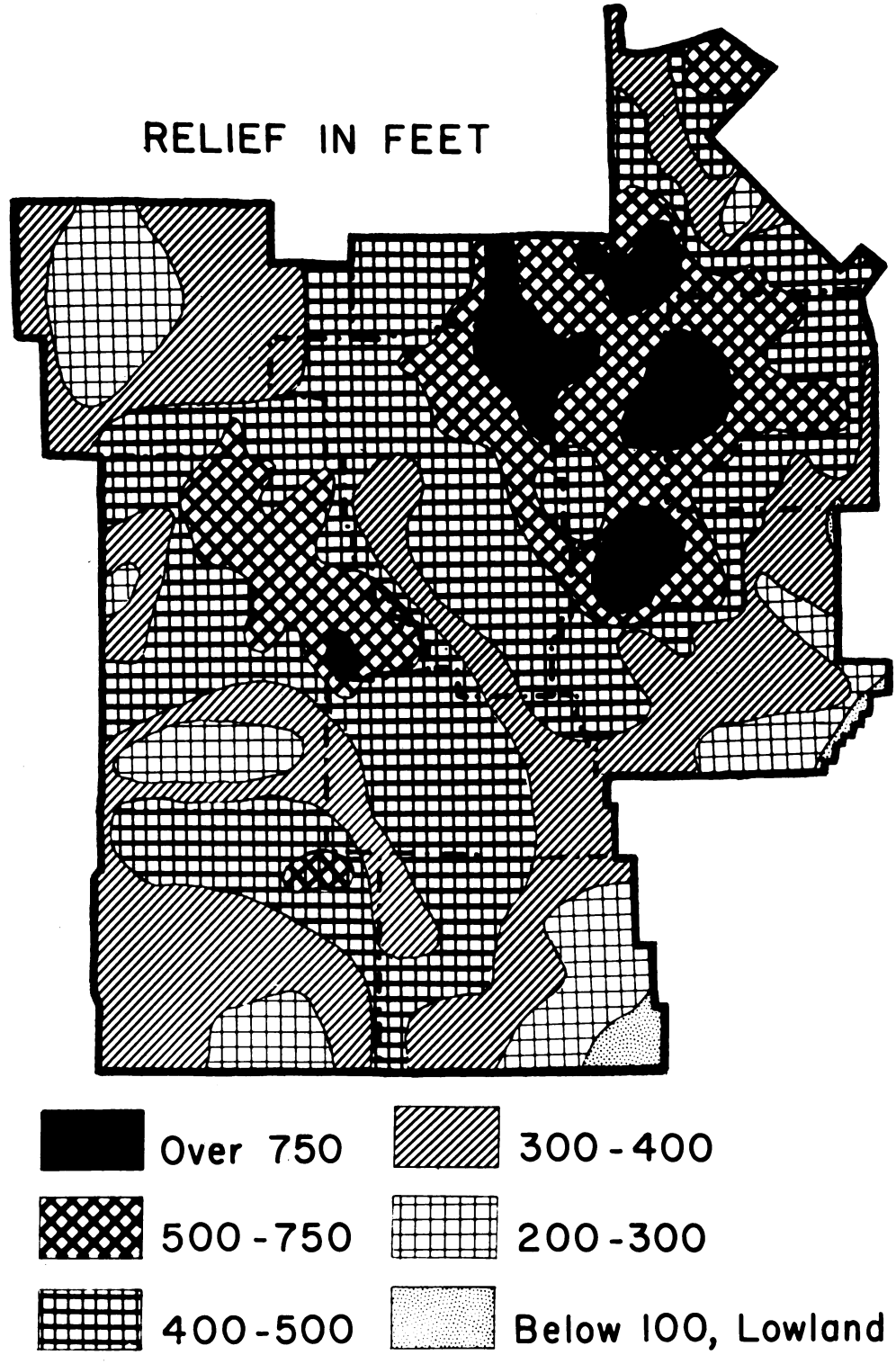
AVERAGE, MONTHLY AND YEARLY RAINFALL IN EACH COUNTY OF MISSOURI ECONOMIC AREA 8 1/

County	Station	Length of Record	Average Precipitations July	Aug.	Sept	Oct.	Nov.	Dec.	Annual
Carter 2/									
Dent	Salem	34	3.21	4.24	4.24	3.57	2.70	2.46	42.95
Iron	Arcadia	40	3.93	4.09	4.15	3.53	3.19	2.84	44.14
	Goodland	39	3.33	3.97	4.00	3.63	2.89	2.51	42.39
Madison	Fredericktown	15	3.70	3.44	4.32	4.17	3.17	2.97	43.86
Oregon	Koshkonong	38	3.56	4.21	3.74	3.19	3.27	3.50	45.86
Reynolds 3/									
Ripley	Doniphan	35	4.08	4.20	3.87	3.23	3.41	3.66	47.94
Shannon	Birchtree	40	3.47	4.43	3.75	3.26	3.14	2.69	43.92
St. Francois	Farmington	23	3.70	3.55	4.02	3.28	3.14	2.69	42.93
Wayne	Greenville	28	3.98	3.82	3.52	3.37	3.34	3.27	44.98
	Leeper	14	3.52	3.62	3.74	3.73	3.14	3.41	45.17
	Williamsville	15	4.19	4.84	3.79	4.13	3.30	3.82	48.58
Average	All Stations		3.70	4.04	3.92	3.55	3.15	3.09	44.79

1/ United States Department of Agriculture, Climate and Man, Yearbook of Agriculture, 1941, United States Government Printing Office, Washington, D.C., 1941, pp. 945-947.

2/ No records were available for Carter County. Conditions there are best represented by the station at Doniphan in Ripley County.

3/ No records were available for Reynolds County. Conditions there are best represented by the station at Goodland in Iron County.



Source: U.S. Geological Survey, 1952.

Figure 2

Local Relief in Missouri Economic Area 8

because of the steep topography. The ruggedness of the landscape decreases toward the south and southeast, indicating drainage toward this part of the area.

A major component of topography is slope. Figure 3 shows that a high proportion of land has slopes greater than 10 percent. Soil conservation technicians usually say that lands having more than 7 to 10 percent slope should not be cultivated. Farmers are following essentially this recommendation. In 1954, less than 43 percent of the land was in farms, and only 6 percent of the total area was cropped.[3] No doubt current farming practices have evolved through time and indicate farmers' appraisal of the best land use. Minor shifts in crops are taking place constantly; however, major changes take considerable time.

SOILS

Most of the soils of the southeastern Ozark area are not very well suited to production of cultivated crops. They are stony, low in minerals, gravelly to stony in texture, and too steep for convenient use of farm machinery. They have been thoroughly leached so most of the lime, fine

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[3]United States Bureau of the Census, United States Census of Agriculture, 1954, Vol. I., County and State Economic Areas, Part 10, United States Government Printing Office, Washington, D. C., 1956, pp. 44-53.

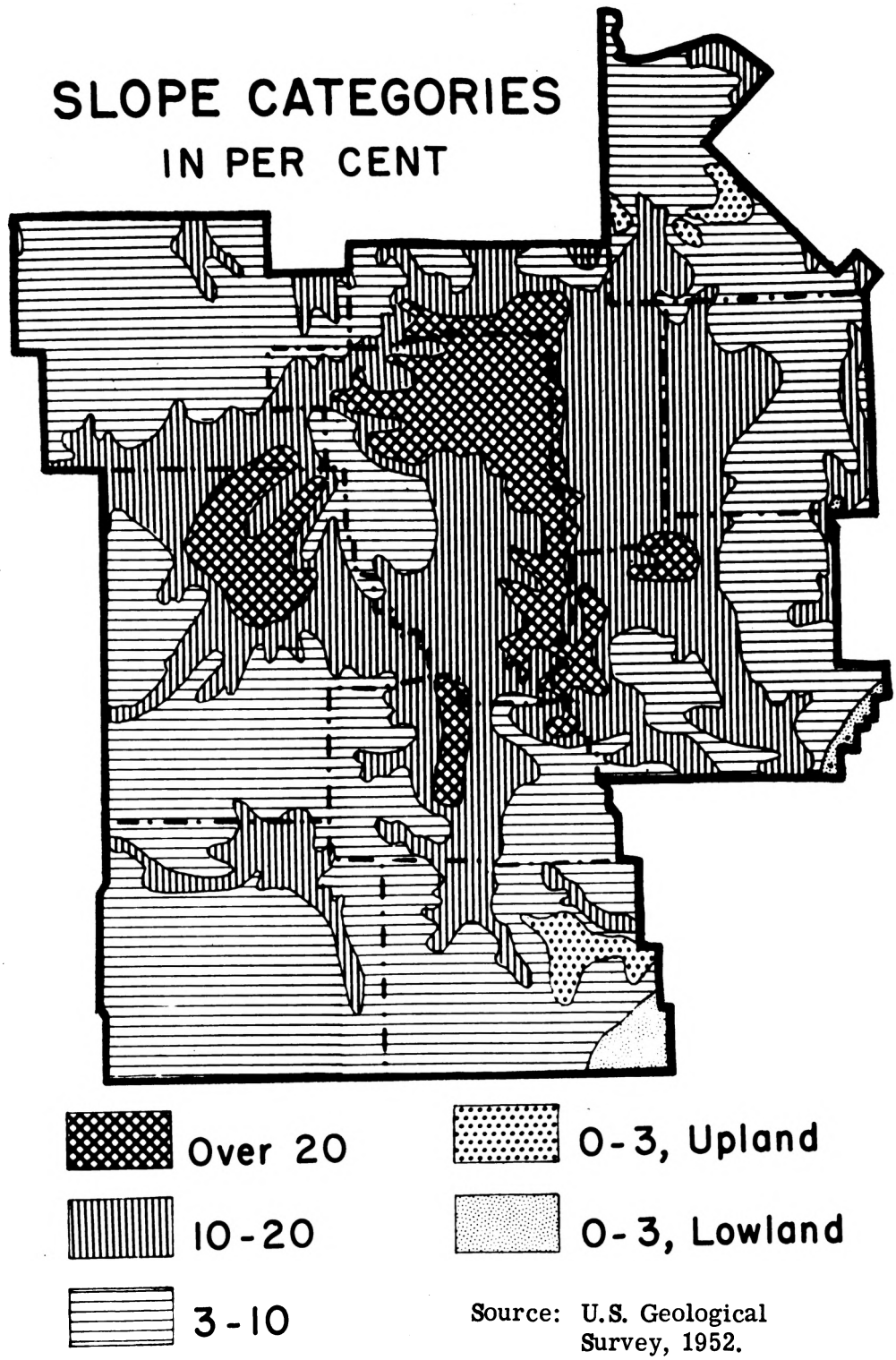

Figure 3

Prevailing Land Slope in Missouri Economic Area 8

silt, and clay have been removed from the surface layers.[4] The cherty limestones, gravel, stone, and other porous materials give them a low water holding capacity, and make them droughty. When rains occur, the water runs off or passes through the surface layers quickly into the stony substratum which underlies the whole region. Where streams cut into these lower strata, the water comes bubbling to the surface in gigantic springs. Small streams and their tributaries usually are dry, except during heavy rains. Deep wells are needed for domestic water supplies.

Soils Formed on Limestone

Cherty limestone soils cover the major proportion of Economic Area 8 in Missouri (Figure 4). Clarksville Stony Loam is the most extensive. It occupies about 2.4 million acres. Clarksville Gravelly Loam is next in total area. It is more desirable for agricultural use than the Clarksville stony loam. It has a little less chert, and the topography is less rugged. However, it is very low in natural fertility and droughty. The content of the gravel in the soil rather than the topography is the limiting factor in its utilization for crops.[5] The principal use is for timber or grazing.

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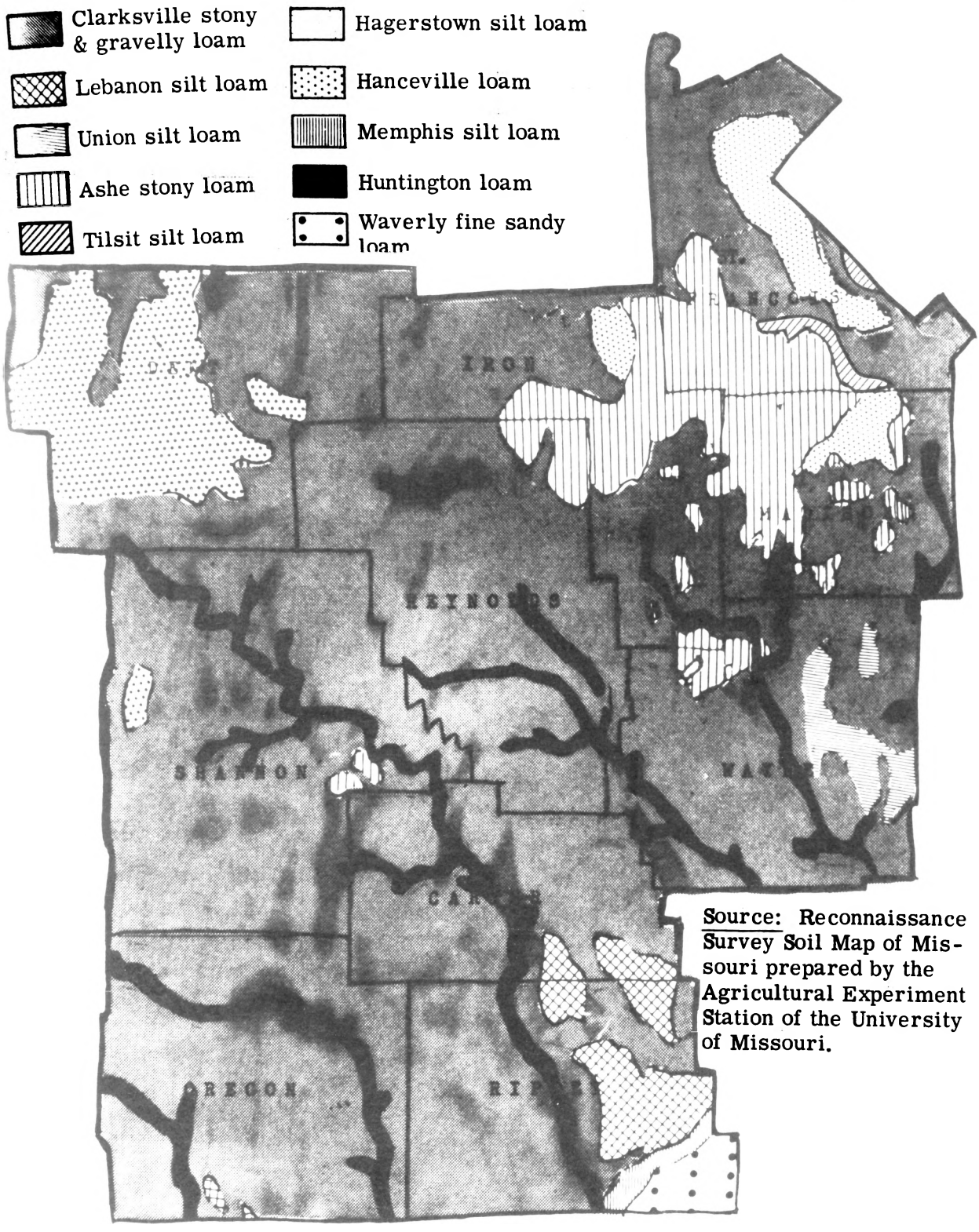
[4] M. F. Miller and H. H. Krusekopf, The Soils Of Missouri, University of Missouri Experiment Station, Bulletin 264, January, 1929, pp. 64-65.

