Bulletin 172 April 1931

STORRS

Agricultural Experiment Station

Labor Efficiency in Planting and Harvesting on Eastern Connecticut Dairy Farms

Department of Agricultural Economics

CONNECTICUT AGRICULTURAL COLLEGE

STORRS, CONNECTICUT

BOARD OF CONTROL AND STAFF

STATION STAFF

Administration	WM. L. SLATE, B.Sc., *Director* WALTER STEMMONS, B.S., *Editor* BETTY PORTER, *Secretary*
Agronomy	WM. L. SLATE, B.Sc., *Agronomist* B. A. BROWN, M.S., *Associate Agronomist* HENRY DORSEY, Ph.D., *Assistant Agronomist* J. S. OWENS, M.S., *Assistant Agronomist* R. I. MUNSELL, B.S., *Research Assistant*
Agr. Economics	I. G. DAVIS, B.A., B.S., *Economist* H. B. BOYD, B.S.A., *Assistant Economist* G. B. CLARKE, Ph.D., *Assistant Economist* CLARISSA LORD WILL, B.A., *Statistician*
Animal Diseases	LEO F. RETTGER, Ph.D., *Bacteriologist* W. N. PLASTRIDGE, Ph.D., *Assistant Bacteriologist* ERWIN JUNGHERR, Ph.D., D.V.S., *Pathologist* E. H. SPAULDING, A.B., *Research Assistant*
Chemistry	H. J. FISHER, B.A., *Chemist*
Dairy Industry	G. C. WHITE, M.A., *Dairy Husbandman* R. E. JOHNSON, M.S., *Assistant Dairy Husbandman* E. O. ANDERSON, M.S., *Asst. in Dairy Manufactures* R. P. REECE, B.S., *Asst. Dairy Husbandman*
Economic Zoology	G. H. LAMSON, JR., M.S., *Zoologist* A. F. SCHULZE, M.S., *Assistant Zoologist*
Genetics	WALTER LANDAUER, Ph.D., *Geneticist* L. C. DUNN, Sc.D., *Consulting Geneticist* D. G. STEELE, Ph.D., *Assistant Geneticist* LORNA THIGPEN DAVID, Ph.D., *Research Assistant*
Home Economics	ELIZABETH V. W. CLAPP, A.B., *Home Economist* WILMA B. BECKMAN, B.S., *Research Assistant* ANNE S. KINSEY, A.B., *Research Assistant*
Poultry Husbandry	WM. F. KIRKPATRICK, M.S., *Poultry Husbandman*
Rural Sociology	J. L. HYPES, Ph.D., *Sociologist* VICTOR A. RAPPORT, Ph.D., *Assistant Sociologist* EILEEN KENNEDY, B.S., *Research Assistant*

TABLE OF CONTENTS

Labor Efficiency in Planting and Harvesting on