[5] M. F. Miller and H. H. Krusekopf, op. cit., p. 72.



Source: Reconnaissance Survey Soil Map of Missouri prepared by the Agricultural Experiment Station of the University of Missouri.

Figure 4

Major Soils in the Ozarks of Southeastern Missouri

Another soil that is derived from limestone is designated as the Lebanon Series. It is found in the southeastern part of Carter County. This soil is relatively stone-free. The top layer consists of a grayish silt loam that is rather low in organic matter. This soil is underlain by a brown silty-clay hardpan which makes internal drainage very poor. The top soil tends to run together and bake after a rain. The Lebanon Soils are, therefore, designated as the least productive of all Ozark Soils, even though the topography favors cultivation.[6] It is recommended that these soils be used mainly for pasture.[7]

Union Silt Loam is found in a small area along the east side of Wayne County. The surface is relatively free of stones, but small out-croppings of chert are common. These soils are low in natural fertility. The structure is good, however, and by using phosphate, lime and nitrogen, good yields of crops can be obtained. It is generally recommended that these soils be used only for hay and pasture because of their low water holding capacity.

Soils Formed on Granite

Ashe Stony Loam has been formed by weathering the granite which originally covered a large part of Economic

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[6] M. F. Miller and H. H. Krusekopf, op. cit., p. 69.

[7] M. F. Miller and H. H. Krusekopf, op. cit., p. 86.

Area 8. It is gray in color, usually very stony and has a yellow clay subsoil. Only limited areas are free of stone. The topography is the roughest in the Ozarks, the major proportion being steep mountain sides and high ridges. In general, this soil is untillable and very low in fertility. It is suitable only for timber production.[8]

Soils Derived From Limestone, Sandstone, and Shale

The Hagerstown Silt Loam is brown in color and is underlain at 8 to 14 inches by yellow or reddish yellow silty clay loam. It is found in the northeastern part of Madison County, and in the eastern part of St. Francois County. This soil is generally free from stones and is located on gently rolling to almost level topography. It is very well drained and is medium in natural fertility. It is one of the best upland soils in the area, and with proper applications of fertilizer, can be made very productive.[9]

A small part of the acreage in St. Francois County is made up of Tilsit Silt Loam. The topography is gently rolling. The typical soil profile consists of pale yellowish brown silt loam with a high mottled yellow and brown silty

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[8]M. F. Miller, and H. H. Krusekopf, op. cit., p. 92.

[9]H. H. Krusekopf, E. Knobel, and F. Deardorff, Soil Survey of St. Francois County, Missouri, United States Department of Agriculture Bureau of Soils, United States Government Printing Office, Washington, D.C., 1921, pp.18-20.

clay subsoil. The surface soil is low in organic matter and is easily eroded.

The main location of the Hanceville Loam is in Dent County. It is level to gently rolling, and has not yet been deeply dissected by streams. The surface is light gray to yellowish brown in color, and is mainly a loam with a few stones scattered throughout. This soil has very low inherent fertility. In general, it is recommended for grazing purposes.

Soils of Loessial Origin

A small acreage of the Memphis Soil Series lies in the southeastern part of Ripley County. Other acreages are located on the outer edge of the uplands bordering the lowlands. These soils are formed on loess material, and have a high degree of natural fertility. The surface is dark brown with a yellowish brown subsoil. It is the best upland soil in the area.[10]

Alluvial Soils

These soils occupy a relatively small proportion of the total area, but they are quite important to the agriculture of the region. It is estimated that more than

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[10]F. Hutton and H. H. Krusekopf, Soil Survey of Ripley County, Missouri, United States Department of Agriculture, Bureau of Soils, United States Government Printing Office, Washington, D. C., 1917, p. 25.

one-fourth of the grain is grown on them. They are located along the major streams. Nearly all of them are mapped in the Huntington Series. They are brown to dark brown in color, and slightly gravelly in texture, especially those adjacent to the smaller streams. The drainage is good and the inherent fertility is high. Practically all of the Huntington Soils are cropped. The main disadvantage is the small acreage. In very few places are the valleys more than one-quarter of a mile wide; and in most places considerably less. The fields are small, irregular in shape and subject to overflow from the streams. As a rule, the damage is not great. The water soon recedes and the flooding may be beneficial as the soil fertility is usually increased from a new deposit of silt.[11]

The second most important alluvial soil is the Waverly fine sandy loam. It is found in the extreme southeastern part of Ripley County. This soil is light to dark gray in color. The topsoil, varies from eight to eighteen inches in depth, and grades into a light gray, impervious silty clay or clay hardpan. In many instances, the subsoil is so compact that the lower parts remain dry, even when surface flooding occurs. This characteristic makes crop production rather difficult. Proper drainage is hard to obtain. The inherent fertility is low and the soil

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[11]M. F. Miller and H. H. Krusekopf, op. cit., p. 94.

is hard to till. Both surface and tile-drains are often necessary to grow crops.[12]

MAJOR LAND USES

About 57 percent of the 4,322,560 acres are in non-agricultural uses (Table III). Only 6.2 percent of the land in farms is used for harvested crops. The average acreage of pasture is almost four times the acreage of crops. More than one-half of the pasture land is wooded. Other land which includes waste, roads and farm building sites occupies more than twice the area used for harvested crops.

Land Use by Economic Class

The acreage of cropland harvested by economic class of farm varies from 7.4 percent to 16.4 percent (Table IV). On the average farm, 14.4 percent or 25.2 acres are used for harvested crops. Corn is grown on nearly four percent of the average farm acreage. The corn acreage makes up approximately 25 percent of the cropland harvested. The acreage in hay is 7.1 percent of the average farm unit. However, hay is harvested from approximately 50 percent of the cropland. Other cropland makes up nearly four percent of the average farm acreage. The acreage of other crops is approximately 25 percent of the average area of cropland.

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[12]F. Hutton and H. H. Krusekopf, op. cit., pp. 30-32.

TABLE III

MAJOR USES OF LAND IN MISSOURI ECONOMIC AREA 8, 1954 1/

	Acres	Percent
Land not in Farms	2,470,884	57.2
Land in Farms	1,851,676	42.8
Total Land Area 2/	4,322,560	100.0
Use of Land in Farms:		
Cropland Harvested	267,217	6.2
Open Pasture 3/	448,108	10.4
Woodland Pasture	589,646	13.6
Other Land	546,705	12.6
Total Land in Farms	1,851,676	42.8

1/ United States Bureau of the Census, United States Census of Agriculture; 1954, Vol, 1, Counties and State Economic Areas, part 10. United States Government Printing Office, Washington D.C., pp. 44-53 and 193.

2/ Total land area is an approximate figure.

3/ Open pasture includes cropland pasture and other pasture (not cropland and not woodland).

TABLE IV

USE OF CROPLAND BY ECONOMIC CLASS OF FARM IN MISSOURI ECONOMIC AREA 8, 1954

Item	I-IV	V-VI	Part-time	Residential	All Farm
Number of Farms	1,336	3,050	2,366	3,808	10,560
Total Acres in Farms	569,206	662,846	335,506	284,118	1,851,676
Acres per Farm	426.1	217.3	141.8	74.6	175.3
Cropland Harvested per Farm:					
(Acres)	69.8	35.6	18.8	5.5	25.3
(Percent)	16.4	16.4	13.3	7.4	14.4
Hay Harvested per Farm:					
(Acres)	25.7	18.4	11.9	3.5	12.5
(Percent)	6.0	8.5	8.4	4.7	7.1
Corn Harvested per Farm:					
(Acres)	18.1	9.6	4.0	1.4	6.5
(Percent)	4.2	4.4	2.8	1.9	3.7
Other Crops Harvested per Farm:					
(Acres)	25.9	9.2	2.9	0.6	6.3
(Percent)	6.1	4.2	2.0	0.8	3.6
Other Land per Farm:					
(Acres)	356.3	181.7	123.0	69.1	150.0
(Percent)	83.6	83.6	86.7	92.6	85.6

Source: United States Bureau of Census, United States Census of Agriculture, 1954, Vol. 1 Counties and States Economic Areas, part 10 United States Government Printing Office, Washington D.C., 1956, pp. 193, 217.

FARM MACHINERY INVESTMENT

Farm machinery is one of the major assets on farms in Missouri Economic Area 8. The average investment was $1,892 in 1955 (Table V). This amount was 15.8 percent of the total assets. Farm machinery was the largest item except land and buildings. It was highest for part-time farmers and lowest for the residential group.

Most of the farms in the area are mechanized. Over 70 percent of the operators had tractors in 1955 (Table VI). Over 50 percent had the following items of equipment: plow, harrow, cultivator, wagon, and trailer. Mowing machines were found on 49 percent of the farms and corn planters on 35 percent. Hay and corn were the principal crops.

The presence of mechanized equipment does not necessarily mean that the farm work is done efficiently. Expensive equipment such as balers and combines were found on 11 and 13 percent of all farms. For some farmers, the large investment in expensive equipment was a forerunner of financial difficulty. In many cases the flow of income was not enough to pay the cost of operating the farm business, family living expenses, interest and depreciation on the equipment.

TABLE V

AVERAGE MACHINERY INVESTMENT ON FARMS WHERE DATA WERE OBTAINED IN 1955 BY ECONOMIC CLASS, MISSOURI ECONOMIC AREA 8

Item	I-IV	V-VI	Part-time	Residential	All Farm
Number of Farms	56	92	66	55	269
Investment in farm machinery	$3,437	$1,698	$1,576	$1,021	$1,892
Total farm assets	$20,748	$11,862	$8,928	$7,169	$11,976
Percent of business assets invested in machinery	16.6	14.3	17.7	14.2	15.8

Source: Basic data obtained from material gathered in inventory study in 1955, Ronald Bird, Frank Miller and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Agriculture Experiment Station, Bulletin 661, March, 1958, p. 55.

TABLE VI

PERCENTAGE OF FARMERS IN MISSOURI ECONOMIC AREA 8 WHO HAD TRACTORS AND TRACTOR EQUIPMENT BY ECONOMIC CLASS, 1955

Item	Economic Class of Farms				
	I-IV	V-VI	Part-time	Residential	All Farm
Number of Farms	56	92	66	55	269
Type of Equipment	Percent	Percent	Percent	Percent	Percent
Tractor	96	74	68	56	74
Plow	100	74	67	53	75
Harrow	80	54	39	35	52
Roller	4	1	-	-	1
Cultivator	93	54	53	38	59
Corn Planter	73	35	18	16	35
Grain Drill	48	17	6	2	18
Grain Binder	22	1	2	2	3
Grass Seeder	2	-	-	-	1
Corn Picker	14	-	3	-	4
Field Chopper	5	-	-	-	1
Combine	3	17	2	-	13
Mower	79	55	38	25	49
Hay Rake	50	26	15	16	19
Hay loader	5	5	2	-	3
Hay Baler	27	9	8	2	11
Wagon	100	46	26	27	50
Trailer	7	8	6	4	63
Manure Spreader	46	13	6	2	16
Sprayer	2	-	-	2	1
Blower	16	-	-	-	1

TABLE VI CONCLUDED

PERCENTAGE OF FARMERS IN MISSOURI ECONOMIC AREA 8 WHO HAD TRACTORS AND TRACTOR EQUIPMENT BY ECONOMIC CLASS, 1955

Item	Economic Class of Farms				
	I-IV	V-VI	Part-time	Residential	All Farm
	Percent	Percent	Percent	Percent	Percent
Corn Sheller	9	1	-	-	2
Hammer Mill	30	16	6	-	13
Elevator	11	1	-	-	3
Ensilage Cutter	-	-	2	-	1

Source: Data from unpublished material gathered in 1955 inventory survey of farms in Economic Area 8 by Ronald Bird, Frank Miller, and Samuel Turner.

FARM MACHINERY EXPENSES

One of the major farm expenses in the area is the cost of operating farm machinery. The fixed cost per unit of work accomplished makes it difficult for farmers to compete with other sections of the country. The cost per acre or per hour of using any machine depends upon the type and the number of units of annual use. Most of the farming operations are performed with tractor power. The data presented in Table IV show that the cultivated acreage is small on most farms. Because of this fact the machinery cost is quite high, per acre of use. On an average farm in 1955, if depreciation and interest on the machinery investment were included, the cost averaged $17.09 per tillable acre (Table VII). This figure did not vary greatly on different sizes of farms. The reason was fewer machines and less valuable equipment on the smaller farms. Tilled land was the actual acreage of cropland on which farm machinery was used. About 57 percent of the cropland actually was tilled.[13]

Farm Transportation

An automobile is an essential piece of equipment on

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[13]Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Agriculture Experiment Station Bulletin 661, March, 1958, p. 58.

TABLE VII

FARM MACHINERY EXPENSES, BY ECONOMIC CLASS OF MISSOURI ECONOMIC AREA 8, 1955 1/

Item	Economic Class of Farm				
	I-IV	V-VI	Part-time	Residential	All Farm
Number of Farms	56	92	66	55	269
Machinery Operation	$463	$231	$167	$109	$239
Machine Hire	163	81	37	33	77
Total Machine Operation	$626	$312	$204	$142	$316
Tilled Cropland (acres)	81	45	28	23	43
Operating Expenses Per Acre Of Tilled Cropland	$ 7.73	$ 6.93	$ 7.29	$ 6.17	$ 7.35
Depreciation of Machinery 2/	$511	$302	$252	$167	$305
Interest on Capital Invested in Machinery 3/	$206	$102	$ 95	$ 61	$114
Total fixed Cost for Machinery Operation	$717	$404	$347	$228	$419
Tilled Cropland (acres)	81	45	28	23	43
Fixed Costs Per Acre of Tilled Cropland	$ 8.85	$ 8.98	$ 12.39	$ 9.91	$ 9.74
Fixed and Operating Expenses Per Acre of Tilled Cropland	$ 16.58	$15.91	$ 19.68	$ 16.08	$ 17.09

1/ Basic data obtained from an inventory study of the farms in the area in 1956. Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri College of Agriculture Research Bulletin 661, pp. 54, 81.

2/ Value of machine based upon replacement value of machine in the area. Depreciation based upon useful life and depreciation rate recommended by Department of Internal Revenue.

3/ Interest rate at 6 percent per annum.

most farms. For this reason, one-half of the automobile expenses are alloted to farm production costs. Trucks are necessary, particularly in present day harvesting operations. It is, therefore, of interest to analyze the distribution of cars and trucks on farms in the area. Approximately ten percent of the farmers had neither auto nor truck, at the time they were interviewed (Table VIII). Most of these operators were in the lower income groups. Almost one-third (31 percent) had automobiles only for transportation. The lowest percentage with car and no truck were in the high farm income group. The highest percentage of those who had only a truck were on Class V and VI farms. Those owning both an automobile and a truck usually were on farms that produced the best income. When truck and automobile both were owned, the larger trucks were found on the most profitable farms.

TABLE VIII

DISTRIBUTION OF FARMS HAVING AUTOMOBILES AND VARIOUS SIZE TRUCKS BY ECONOMIC CLASS, MISSOURI ECONOMIC AREA 8, 1955

Item	I-IV	V-VI	Part-time	Residential	All Farms
Number of Farms	56	92	66	55	269
Type of Vehicle	Percent	Percent	Percent	Percent	Percent
Neither auto nor truck	2	11	9	16	10
Auto only	18	26	33	49	31
Truck only (½ Ton)	39	40	23	18	31
(3/4 Ton and larger)	5	12	6	8	8
Truck and auto (½ Ton)	15	2	18	4	9
(3/4 Ton and larger)	21	9	9	5	11
Total Percent	100	100	100	100	100

Source: Data obtained from unpublished material gathered in the 1955 survey of farms in Missouri Economic Area 8 by Ronald Bird, Frank Miller, and Samuel Turner.

CHAPTER III

ALTERNATIVE METHODS OF LOWERING FARM MACHINERY COSTS

FARM MACHINERY CHARGES

A major problem of increasing net returns to farmers is that of lowering the cost of operating the business. Farm record data from Economic Area 8 show that machinery costs, including depreciation, make up about 40 percent of the total cost of operating the business.[1] Alternative patterns of machinery ownership can be used to lower this cost. Full ownership, joint ownership, and purchase of used equipment are examples. Other measures that can be used include leasing and custom hiring of machinery. The procedure that will give the lowest cost depends upon a number of factors. More than nine tenths (94 percent) of the farms contain less than 75 acres of cropland. Under these conditions fixed charges per acre are high. These items include the part of depreciation that is due to obsolescence, interest on investment, housing, insurance, and taxes. All of these items remain relatively fixed regardless of units of annual use. If the number of units

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[1]Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Experiment Station, Bulletin 661, March, 1958, p. 54.

is small, the cost per unit is high. Variable costs depend upon the amount of use. They include fuel, oil, grease, repairs, and labor. Wages for the operator are a large portion of operating costs. If the work is done by the farm operator or a member of his family, the return that could be obtained from employment at some other task, either on or off the farm, determines the labor cost. As previously stated, other data required to determine whether or not a particular machine should be purchased include the price of the machine itself, the units of annual use, the interest rate, the years of life, repairs, operating costs, housing charges, taxes, insurance and other miscellaneous items and the cost of having the work done on a custom basis.

The power charge in this analysis is based on an average annual use that will give a farmer relatively low cost per hour or acre. A Missouri study by Day and Jones showed that approximately 565 hours was the average annual use for a two-plow tractor.[2] The average acres of crops on all farms in the area is 25 which gives an annual use of 250 hours for the power unit under present cropping practices. If the present acreage of crops indicated in Table IV of

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[2]C. L. Day and M. M. Jones, Farm Tractor Costs, University of Missouri Agriculture Experiment Station, Bulletin 662, October, 1955, p. 3.

Chapter II were used, fixed costs per hour or acre would be higher than the charge that was made in the analysis. It was assumed that an operator who provided himself with equipment would have a large enough acreage of cropland to justify ownership of a power unit. Therefore, all power unit costs were based on this average cost per unit of use.

To assist the farmer in deciding whether he should own or hire a machine, it is necessary to determine the break-even point between alternative procedures of getting farm work done. This is the point of annual use below which it would be cheaper to hire the work done on a custom basis than to own the equipment and bear all of the costs incident to ownership. A similar procedure can be used in calculating the break-even point between ownership and leasing farm machinery.

The cost per unit of operating farm equipment varies with the price of the machine, the conditions under which it is used and many other factors. For example, the original cost of a machine may not be the average retail price in the area. Retail prices of the same make and model are not uniform. Many farmers purchase used equipment and are able, because of their mechanical ability, to repair and keep it in operation at only a fraction of the cost others must pay. For these reasons, a schedule of break-even points for the average farmer may not be applicable to all of the farmers

in the area. It is hoped, however, that by outlining the steps followed in calculating the break-even points, farm operators can substitute the cost figures that are applicable on their farms and thus derive their own break-even points. In general, the costs used in the analysis are applicable to most farms in Missouri Economic Area 8.

PROCEDURE USED IN THE ANALYSIS

Fixed Charges

The fixed costs such as depreciation, housing, insurance, taxes, and interest on investment were charged to the units of use required to take care of the enterprises on the farm. Repair bills vary with the use of the machine, but should be charged against all of the units of use between the time of purchase and date when repairs are made. A machine may be two or more years old when a part needs to be replaced. Not all of the cost should be charged to the year when the expense was incurred. Rather than try to allocate the repair cost to units of use in a particular year, this item was treated as a fixed charge in calculating the break-even point between ownership and hiring the work done. Annual repair charges were based upon a fixed percentage of the original cost. The amount charged varied between one percent for a harrow and seven percent for a plow. The depreciation charge for each machine was obtained

by dividing the replacement value by the useful life suggested by the Department of Internal Revenue. The schedule assigns a longer life to a new machine than to an old one. This procedure was used because of lack of empirical data showing what the depreciation rate should be in Economic Area 8. It is possible that the charges were proportionally lower on the newer machines than on the older ones. However, it was assumed that the useful life of an older machine would decrease in the same proportion as would a newer piece of equipment.

Charges for housing, insurance, and taxes were estimated at a fixed percentage of the replacement value. A rate of one percent was used for housing and 50 cents per $100 of value for insurance and taxes. Interest charges were estimated at six percent of one-half the original cost. The annual fixed cost of owning farm machinery arrived at by this procedure varied from $13 for a spike tooth harrow to $551 for a 1½ ton truck (Table IX).

Variable Charges

The costs that were directly related to the use of a machine were assumed to be fuel and lubricants plus the labor required to operate it. Data showing the actual rate of accomplishing work were not available from the area itself. It was assumed, however, that the time required to perform the various farm operations would not differ

TABLE IX

ESTIMATED ANNUAL FIXED COSTS OF OWNING EQUIPMENT IN ECONOMIC AREA 8

Item	Size of Equipment	Type of Equipment	Local Replacement Values	Depreciation 1/	Repairs 2/	Insurance and Taxes 3/	Housing 4/	Interest Chg. 5/	Total Annual Fixed Cost
			dollars	dollars	dollars	dollars	dollars	dollars	dollars
Tractor	2 plow	Gasoline 4 wheel	1,388	138	49	7	14	42	250
Truck	1½ ton	Platform body	2,350	220	117	120 6/	23	71	551
Harrow	6 foot	Tandem disc	190	12	6	1	2	6	27
Harrow	3 section	Spike-tooth	110	7	1	1	1	3	13
Cultivator	2 row	Tractor mount	215	14	8	1	2	6	31
Cultivator	2 row	Rotary hoe	170	11	6	1	2	5	25
Plow	2 bottom	2 bottom	242	16	17	1	2	7	43
Planter	2 row	Corn	325	21	7	2	3	10	43
Seeder	5 bushel	Grass	115	3	2	1	1	3	15
Seeder	8 foot	Packer	475	34	17	2	5	14	62
Sprayer	20 foot	Field	375	20	19	2	4	11	56
Rake	4 wheel	Side-delivery	400	26	8	2	4	12	52
Mower	7 foot	Tractor mount	300	20	11	1	3	9	44
Baler	Medium	Auxiliary-engine	2,200	146	66	11	22	66	311
Forage harvester	1 row	Auxiliary-engine	2,000	133	80	10	20	60	303
Wagon	4 wheel	Steel frame	120	8	2	1	1	3	15
Corn picker	1 row	Tractor mount	1,750	116	53	9	17	53	248
Elevator	34 foot	Portable	550	36	8	3	5	17	69
Fertiliser spreader	10 foot	Trailer	230	15	3	1	2	7	28

TABLE IX CONCLUDED

ESTIMATED ANNUAL FIXED COSTS OF OWNING EQUIPMENT IN ECONOMIC AREA 8

Item	Size of Equipment	Type of Equipment	Local Replacement Values	Depreciation 1/	Repairs 2/	Insurance and Taxes 3/	Housing 4/	Interest Chg. 5/	Total Annual Fixed Cost
			dollars	dollars	dollars	dollars	dollars	dollars	dollars
Combine	6 foot	Motor	1,800	120	54	9	18	54	255
Drill	14 foot	Grain	620	41	9	3	6	19	78

1/ Straight line depreciation of the 1955 replacement costs were used. Useful life used was as suggested by United States Treasury Department, Internal Revenue Service, Bulletin F, Tables and Useful Lives of Depreciable Property, Internal Revenue Service Publication No. 173, United States Government Printing Office, Washington D.C., 1942, pp. 2-3.

2/ Repairs are normally treated as variable costs, however, to reach an average cost per unit repairs were included in the fixed costs. Annual repairs based upon varing percentages of replacement costs; percentages used were those suggested in the publication by I.M. Hoover, Farm Machinery to Buy or not to Buy. Kansas State College Agricultural Experiment Station Bulletin 379, March 1956, pp. 3-6.

3/ Estimated at 50¢ per $100 of value.

4/ Estimated at an annual charge of 1 percent of purchase price as suggested by F.C. Fenton, and G.E. Fairbanks, The Cost of Using Farm Machinery, Kansas Engineering Experiment Station Bulletin 74, 1954, p. 32.

5/ Interest, charged at 6 percent per annum times one-half the purchase price.

6/ Includes, insurance and taxes that are related to highway use.

appreciably from the findings in other areas. Variations in total costs were due to differences in price of fuel and lubricants and to wages for operators of the machines. Empirical data on the amount of fuel and lubricants used per hour of operation of tractors and the costs of these fuels in Missouri for the 1952-53 period were taken from a publication by C. L. Day and M. M. Jones.[3] These data were combined with the time estimated to perform the actual operation to arrive at the charges used in Table X. Wages for the operator were included at 50 cents per hour. This was the average wage of hired farm labor in the area in 1955.[4]

Custom Charge

Custom rates for various kinds of farm work are usually available locally. In this area, however, certain farming operations such as harrowing, seeding, planting and fertilizing are not usually custom done. To arrive at these values, the rates in Missouri where custom work is done were used. The rates indicated in Table XI may be higher in other parts of the state than in Economic Area 8.

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[3]C. L. Day and M. M. Jones, Farm Tractor Costs, University of Missouri Agriculture Experiment Station, Bulletin 662, October, 1955, p. 8.

[4]Ronald Bird, Frank Miller, and Samuel Turner, Resources and Levels of Income of Farm and Rural Nonfarm Households in Eastern Ozarks of Missouri, University of Missouri Agriculture Experiment Station, Bulletin 661, March, 1958, p. 57.

TABLE X

ESTIMATED OPERATING COSTS OF FARM MACHINERY IN ECONOMIC AREA 8

Operation	Type of Equipment	Size of Equipment	Time per Acre 1/	Fuel Used Per Hour 2/	Fuel Used Per Acre	Total Fuel & Lubricating Charge per Acre 3/	Labor Charge ($.50 per hr. per acre 4/	Total Operating Cost
			hours	Gal.	Gal.	Dollars	Dollars	Dollars
Plowing	Two plow	14 inch	1.0	1.8	1.8	.43	.50	.93
Harrowing	Spike tooth	5 foot (3)	.3 5/	1.7	.5	.12	.15	.27
Harrowing	Disc harrow	8 foot	1.0	1.7	1.7	.41	.50	.91
Planting	Planter	2 row	.5 5/	1.2	.6	.16	.25	.41
Seed grass	Packer type	8 foot	1.0	1.2	1.2	.27	.50	.77
Cultivating	Rotary hoe	2 row	.3 5/	1.2	.4	.10	.15	.25
Cultivating	Cultivator	2 row	.8	1.2	.9	.24	.40	.64
Fertilizing	Trailer	8 foot	1.0	1.2	1.2	.31	.50	.81
Spraying	Sprayer	20 foot	.4	1.2	.5	.13	.20	.336/
Raking	Side Del.	4 wheel	.4	1.2	.5	.13	.20	.33
Mowing hay	Tr. mount	7 foot	.5	1.2	.6	.16	.25	.41
Baling hay	Aux. engine	Medium	.5	1.8	.9	.21 7/	.25	.466/
Storing hay	Wagon	Steel	2.2 5/	1.2	2.6	.68	1.10	1.78
Storing hay	Truck	1½ Ton	2.2 5/	-	-	1.65 8/	1.10	2.75
Cut Forage	Aux. Engine	Medium	1.6 9/	1.8	2.9	.69	.80	1.49
Silage hauling	Wagon	Steel Frame	1.6 9/	1.2	1.9	.50	.80	1.30
Silage packing	Tractor	2 plow	1.6 9/	1.2	1.9	.50	.80	1.30
Silage hauling	Truck	1½ Ton	1.6 9/	-	-	1.20 8/	.80	2.00
Corn harvest	Picker	1 row	1.2	1.8	1.9	.47	.80	1.07
Corn storage	Truck	1½ Ton	1.2	-	-	.90 8/	.60	1.50
Corn Storage	Wagon	Steel Frame	1.2	1.2	1.4	.37	.60	.97
Combining	Combine	6 foot	1.4	1.8	2.5	.60	.60	1.30

TABLE X CONCLUDED

ESTIMATED OPERATING COSTS OF FARM MACHINERY IN ECONOMIC AREA 8

Operation	Type of Equipment	Size of Equipment	Time per Acre 1/	Fuel Used per Hour 2/	Fuel Used per Acre	Total Fuel & Lubricating Charge per Acre 3/	Labor Charge ($.50 per hr. per acre 4/	Total Operating Cost
			Hours	Gal.	Gal.	Dollars	Dollars	Dollars
Drilling	Grain	10½ foot	.5 5/	1.2	.6	.16	.25	.41
Grain storage	Truck	1½ Ton	1.4	-	-	1.05	.70	1.75

1/ G. E. Frick, and S. B. Weeks, When to Hire and When to Own Farm Equipment on New Hampshire Farms, Cooperative Extension Service Bulletin of New Hampshire No. 136, September, 1956, p. 4.

2/ C. L. Day and M. M. Jones, Farm Tractor Costs, University of Missouri Agricultural Experiment Station Bulletin 662, October, 1955, p.2. Time for a regular 2 plow 19-21 rated D.B.H.P. used.

3/ Gasoline fuel cost estimated at 19.5 cents per gallon and oil and grease charge at 8 cents per hour of operation of 2-plow tractor as indicated in Day, Jones, Farm Tractor Costs, University of Missouri Agricultural Experiment Station Research Bulletin 662, October, 1955, pp. 1, 6.

4/ Average wages for hired labor in Ozarks in 1955 was $0.50 per hour.

5/ Reuben Hecht, "Labor and Resources Used for Farm Enterprises in Indiana" Farm Management Report, United States Department of Agriculture Bureau of Agricultural Economics, United States Government Printing Office, Washington D.C., 1952, pp. 7, 18.

6/ Spraying and baling supplies are not included in operating costs.

7/ Auxiliary engine fuel and lubricants are included in operating costs.

8/ Estimated at $.75 per hour of operation as obtained in G. E. Frick, and S. B. Weeks, When to Hire and When to Own Farm Equipment on New Hampshire Farms, Cooperative Extension Service Bulletin of New Hampshire No. 136, September, 1956, p. 6.

9/ Gregory, Wade, Silage Making Costs and Practices, Agricultural Experiment Station Bulletin of Alabama Polytechnic Institute, Number 310, p. 8.

TABLE XI

ESTIMATED CUSTOM CHARGE FOR VARIOUS FARMING OPERATIONS IN ECONOMIC AREA 8

Operation	Type of Equipment	Size of Equipment	Rates Estimated Range (dollars)		Probable Charge (per acre) (dollars)
Plowing	Two bottom plow	14 inch	3.75	4.00	3.75
Harrowing	Spike tooth	5 foot (3)	.75	1.25	1.00
Harrowing	Disc harrow	8 foot	1.25	1.75	1.50
Plant and fertilize	Planter	2 row	1.75	2.25	2.00
Seed grass 1/	Packer type	8 foot	1.20	1.50	1.35
Cultivation	Rotary hoe	2 row	1.00	1.25	1.15
Cultivation	Cultivator	2.row	1.50	2.00	1.75
Fertilizer (top dress) 1/	Trailer	8 foot	1.50	2.00	1.75
Spraying 1/	Sprayer	20 foot	.65	.75	.70
Raking hay	Side delivery	4 wheel	1.00	1.50	1.25
Mowing hay	Tractor mount	7 foot	1.50	2.00	1.75
Baling hay 2/	Auxiliary engine	Medium	3.50	4.00	3.75
Hay storage	Wagon or truck	-	3.00	4.00	3.50
Forage harvesting	Auxiliary engine	Medium	7.50	9.00	8.50
Haul, elevate, blow and pack silage 3/	-	-	12.00	16.00	14.00
Corn harvest	Corn picker	2 row	4.00	6.00	5.00

1/ Based on data from G.E. Frick and S.B. Weeks, When to Hire and When to Own Equipment on New Hampshire Farms, Cooperative Extension Service, University of New Hampshire, pp. 2-6.

2/ Based upon yields of 1 ton per acre.

3/ Based upon yield of 8 ton of corn silage, custom rate based on tonnage ($1.75 per ton).

TABLE XI CONCLUDED

ESTIMATED CUSTOM CHARGE FOR VARIOUS FARMING OPERATIONS IN ECONOMIC AREA 8

Operation	Type of Equipment	Size of Equipment	(dollars)	(dollars)	Probable Charge (per acre) (dollars)
Corn storage 4/	Wagon or truck	-	3.25	4.25	4.20 5/
Drill	Grain	10½ foot	1.75	2.25	2.00
Combine	Motor driven	6 foot	4.75	5.25	5.00
Grain storage 4/	Wagon or truck	-	1.75	2.25	3.00 6/

4/ Based on data from "Iowa Farm Custom Rate Guide", Agricultural Experiment Station, Iowa State College 1957, (Mimeographed).

5/ Based upon yield of 60 bushels of corn, custom rate based on bushels (7 cents per bushel).

6/ Based on yield of 60 bushels for small grain, custom rate based on bushels (5 cents per bushel).

CUSTOM COST VERSUS OWNERSHIP

One of the important decisions for a farmer to make in buying machinery is the relative cost of owning a piece of equipment or having the work done. If only direct operating costs are compared, it is obvious that under almost all conditions ownership would be cheaper. However, depreciation, interest and other fixed charges must be considered when machines are purchased. As the size of a farm business and the units of use increase the fixed costs per unit of use decrease. Therefore, the break-even point easily can be ascertained by subtracting the operating costs from the custom rate or cost of hiring the job done per acre and dividing the remainder into the fixed cost of ownership. If a plow is used as an example, the custom cost of $3.75 per acre minus operating costs of $0.93 gives a net cost of $2.82. Dividing this amount into $43, the annual fixed cost of owning the plow, gives 15 acres as the acreage needed to make the cost of ownership equal to that of hiring the work done. If the acreage that is operated is less than this figure, it would pay to have the work custom done; if greater, it would be cheaper to own the machine.

The big problem is accurate determination of the fixed cost of owning each of the machines needed for a particular farming operation. The farm tractor is used for many jobs. For this reason a definite fixed cost for

the power unit cannot be established until the time for all operations is known. A partial solution to the problem is to assume that none of the fixed cost of the tractor should be allocated to a particular cropping operation. This would be equivalent to assuming that the tractor was not charged against the operation. The break-even point for a particular machine such as a gang plow would be the minimum acreage that a farmer should have, if he wants to own a plow rather than hire the work done on a custom basis. Data in Table XII show the minimum acreage for most of the machines found on farms in Economic Area 8.

Break-even Points for Owning Plow and Baler

The relation of fixed costs to annual use can also be displayed graphically (Figure 5). The annual ownership costs of the plow and tractor are combined with variable costs to give a statistically fitted average cost curve. As annual use of the plow increases, cost per acre decreases. Variable costs are assumed to be constant per acre of use. If all of the costs of the power unit were charged against a 20 acre plowing operation, the average cost per acre would be $15. When the tractor is not charged against the plowing operation, the cost per acre of providing a plow for 20 acres of use is $3.02. If used to plow 100 acres, the cost would be $1.37 an acre. The break-even point between ownership and custom work is 15.2 acres. A plow is

TABLE XII

APPROXIMATE BREAK EVEN POINT IN THE ANNUAL ACRES OF WORK BETWEEN OWNING AND CUSTOM HIRING OF INDIVIDUAL PIECES OF FARM EQUIPMENT WITH AND WITHOUT TRACTOR CHARGE IN ECONOMIC AREA 8

Operation	Break-even Point 1/ When Farmer's Labor is Valued at $0.50 per Hour	
	With Tractor Charge 2/ (acres)	Without Tractor Charge 3/ (acres)
Plowing (2-14, tractor)	104	15
Harrowing (3-5 foot spike tooth sections)	76	4
Harrowing (8-foot disc tractor)	98	10
Plant and fertilize (2-row corn planter, tractor)	269	39
Seed Grass (8-foot packer)	457	26
Cultivation (2-row rotary hoe)	306	28
Cultivation (2-row cultivator)	253	28
Fertilize (10-foot trailer)	296	30
Spraying (20-foot sprayer)	827	151
Raking hay(side delivery)	328	57
Mowing hay (7-foot tractor)	219	33
Baling hay (medium engine) 4/	171	95
Hay storage (wagon) 4/	154	9
Hay storage (truck 1½ ton)	-	735 4/
Forage Harvester (1-row motor)	79	43
Silage hauling (truck 1½ ton)	-	99 5/
Corn harvesting (1-row pull type)	127	63
Corn storage (truck 1½ ton)	-	167 6/
Corn storage (wagon) 6/	82	5
Combine (6-foot, motor) 7/	136	69

1/ Break-even point derived by dividing annual fixed cost of ownership by custom rate per acre minus variable operating cost.

2/ Fixed cost of tractor ownership is charged to the farm operation indicated.

3/ Fixed cost of tractor ownership is not charged to the farm operation indicated.

4/ Estimated yield of 1 ton of hay per acre.

5/ Estimated yield of 8 ton of corn silage per acre.

6/ Estimated yield of 60 bushels of corn per acre.

7/ Estimated yield of 43 bushels of small grain per acre.

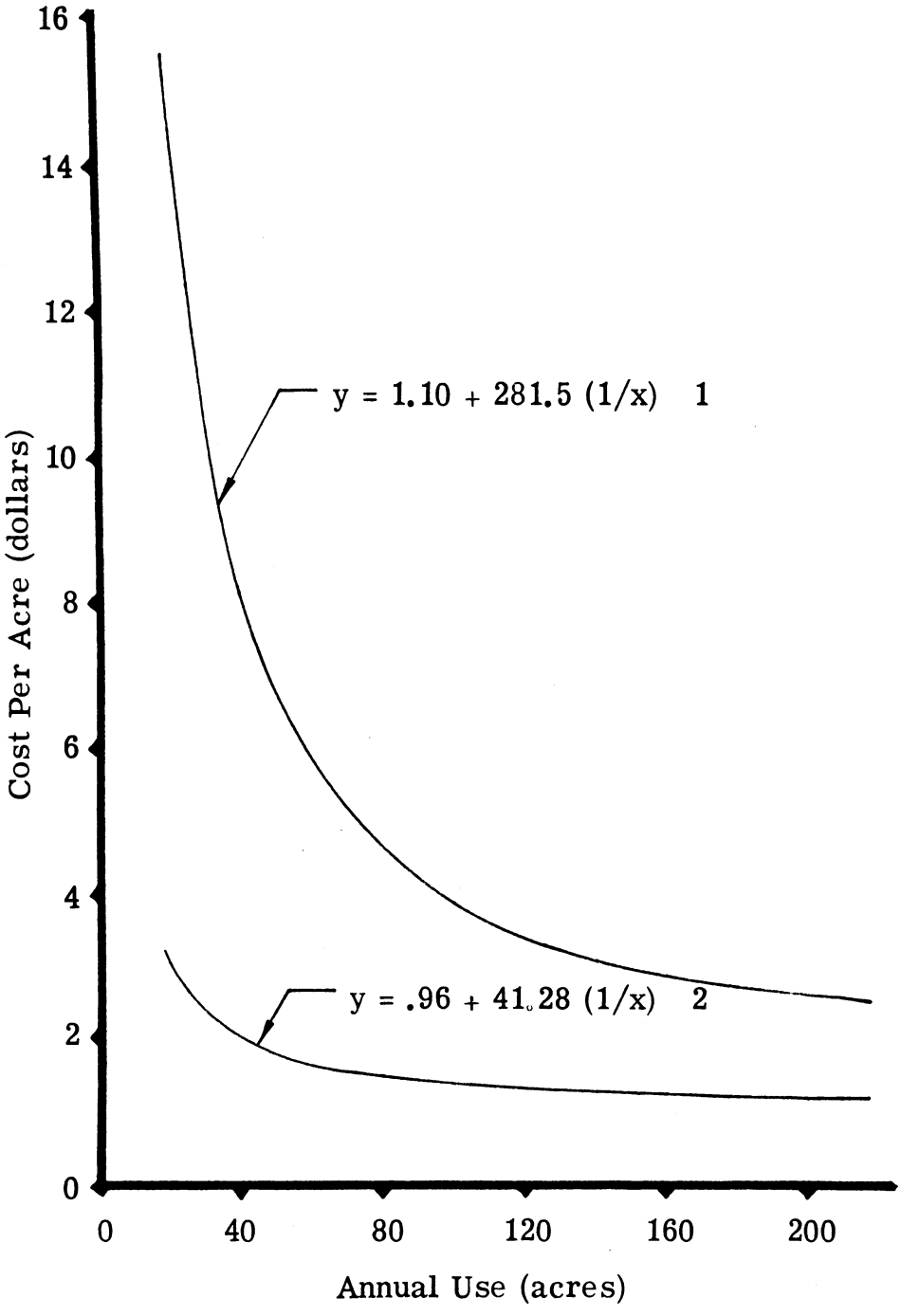

Figure 5. The relation of plow ownership to custom hire. (Variable costs are assumed to be constant per acre of use.)

1/ Average variable and fixed costs of plow and tractor.

2/ Average variable and fixed costs of the plow.

a low cost machine compared to a hay baler or forage harvester. However, low usage and high fixed costs can make plows expensive machines too.

The cost per unit of use was computed by substituting values in the equation, $y = a + b\ (1/x)$, where y = cost per unit of use and x = annual units of use. Assignment of different values to x gives the curve shown in Figure 5. Simultaneous equations were employed to fit the data to the curve. These equations gave an a value of $.96 and a b value of $41.28.

Relationships between annual use and cost per acre for other machines are shown in Figures 5, 6, 7, 8, and 9.

The break-even points for owning a hay baler varies from 95 to 171 acres (Table XII). The greatest percent change in average cost per acre is from 20 to 40 acres (Figure 6). If all variable and fixed charges were included, the average cost for 20 acres of annual operation would be $28 per acre. The average cost for 40 acres of operation would be $14 per acre. This is approximately a 50 percent change in average cost. The break-even point between ownership and custom work is 171 acres of annual use. A hay baler is one of the most expensive machines to own.

Alternative Use of Labor

Another problem to be resolved in deciding upon

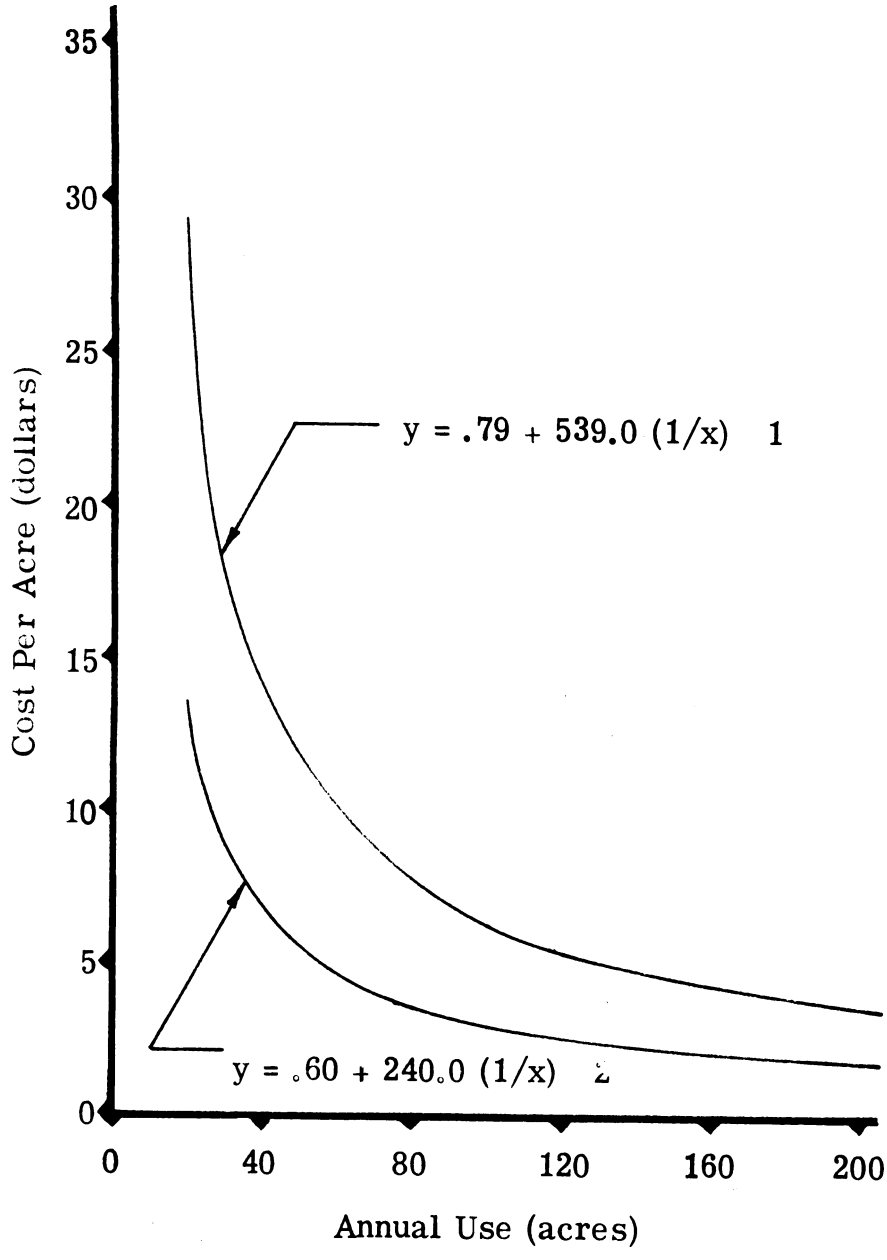

Figure 6. The relation of baler ownership to custom hire. (Variable costs are assumed to be constant per acre of use.)

1/ Average variable and fixed costs of the baler and tractor.

2/ Average variable and fixed costs of the baler.

ownership or custom hiring is the time spent in performing a given task. The custom charge usually includes wages of the operator and pay for the service of the machine. Time spent by the owner operation, therefore, must be considered as an operating cost. The wages attributable to the work are directly related to the alternatives available to the owner operator. For each farmer, this is a different figure. It was assumed, however, that the alternatives to the farm operator should be at least equal to the prevailing farm wage rate in the area. Otherwise, the farmer would be better off working as a hired hand instead of working on his own farm. The operator's wage, therefore, was included as a cost in making an estimate of the break-even point between ownership of a machine and custom hiring a job done.

Timeliness of Operation

One of the costs of waiting for a custom operator to do a job is waste and spoilage from not getting a crop cultivated or harvested at the optimum time. Delays in crucial planting and harvesting periods may mean greater losses than the saving in machinery cost. Off-setting this disadvantage is the opportunity a small operator has of shifting a high cost per unit of work to the custom operator who can escape the consequences by spreading his fixed charges over a full work load. Also, the efficiency of the custom operator will increase as he performs the job

more often. This is especially true where one individual becomes a specialist in operating a machine as contrasted with a number of workers doing small occasional jobs. Delays in getting work done are not restricted to custom operations. When machinery is owned by farm operators, many tasks are accomplished by exchange of work with neighbors. Each farmer must adjust his time schedule to that of other men in the work group. In many cases the custom operator can get the job done more promptly than the farmer. For this reason, timeliness of operations was not considered as a cost in the analysis.

ACRES OF CROPS PER FARM

The acreage of cropland is very small in Economic Area 8. Table XIII shows that over 94 percent of the farms have 74.5 or fewer acres of crops. If 24.5 acres are used, the data will represent average conditions for 59 percent of the operating units in the area. The acres of different crops per farm were computed from the percentages given in Table IV.

BREAK-EVEN POINTS FOR INDIVIDUAL CROPS

Since this is a livestock producing area, corn silage, small grain and lespedeza hay were chosen as crops that normally should be grown. The harvesting of corn for

TABLE XIII

CLASSIFICATION OF FARMS BY ACRES OF CROPLAND HARVESTED AND DISTRIBUTION OF CROPS PER FARM IN MISSOURI ECONOMIC AREA 8, 1954, 1/

Average acres of Cropland harvested per farm 2/	Number of Farms	Percent	Cropping system 3/		
			Corn	Hay	Other crops
4.5	1,844	23.6	1.1	2.3	1.1
14.5	1,535	19.6	3.6	7.3	3.6
24.5	1,226	15.7	6.1	12.3	6.1
39.5	1,497	19.2	9.9	19.7	9.9
74.5	1,282	16.4	18.6	37.3	18.6
149.5	391	5.0	37.4	74.7	37.4
249.5	37	.5	62.4	124.7	62.4
500 and over	4	-	-	-	-
Total	7,816	100.0	-	-	-

1/ The United States Bureau of the Census, United States Census of Agriculture, 1954, Vol. 1, Counties and State Economic Area, Part 10, United States Government Printing Office, Washington, D.C. 1956, p. 193.

2/ The average acreage is the mean of the range of cropland harvested.

3/ The cropping system for all farms is made up of 25 percent corn, 50 percent hay, and 25 percent other crops as shown in Table IV.

grain was included as an alternative for corn silage. The analysis in this section will determine break-even points between ownership and custom work for each individual crop. Each crop will be treated as a specialized operation.

Break-even Point for a Small Grain-Lespedeza Hay Operation

The usual cropping procedure in the area is to plant a hay crop such as lespedeza with the small grain. A crop of hay is harvested from the land that is in small grain.

The total annual fixed charge for the equipment needed to carry on a small grain-lespedeza hay cropping system is $1,721 (Table XIV). Total custom costs for this operation is $28.25 per acre. When the variable charges are deducted from the custom charge, the fixed cost is $17.92 per acre. The fixed cost per acre is then divided into the annual fixed cost to determine the number of acres needed to break-even between ownership of the equipment and hiring the work done by a custom operator. A farmer would need at least 96 acres of cropland before it would be cheaper for him to own his machinery than to hire the work done.

The cost per acre for the small grain lespedeza hay crop is shown graphically in Figure 7. The cost of growing 100 acres of the two crops is $27.84 per acre. However, the cost for a 20 acre operation is $93.98 per acre. If other

TABLE XIV

APPROXIMATE BREAK EVEN POINT BETWEEN OWNING MACHINERY TO GROW SMALL GRAIN AND LESPEDEZA HAY AND HIRING THE WORK DONE IN MISSOURI ECONOMIC AREA 8

Operation	Custom Rate (dollars)	Annual Fixed Charge (dollars)	Fuel and Lubrication (dollars)	Labor Charge 6/ (dollars)	Break-even Point With Tractor Truck Charge (acres)	Break-even Point Without Tractor Truck Charge (acres)
Tractor	-	250				
Plow	3.75	43	.43	.50		
Harrow (disc)	1.50	27	.41	.50		
Harrow (drag)	1.00	12	.12	.15		
Spread fertilizer	1.75	28	.31	.50		
Drill seed	2.00	78	.16	.25		
Combine	5.00	255	.60	.60		
Grain storage 1/	3.00 2/	551	1.05	.70		
Mow	1.75	44	.16	.25		
Rake	1.25	52	.13	.20		
Bale	3.75 3/	311	.21	.25		
Hay storage 4/	3.50 5/	69	1.65	1.10		
Total	28.25	1,721	5.23	5.10	96.0	51.3

1/ Annual fixed charge for truck which is used for both hay and grain storage.
2/ Estimated cost of 7 cents per bushel, estimated yield of 43 bushels per acre.
3/ Estimated yield of 1 ton of lespedeza hay per acre.
4/ Annual fixed charge for elevator which is used for both hay and grain storage.
5/ Hauling charge estimated at 10 cents per bale.
6/ Labor is charged at 50 cents an hour.

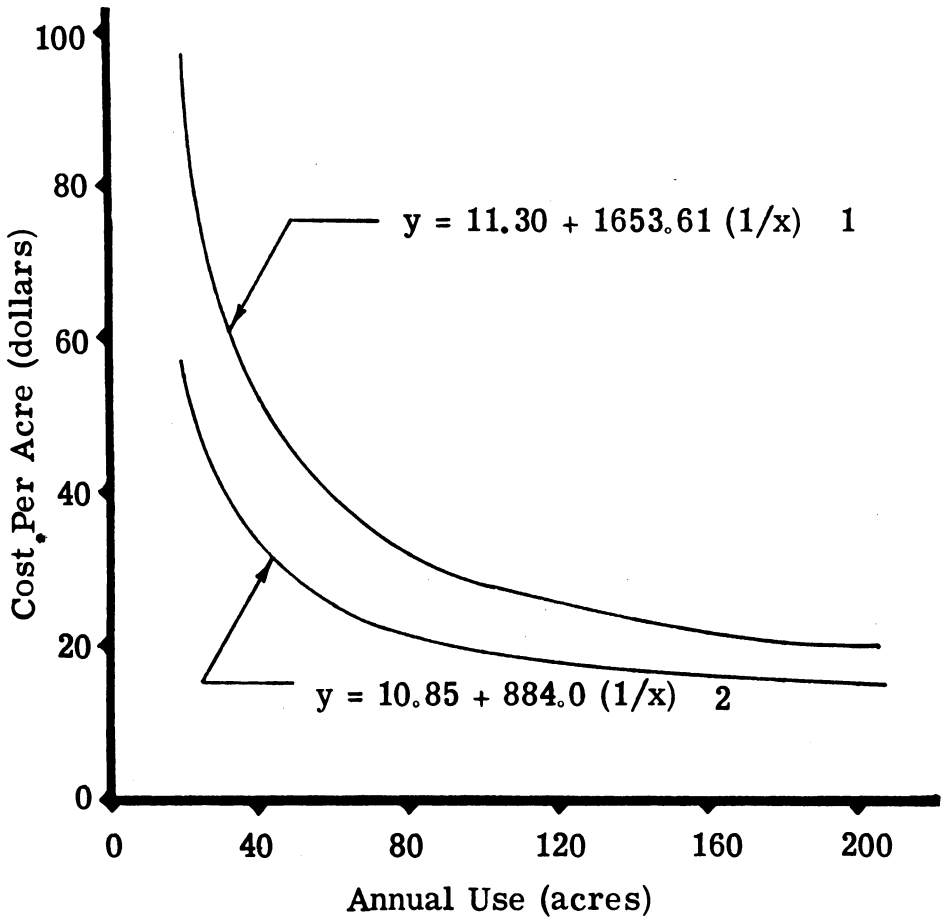

Figure 7. The relation of farm machinery ownership to custom hire for a small grain - lespedeza hay operation. (Variable costs are assumed to be constant per acre of use.)

1/ Average variable and fixed costs of the machinery.

2/ Average variable and fixed costs of the machinery less truck and tractor.

use of the truck and tractor is made during the year, the farmer may not want to charge the annual fixed costs to the crop operation. With these charge methods, the cost would be $55.05 per acre for a 20 acre operation. The break-even point between ownership and custom hire would be approximately 82 acres.

Break-even Point for a Corn Operation

The custom charge per acre for all of the work on a corn crop is $24.55 (Table XV). If the variable charges such as fuel, lubricants, and labor are deducted, the fixed cost per acre is $16.77. The total annual fixed charges for owning the equipment are $1,384. If this amount is divided by the $16.77 per acre, it appears that the farmer must have 85 acres of corn for grain before it is cheaper for him to own the equipment, than to have the work done on a custom basis. However, if the annual fixed charges for the truck and tractor are not included, the break-even point is 35 acres. The total machinery and labor charge is $23.29 per acre at the 80 acre scale of operation (Figure 8). The cost at the 20 acre scale of operation is $66.98 per acre or almost three times that of the larger cropping unit.

Break-even Point for a Corn Silage Operation

The use of corn for silage has considerable potential in the area, but is not common practice now. If corn were

TABLE XV

APPROXIMATE BREAK EVEN POINT BETWEEN OWNING MACHINERY TO GROW CORN FOR GRAIN AND HIRING THE WORK DONE IN MISSOURI ECONOMIC AREA 8

Operation	Custom Rate (dollars)	Annual Fixed Charge (dollars)	Break-even Point When Farmer's Labor is Valued at $0.50 per hour			
			Fuel and Lubrication (dollars)	Labor Charge (dollars)	With Tractor & Truck Charge (acres)	Without Tractor & Truck Charge (acres)
Tractor	-	250				
Plow	3.75	43	.43	.50		
Harrow (disc)	1.50	27	.41	.50		
Harrow (drag)	1.00	13	.12	.15		
Cultivate (rotary hoe)	1.15	25	.12	.15		
Cultivate (tractor)	3.50 1/	31	.48	.80		
Plant	2.00	43	.16	.25		
Spread fertilizer	1.75	28	.31	.50		
Spray	.70	56	.13	.20		
Harvest Corn	5.00	248	.47	.60		
Storage	4.20 2/	620	.90	.60		
Total	24.55	1,384	3.53	4.25	82.5	34.8

1/ Cultivate twice.
2/ Truck and elevator custom charges are included here.

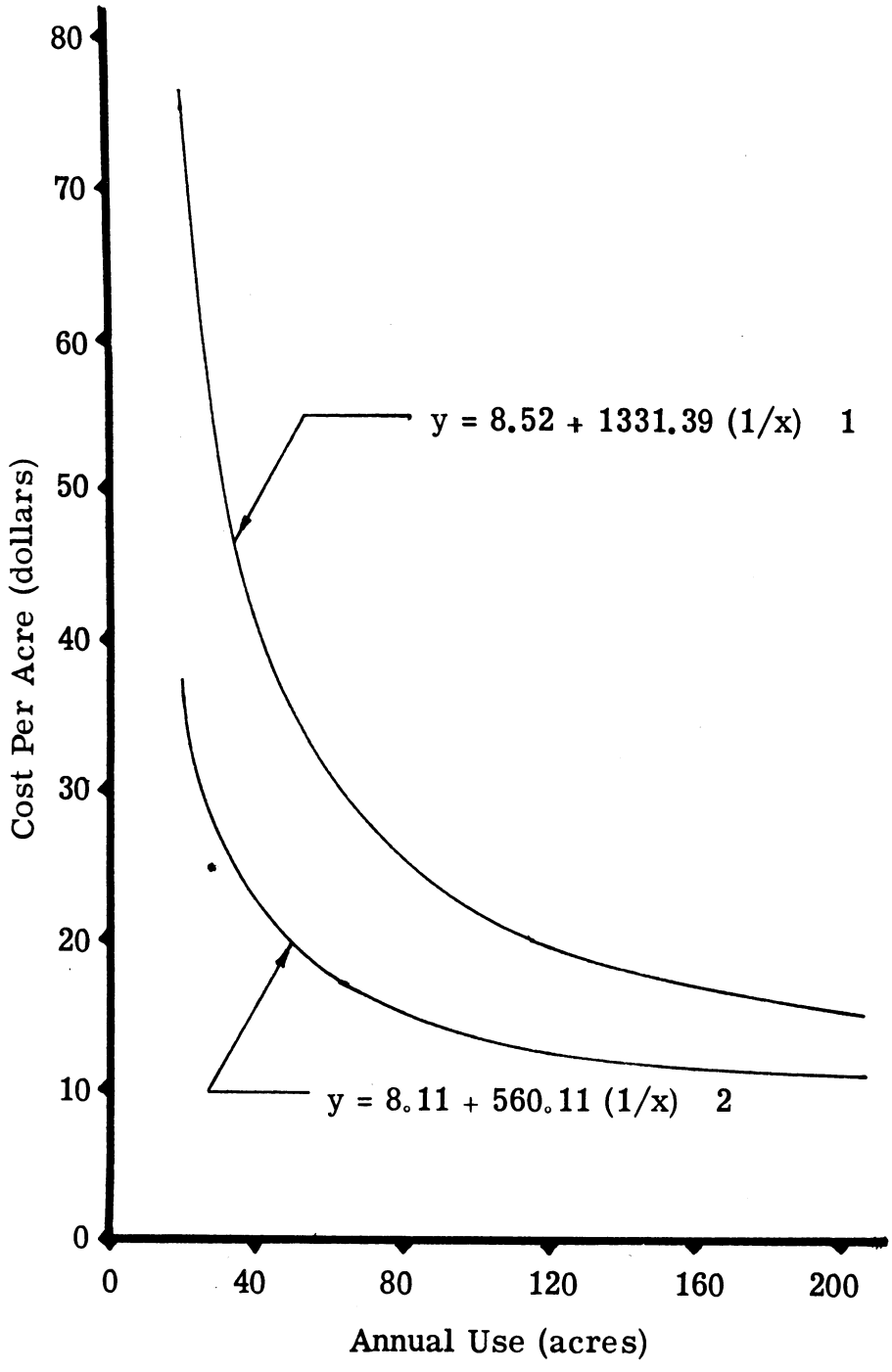

Figure 8. The relation of farm machinery ownership to custom hire for a corn operation. (Variable costs are assumed to be constant per acre of use.)

1/ Average variable and fixed costs of the machinery.

2/ Average variable and fixed costs of the machinery less truck and tractor.

harvested as silage, about 57 acres would be needed before it would be cheaper to own the harvesting machinery than to hire a custom operator to do the work (Table XVI). This acreage is much lower than for other crops. The major reason is that a considerable amount of labor is required to put up corn silage. The assumption is made here that the extra trucks and tractors needed for the harvesting operation are available by trading work with neighbors. Only the variable costs would be paid on this equipment.

The greatest percentage change in machinery cost per acre occurs between 20 and 40 acres (Figure 9). The machinery and labor charge for harvesting 40 acres of corn silage is $47.46 per acre. The cost per acre for a 20 acre operation is $80.38 or a 69.4 percent increase over the 40 acre operation

BREAK-EVEN POINT FOR A CROPPING SYSTEM

The break-even point between ownership and hiring work done also can be determined for machinery used in producing a combination of crops. Some machines, a gang plow or a tractor, for example, can be used on more than one crop; others such as a combine or a corn picker are specialized. Corn for grain or silage and small grain followed by lespedeza hay are the crops usually grown in Economic Area 8. The annual fixed cost on a full set of

TABLE XVI

APPROXIMATE BREAK EVEN POINT BETWEEN OWNING MACHINERY TO GROW AND HARVEST CORN SILAGE AND HIRING THE WORK DONE IN MISSOURI ECONOMIC AREA 8

Operation	Custom Rate (dollars) per acre	Annual Fixed Charge (dollars)	Break-even Point When Farmer's Labor Valued at $0.50 per hour: Fuel and Lubrication (dollars) per acre	Labor Charge (dollars) per acre	With Tractor & Truck Charge (acres)	Without Tractor & Truck Charge (acres)
Tractor	-	250				
Plow (tractor)	3.75	43	.43	.50		
Harrow (disc)	1.50	27	.41	.80		
Harrow (drag)	1.00	13	.12	.15		
Cultivate (rotary hoe)	1.15	[illegible]	.10	.15		
Cultivate (tractor)	3.50 1/	31	.48	.80		
Planter (2-row)	2.00	43	.16	.25		
Spread Fertilizer	1.75	28	.31	.50		
Spray	.70	56	.13	.20		
Harvest Forage	22.50 2/	303	.69	.80		
Tractor (pack) 3/	-	-	1.00	1.60		
Truck (haul)	-	551	2.40	1.60		
Total	37.85	1,370	6.73	7.05	56.9	23.6

1/ Cultivate two times.
2/ Custom charge for forage harvester and extra tractor is derived from data included in Footnote 1 of Table XI.
3/ Extra trucks and tractors are assumed to be available by trading work with neighbors and only operating expenses are paid.

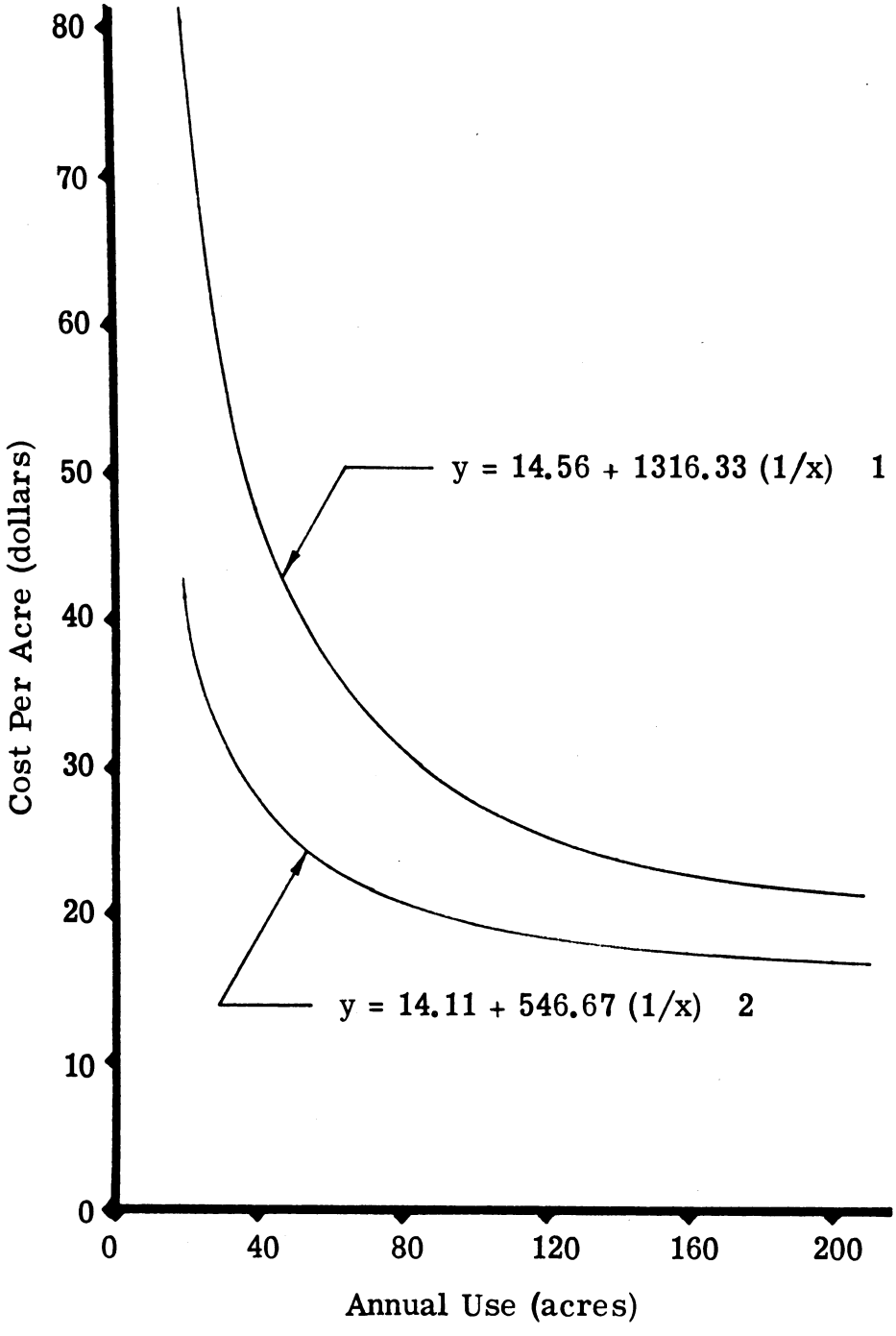

Figure 9. The relation of farm machinery to custom hire for a corn silage operation. (Variable costs are assumed to be constant per acre of use.)

1/ Average variable and fixed costs of the machinery.

2/ Average variable and fixed costs of the machinery less truck and tractor.

machinery that is needed to grow a combination of these crops is $2,426. The fixed charges based on the contribution that the farmer would make to the overhead costs in paying for custom work are approximately $16.91 per acre of crops. The break-even point between ownership and hiring the work done is 143 acres. This acreage is obtained by dividing the annual fixed costs ($2,426) by the custom charge for one acre of the combined crops less the variable costs such as fuel, lubricants, and wages that are included in the custom rate.

LEASING FARM MACHINERY

The cost of buying, maintaining, and operating machinery is a major part of the cost of operating a farm business. Yet, some of the machines are used only a few days a year. A high fixed cost is incurred for the privilege of using this equipment. If this cost could be reduced by other methods of getting the work done, net returns would be increased. For this reason, operators of small farms who are short of working capital should consider other methods of getting control of machinery. Leasing or renting the equipment is one of these methods. This procedure is not new to the farm machinery industry. It has

been followed for years.[5] However, the practice is not wide spread among operators of small farms and the rental rates are high for less than full seasonal use. The practice of renting machinery could be used in Missouri Economic Area 8, if a rental firm or agency were established that would make specialized equipment such as combines or hay balers available to a number of farm operators in a community. The following analysis presents a procedure that can be used to determine leasing rates for some of these machines. Normal full-time use and life expectancy of various pieces of farm equipment will be used in establishing these rates. Also the normal cost of ownership will be used to compute cost for both the machinery dealer and the farm operator. It will be necessary to determine how much use a dealer can expect to be made of his leased equipment in order to calculate the years or acres of use necessary for a successful machinery leasing business. Lease rates are determined by calculating the cost per unit under anticipated annual use and years of life. In figuring lease rates, fixed costs are used as a base. The operator would furnish fuel and labor for each type of work. However, each dealer would need to include handling charges in the

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[5]W. G. Phillips, "The Changing Structure of Markets for Farm Machinery," Journal of Farm Economics, Proceedings Number 5, Vol. 40, The American Farm Economics Association, Menasua, Wisconsin, December, 1958, pp. 1180-1181.

rate. An estimate of annual rental use must be made to determine the life of the machine. The rates are then based on annual fixed costs which include the fraction of investment or amount of depreciation necessary to recover the dealer's investment, service charges and profit to the owner of the rental firm or agency.

Age and Use Expectancy

Ground preparation equipment has the longest age expectancy in acres or years of use and harvesting equipment the shortest. The data in Table XVII are based on the assumption that a machine will be obsolete if not worn out in the number of years indicated. The average acreage of harvested crops is 25 per farm in Economic Area 8. A plow does not become obsolete as quickly as a combine or hay baler, but a great many years would be required to wear a plow out on the average farm.

Annual Cost of Ownership

A farm operator needs to know the cost of owning a piece of equipment before making a decision to lease the machine. If a plow is used as an example, the cost would be $2.15 per acre for 20 acres of annual use (Table XVIII). Fixed costs are the only items considered in making the calculations. Variable costs, for the operator, would be the same for renting or owning the equipment.

TABLE XVII

TOTAL ACRES OR YEARS OF USE TO BE EXPECTED FOR THE LIFE OF VARIOUS PIECES OF FARM MACHINERY

Machine	Acres	Years
Item		
Plow (tractor)	2,000	15
Harrow (disc)	2,000	15
Harrow (drag)	7,500	20
Grain drill	2,400	20
Corn planter	2,400	20
Field sprayer	2,100	10
Cultivator (rotary hoe)	4,500	15
Cultivator (tractor)	3,000	12
Mower (tractor)	4,000	12
Side delivery rake	2,400	15
Forage harvester	800	12
Pick-up baler	3,000	12
Combine	1,200	10
Corn picker	1,200	10
Tractor	-	15
Wagon geer and box	-	15
Elevator (portable)	-	15

Source: C. B. Rickey, American Society of Agricultural Engineers: "Crop Machine Use" Agricultural Engineers Yearbook, American Society of Agricultural Engineers, 5th Edition, St. Joseph, Michigan, April, 1958, p. 77.

TABLE XVIII

ESTIMATED ANNUAL COST OF OWNERSHIP PER ACRE FOR A FARMER TO OWN A TWO BOTTOM PLOW IN MISSOURI ECONOMIC AREA 8. 1/

Annual Use (acres)	Cost per Acre 2/ (dollars)
10	4.30
20	2.15
30	1.43
40	1.08
50	.86
60	.72
70	.61
80	.54
90	.48
100	.43

1/ Annual ownership costs are taken from Table IX.

2/ Service charge and profits to management are not included.

Lease Charge per Acre at Different Levels of Use

The annual costs of ownership which includes a capital recovery charge must be computed to determine the lowest rental rate that an owner can afford to make. The data presented in Table XVIII show the cost of owning a two-bottom plow at different rates of annual use. Service expenses and profit to the owner should be added in arriving at the rental charge. If the annual use is 100 acres and 25 percent is added to the other cost items to take care of service charges and profit to the owner, the rental charge is .57 cents an acre ($0.43 is 75 percent of $0.57). Service charges, acres of use and profits are not uniform for all dealers. For this reason, rental rates should vary with local conditions. Data in Tables XVIII and XIX provide a basis for calculating the proper rental charge. Estimated lease charges per acre at different levels of annual use for a two-bottom plow are shown graphically in Figure 10.

JOINT OWNERSHIP OF FARM MACHINERY

Ownership of machinery by two or more farmers can be used to lower the cost per acre. Where farms are small, this procedure will spread the fixed cost and reduce the charge per unit of use. Different machines can be owned by each farmer so all members of the group can get their work completed with a minimum of delay. In Missouri Economic

TABLE XIX

ESTIMATED LEASE RATES FOR A TWO-BOTTOM PLOW AT DIFFERENT LEVELS OF ANNUAL USE IN MISSOURI ECONOMIC AREA 8

Annual Use per Year (acres)	Life of Plow 1/ (years)	Annual Charges for Plow per Acre 2/ (dollars)	Annual Capital Recovery Charge per Acre 3/ (dollars)	Total Ownership Charge per Acre 4/ (dollars)	Estimated Lease Rate per Acre 5/ (dollars)
100	15	.27	.16	.43	.57
200	10	.14	.12	.26	.35
300 6/	7	.10	.12	.22	.29
400	5	.07	.12	.19	.25
500	4	.06	.12	.18	.24
600 6/	3	.04	.12	.16	.21
1000	2	.03	.12	.15	.20
2000	1	.01	.12	.13	.17

1/ Total life of the plow is 15 years or 2000 acres. The dealer can use the period he expects to own the plow.

2/ The charges include repairs, interest on investment, insurance, taxes, and housing as computed in Table IX.

3/ The capital recovery charge is the depreciation that must be included in the rental rate for the firm or agency to recover the original investment.

4/ The summation of annual charges and capital recovery costs.

5/ A service charge and profit to management estimated at 25 percent is added to the total ownership charge. No variable charges are included in the rate.

6/ These computations are based on 2000 acres of life for the plow.

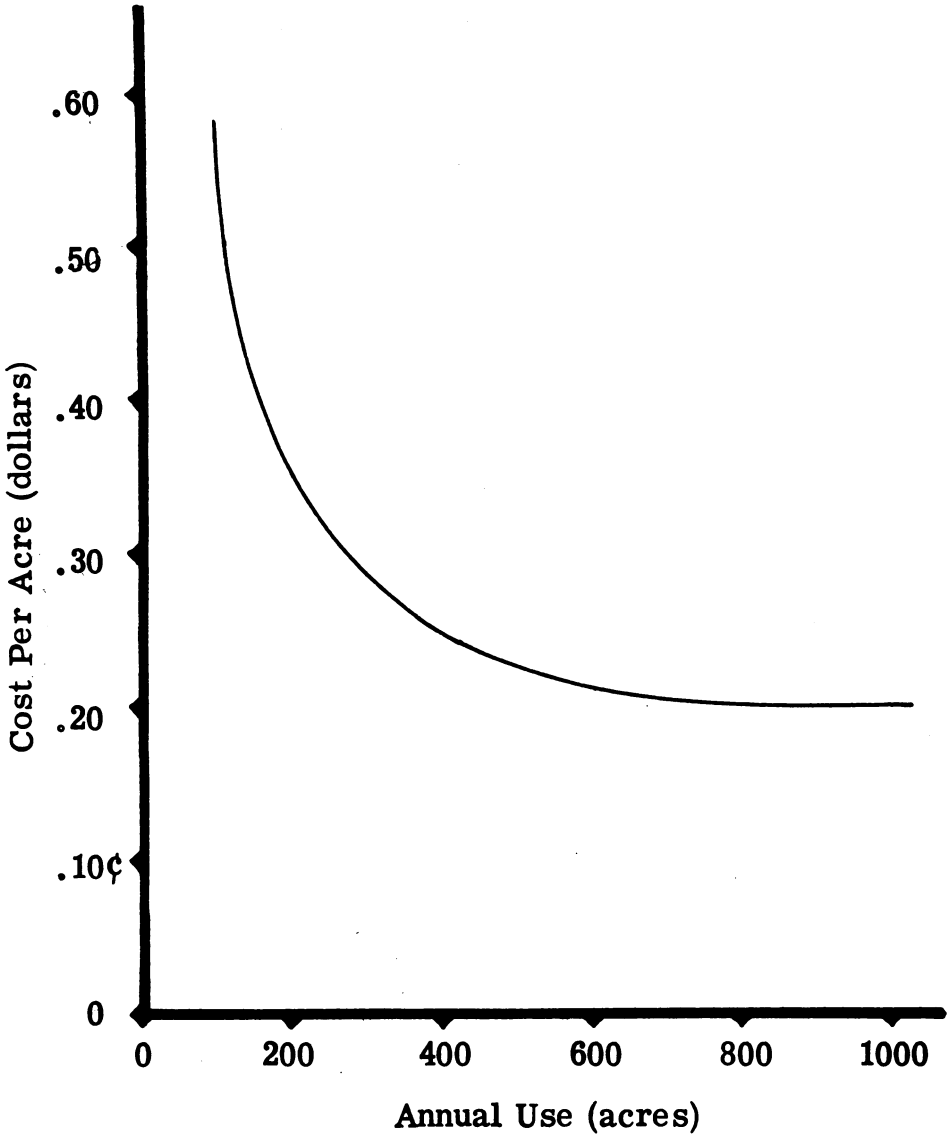

Figure 10. Estimated lease rates for a two bottom plow at different levels of annual use. (Variable costs are not included in the rental rate.)

Area 8, most farms are small; yet there is a tendency for each operator to own a full line of equipment. The data presented in Table XX show the annual fixed cost for a full set where corn silage, small grain and lespedeza hay are used in the cropping system. The cost is determined for each machine needed to accomplish the work that needs to be done in growing and harvesting the crops. This procedure gives the annual ownership cost for a full set of equipment. One machinery unit is made up of a tractor and the equipment necessary to perform the cropping operations.

The cropping system usually found in Economic Area 8 consists of 25 percent corn and 75 percent small grain-lespedeza hay.[6] The average operator with 25 acres of cropland would have six acres of corn and 19 acres of small grain from which he would also harvest lespedeza hay. By using standard rates of accomplishing work, the hours of machine use on a farm of this size were calculated. Through this analysis, the feasibility of cooperative ownership may be determined.

The cropland in this area is only six percent of the

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[6]Samuel C. Turner, "Resources and Farm Income in the Missouri Ozarks," Unpublished Master's Thesis, University of Missouri, Columbia, Missouri, 1958, p. 32.

total land in farms.[7] It usually is located along streams. Consolidating farms would not significantly change the proportion of land that is cropped. Because of this fact, it is assumed that any consolidation of existing units would leave the percentage of land in each use approximately unchanged. It has already been pointed out that most of the income is from livestock. The organization of farms is not likely to change appreciably. In the future more of the cropland will be needed for feed grain and roughage, so livestock numbers can be expanded. Thus the type of machinery needed is not likely to change. This fact makes it possible to outline the fixed costs for sets of machinery needed on typical farms in the area.

Fixed Cost per Set of Machinery

The data presented in Table XX show the annual ownership cost of a set of farm machinery on a typical farm. With the exception of additional equipment required for harvesting corn silage, the set of machinery described would be capable of performing all of the crop operations on a much larger acreage than is found in the average operating unit. The cost shown in Table XX can be spread over more units of use through cooperative or joint

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[7]United State Bureau of the Census, United States Census of Agriculture; 1954, Vol. 1, Counties and State Economic Areas, Part 10, United States Government Printing Office, Washington, D. C., 1956, pp. 44-53.

TABLE XX

FIXED COSTS OF OWNING THE MACHINERY NECESSARY TO PERFORM CROP OPERATIONS ON A REPRESENTATIVE FARM IN MISSOURI ECONOMIC AREA 8 WHERE CORN SILAGE, SMALL GRAIN, AND LESPEDEZA ARE GROWN ON THE CROPLAND.

	Annual Cost (dollars)
Tractor 1/	250
Plow	43
Fertiliser Spreader	28
Corn Planter	43
Harrow (disc)	27
Harrow (drag)	13
Cultivator (rotary hoe)	25
Cultivator (tractor)	31
Combine	255
Sprayer	56
Baler	311
Mower	44
Side delivery rake	52
Forage harvester	303
Drill	78
Total	1,559

1/ Annual costs taken from Table IX.

ownership by two or more farmers who live near each other. Methods of accomplishing this task will be discussed in the next chapter.

Acres of Annual Use per Set of Machinery

The representative farm in this area has 25 acres of harvested cropland. The cropping system usually includes 75 percent small grain and lespedeza hay, and 25 percent corn. This plan of land use provides for approximately the same differential between tilled and non-tilled crops that presently prevails in the area. The crops include six acres of corn for silage and 19 acres of small grain and lespedeza hay. Table XX shows the machinery that would be necessary to produce these crops. To obtain low cost, the annual use of the machinery would need to be increased beyond 25 acres.

The annual cost of ownership is $1,559 (Table XXI). The equipment needed to move the crops into storage is not included in this figure, since these items would vary from farm to farm. The fixed cost of owning the complete set is $16.06 per acre. The set of machinery listed in Table XXI should be used on 97 acres, if the ownership cost per acre is to be kept at the same level as would be contributed in the charge for custom work.

This acreage is approximately four times the average number of crop acres found in farms in the area. In other

TABLE XXI

ANNUAL FIXED COSTS ON MACHINERY REQUIRED TO PRODUCE SIX ACRES OF CORN SILAGE AND NINETEEN ACRES OF SMALL GRAIN AND LESPEDEZA HAY ON AN AVERAGE FARM IN MISSOURI ECONOMIC AREA 8 1/

Crop Operation 2/	Charge for Custom Work per acre			Fixed Cost Paid in the Custom Charge	Annual Fixed Cost of Owning the Machinery
	Fixed Cost	Variable Cost	Total		
Corn for Silage					
Plowing	$2.82	$0.93	$3.75	$16.92	$ 43.00
Fertilizing	.94	.81	1.75	5.64	28.00
Planting	1.59	.41	2.00	9.54	43.00
Discing	.59	.91	1.50	3.54	27.00
Harrowing	.73	.27	1.00	4.38	13.00
Hoeing (rotary)	.88	.27	1.15	5.28	25.00
Cultivating (twice)	2.22	1.28	3.50	13.32	31.00
Spraying	.37	.33	.70	2.22	56.00
Cutting Silage	7.01	1.49	8.50	42.06	303.00
Sub-total				$102.90	$ 569.00
Small Grain and Hay					
Plowing	$2.82	$0.93	$3.75	$ 53.58	
Fertilizing	.94	.81	1.75	17.86	
Discing	.59	.91	1.50	11.21	
Harrowing	.73	.27	1.00	13.87	
Drilling	1.59	.41	2.00	30.21	$ 78.00
Combining	3.70	1.30	5.00	70.30	255.00
Mowing hay	1.34	.41	1.75	25.46	44.00
Raking hay	.92	.33	1.25	17.48	52.00
Baling hay	3.09	.46	3.75	58.71	311.00
Tractor					250.00
Sub-total				$298.68	$ 990.00
Total				$401.58 3/	$1,559.00

1/ Fixed costs per acre are computed for a representative cropping system of six acres of corn silage and 19 acres of small grain followed by lespedeza hay.

2/ Costs are not computed for corn silage, hay and grain storage, since storage equipment is not included in the set of machinery.

3/ The fixed cost per acre included in the custom charge is $16.06. By dividing $16.06 into $1,559, the acres of annual use that justify ownership is found to be 97.

words, cooperative ownership arrangements that would make a set of machinery available to four farmers would aid materially in reducing costs.

CHAPTER IV

POTENTIAL MACHINERY INVESTMENT AND COSTS IN MISSOURI ECONOMIC AREA 8

The investment in a full set of farm machinery is a large capital item in Missouri Economic Area 8. This chapter deals with this investment and with procedures of distributing it between farmers so they can employ mechanized production methods and still keep their costs per unit of use low. The average farmer in the area grows and harvests about 25 acres of crops. As shown in Chapter III, full use of complete sets of machinery cannot be accomplished on individual farms with this number of crop acres. More than three-fourths of the farmers will have extremely high machinery cost per unit of use and more than ninety percent will exceed the cost of having their work done at standard custom rates, if the pattern of ownership and use cannot be changed.

Several procedures can be adopted to increase the annual use of machinery. If the size of the farm is increased, the acreage of cropland normally will go up and the use of machinery will be increased. Enlargement of farms should be encouraged, but other means of increasing annual use and lowering unit costs already have been pointed out. They include (1) cooperative ownership of machinery,

(2) establishing rental agencies at central points that rent machines to farmers, and (3) ownership of machines by individual farmers who do custom work in the neighborhood. Each farm operator does not need to own every individual machine needed to carry out his cropping operations. However, each machine must be available through some combination of these types of ownership.

The machines needed for the cropping system found on the typical farm in the area, and the approximate annual fixed cost is found in Table XX, Chapter III. The units of annual use required for reasonably low cost are presented in Table XXI. One set of machinery must be used on four typical farms to get the crop acres necessary for low fixed costs. These facts were used to estimate the machinery investment required to accomplish the work that needs to be done in the area. The results are presented in Table XXVI. As a matter of course, the cost of new equipment exceeds the present value of the machinery that is being used. If the age of equipment is known, the future machinery investment can be depreciated to this age for comparative purposes. It is then possible to determine the optimum potential investment for the area. Present machinery costs likewise can be compared with potential costs under more nearly full use. These comparisons will be made in this chapter.

Full seasonal utilization of each machine must be

accomplished, if fixed costs are to be kept low. This goal cannot be achieved on most of the farms in Missouri Economic Area 8 without following one or more of the procedures already outlined. If full ownership of machinery is used, the acreage of cropland must be increased on most farms. This may be done by purchasing or renting land. As shown in Table IV, Chapter II, approximately 14 percent of the land in farms is tillable. Many operators who try to adjust their businesses to get more nearly optimum use of a full set of machinery will find it necessary to purchase or rent relatively large acreages. The data presented in Table XXII show that this type of adjustment is being made; but the rate is too slow to be considered satisfactory. The average size of farm was increased from 133 acres in 1930 to 175 in 1954 or 32 percent. Total cropland acres declined from 756,000 to 600,000 or 21 percent. However, due to a decrease in the number of farms, the average number of crop acres per farm changed very little. If acquisition of additional land is to be the adjustment procedure, the average operating unit needs to be increased fourfold. Obviously the rate of adjustment has been entirely too slow to keep pace with the advance in technology.

A second method of lowering cost could be joint ownership of machinery. If several operators could use the same machine or set of machinery, the full seasonal capacity

TABLE XXII

NUMBER AND AVERAGE SIZE OF ALL FARMS AND AVERAGE ACRES OF CROPLAND PER FARM IN MISSOURI ECONOMIC AREA 8, 1930-1954 1/

Year	Number of Farms	Average Cropland Acres 2/	Average Size of Farm Acres
1930	13,304	56.8	132.4
1935	15,061	49.5	123.4
1940	14,530	53.8	127.4
1945	13,118	45.8 3/	142.1
1950	12,514	52.3	152.3
1954	10,560	56.8	175.3

1/ Fifteenth Census of the United States, 1930, United States Government Printing Office, Washington, D.C., Vol. II, Part 1, pp. 980-988; United States Census of Agriculture, 1935, United States Government Printing Office, Washington, D.C. Vol. 1, pp. 260-271; Sixteenth Census of the United States, 1940, United States Government Printing Office, Washington, D.C., Vol. 1, Part 2, pp. 244-253; United States Census of Agriculture, 1945, United States Government Printing Office, Washington, D.C., Vol., 1, Part 10, pp. 18-46; 1950 Agriculture Census, United States Government Printing Office, Washington, D.C., Vol. 1, Part 10, pp. 164-172; 1954 Census of Agriculture, United States Government Printing Office, Washington, D.C., Vol. 1, Part 10, p. 193.

2/ Compiled from United States Census of Agriculture.

3/ Cropland data prior to 1946 included land pastured which could have been plowed and used for crops without cleaning, drainage or irrigation.

could be approached and operating cost per acre reduced. If four average sized farm units were combined as shown in Chapter III, annual use of machinery could be increased. This goal can be reached through cooperative ownership as well as by combining operating units. A full set of machinery can be owned by the group with each farmer investing his proportionate share in the total cost; or, individual machines can be selected for separate ownership with the investment per man in proportion to his use of all the machines that make up the complete set.

A third procedure that could be used to get full seasonal use of machinery would be to increase custom work. It has already been pointed out that the cost of ownership is higher than the custom charge on many small farms. The break-even point for several machines and combinations of machinery are given in Chapter III. This method of lowering fixed costs has the advantage of making it possible to hire one task such as combining small grain while operator owned machines are used for the other work. It is also possible to hire all of the crop work done. The major disadvantage is loss of a crop or deterioration in quality because of delays in getting the work done. This disadvantage can be overcome to some extent by planning the work in advance.

The development of machinery rental agencies to lease equipment to farmers is a fourth procedure that could be

used to reduce costs. This practice is not common in the area. However, it has very good possibilities of success where farms are small, as is the situation in this area.

Farm Machinery Sets or Units

The analysis presented in Chapter III was based on use of the cropland for corn, corn silage, small grain and lespedeza hay and combinations of these crops. Successful production of these crops requires a specific set of machinery, but each operator need not own every machine. However, he must have access to it through one of the procedures described above. Assuming that each set of machinery is used at the break-even level between ownership and custom operation, the amount needed for low-cost use can be estimated. The two-plow tractor is assumed to be the basic power unit. The average age of two-plow tractors in Economic Area 8 is six years (Table XXIII). Over 50 percent were obtained during or before 1949. It is assumed that tractor equipment would have the same age distribution.

The retail value of the machinery necessary to operate the cropping system that is found on the average farm in Missouri Economic Area 8 is $10,565 (Table XXIV). The depreciation for a complete set is $4,440. This is the sum of six years of annual depreciation. When this amount is deducted from the total investment, the present value of the set is $6,105. In other words, a man who supplies

TABLE XXIII

AGE DISTRIBUTION OF TRACTORS IN MISSOURI ECONOMIC AREA 8, 1946 - 1956. 1/

	1946	1947	1948	1949 2/	1950	1951	1952	1953	1954	1955	1956	Total
Item							Percent					
1 plow	15	15	7	15	15	15	4	4	3	7	0	100
2 plow	32	6	7	7	1	9	8	6	2	4	2	100
3 plow	20	5	0	5	10	20	0	5	20	10	5	100
Total	28	7	6	8	16	11	7	5	5	5	2	100

1/ Unpublished data obtained from a 1955 inventory study by Ronald Bird, Frank Miller, and Samuel Turner.

2/ Average age is six years.

TABLE XXIV

FARM MACHINERY NEEDED FOR A SMALL GRAIN LESPEDEZA HAY AND CORN SILAGE CROPPING SYSTEM IN MISSOURI ECONOMIC AREA 8

Item	Original Cost 1/	Annual Depreciation 2/	Total Depreciation Cost	Present Value (Cost-Depreciation) 3/
Tractor	$ 1,388	$138	$ 828	$ 560
Plow	242	16	96	146
Fertilizer Spreader	230	15	90	140
Corn Planter	325	21	126	199
Harrow (disc)	190	12	72	118
Harrow (drag)	110	7	42	68
Cultivator (rotary hoe)	170	11	66	104
Cultivator (tractor)	215	14	84	131
Combine	1,800	120	720	1,080
Sprayer	375	20	120	255
Baler	2,200	156	876	1,324
Mower	300	20	120	180
Side delivery rake	400	26	156	244
Forage harvester	2,000	133	798	1,202
Grain drill	620	41	246	374
Total	$10,565	$740	$4,440	$6,125

1/ New equipment cost.
2/ Straight line depreciation.
3/ Actual value of machinery.

himself with a full set of equipment would have an annual decline in value of approximately $740. In order to get low fixed cost per unit of use, this amount and other cost items such as interest, taxes and insurance would need to be spread over a large number of acres or hours of use, approximately 97 acres are required to accomplish this task. A small operator could accomplish it through cooperative ownership, by renting the equipment for the time he wanted to use it or by hiring a custom operator to do his work.

Machinery Investment

The analysis presented here suggests that the average farm in Economic Area 8 is over equipped. The present investment in the area is $17,387,516 (Table V). This amount includes the value of all farm machinery. The total cropland harvested is approximately 267,217 acres. If 97 acres of cropland were cultivated and harvested with each set of machinery, 2,755 sets would be required. The present value would be $16,874,375. In 1954 only 5.5 percent of the farmers had 100 or more acres of cropland (Table XXV).

It should be kept in mind that the analysis presented in the preceding paragraph merely indicates the minimum acreage of cropland that a farm operator should have if he wants to own a set of machinery. Much more than 97 acres can be farmed with a two-plow tractor and the equipment that usually goes with it. If all operating units were adjusted

TABLE XXV

NUMBER OF FARMERS IN ECONOMIC AREA 8 BY ACRES OF CROPLAND HARVESTED, 1954. 1/

Range in Acres	Number	Percent
1 - 9	1,844	23.59
10 - 19	1,535	19.64
20 - 29	1,226	15.69
30 - 49	1,497	19.15
50 - 99	1,282	16.40
100 - 199	391	5.00
200 - 499	37	.48
500 and over	4	.05
Total	7,816 2/	100.00

1/ The United States Bureau of the Census, United States Census of Agriculture, 1954 Vol. 1, Counties and State Economic Areas, Part 10, United States Government Printing Office, Washington D.C. 1956, p. 193.

2/ Number of farms reporting. The total number for the area is 10,560.

to 140 acres of cropland, only 1,909 sets of machinery would be needed. Under these conditions, the investment would be reduced from $17,387,516 to $11,692,625 or $5,694,891, a 32.8 percent reduction. Farmers who have fewer than 140 acres of cropland would profit materially by turning to cooperative ownership of equipment. Those with no more than 97 acres would get their work done at less cost by custom operators or by leasing equipment than by owning it.

Current and Potential Machinery Costs

The data presented in Table XXVI show that the present investment in farming machinery on all units with 140 or fewer acres of cropland would be $16,425,986 if each operator had a full set. The ownership cost would be $3,442,436. If the farms were adjusted to 140 acre cropland units and the fixed costs remained constant, the sets of machinery needed would decline from 9,976 to 1,909; the investment would go down from $16,425,986 to $11,692,625 and the annual ownership cost would be reduced from $3,442,436 to $2,976,131. On an acre basis, fixed costs would be reduced from $13.64 to $11.14 or 18.3 percent. A reduction is possible on 94.5 percent of the farms in the area where operating units can be combined or cooperative ownership arrangements can be made among farm operators.

TABLE XXVI

POTENTIAL REDUCTION IN INVESTMENT AND IN FIXED COST OF PROVIDING FARM MACHINERY IN MISSOURI ECONOMIC AREA 8

Item	Farms with fewer than 140 acres of cropland 1/	Adjusted farm units 2/
Number	9,976	1,909
Average crop acres per farm	25	140
Total acres controlled	175	970
Units of machinery needed:		
Number	9,976	1,909
Investment	$16,425,986	$11,690,625
Percent of present requirement	94.5	67.2
Fixed annual ownership cost 3/	$ 3,442,436	$ 2,976,131
Percent of present cost	94.5	81.7
Cost per acre of cropland	$ 13.64	$ 11.14
Percent of present cost	100	81.7

1/ Number of farms, average crop acres per farm, acres controlled and investment are taken from the following figures: total number of farms, 10,560, total cropland harvested, 267,217, total land in farms, 1,851,676, and total investment, $17,387,516. Of the present farms 5.53 percent have 140 or more acres of cropland.

2/ The fixed cost per set of machinery is assumed to remain constant for an increased scale of operation.

3/ Fixed ownership cost data available for the area include depreciation and interest. The total cost for these two are $2,550,762 for the area (Table VII, Chapter II). Repairs, insurance, taxes and housing were computed at 30 percent of the total fixed cost for the area. This is the approximate percent that these items are for any individual machine. This gave a total figure of $3,643,946, for the area.

CHAPTER V

SUMMARY AND CONCLUSION

Summary

Net income from sale of products is extremely low on most farms in Missouri Economic Area 8. One of the major contributing causes is the low crop acreage per farm. Crops return only 20 percent of the gross income, but farm machinery costs are 41 percent of the total expenses. Sale of livestock and livestock products account for 75 percent of the farm income while livestock expenses are only 28 percent of the operating costs. One method of improving net farm income would be to lower farm machinery costs.

Several procedures can be used to reduce machinery costs. They include purchasing or renting additional cropland, custom hiring, leasing and joint ownership to get control of the services of machinery. The method that will get the work done at least fixed cost varies with the circumstances surrounding each farm business.

This study was undertaken to outline the procedures that could be used to reduce farm machinery costs. The analysis revealed the following facts:

1. The present investment in farm machinery in the area exceeds the actual need under desirable levels of use.

2. Substantial savings could be made in fixed costs by using farm equipment to its full capacity.
3. Cooperative ownership, hiring work done at standard custom rates or leasing the machinery itself could be used to reduce the cost per acre or hour of use on 95 percent of the farms.

The owner of farm machinery incurs two types of cost: (1) fixed (2) variable. The fixed costs include interest on the investment, depreciation due to obsolescence, insurance, taxes, and housing charges. Annual charges for these items are constant regardless of the acres or hours of use. The variable charges include labor, fuel, repairs and lubricants. These costs are associated with operating the machinery and are directly related to hours or acres of use.

The topography of Missouri Economic Area 8 is rough. The acreage of tillable land lies in small irregular tracts surrounded by steep stony land that is not tillable. Thus, the tillable acreage per farm is relatively small.

To assist the farmer in deciding on the type of machinery control that best fits his farm business, it is necessary to determine a break-even point between ownership and other means of controlling use of machinery. This point is determined by the amount of work below which it would be better to custom hire or lease the equipment and above which it would be cheaper to own it. Break-even

points may vary from farm to farm due to differences in fixed and variable costs. However, by following the procedure outlined here farmers can derive their own break-even points.

The cropping system used in the analysis consisted of corn for grain or silage, small grain and lespedeza hay. To operate this system for the total area, machinery that has a current value of approximately $11,690,625 is needed. The cropland in the area is limited. To provide the necessary machinery at reasonable cost, the findings suggest that each set should be used to grow and harvest crops on at least 140 acres. If each set were used on this acreage, the number in the area would be reduced from 9,976 to 1,909, a decrease of 81 percent. Costs could be reduced further by using each piece of equipment to its full seasonal capacity.

Conclusions

It is impractical for farmers who have less than 97 acres of cropland to own full sets of machinery in Missouri Economic Area 8.

Costs could be reduced materially by working out procedures that would lead to greater annual use of each machine. These procedures include increasing the size of the farm unit, joint ownership of machinery by two or more farm operators, custom hire, and leasing equipment.

If full use of the machinery could be obtained, total investments and costs would be reduced greatly. The investment could be reduced by 32.8 percent by following the procedures outlined in this study. Fixed costs per unit of use can be reduced at least 18 percent by keeping machinery in use near its full capacity.

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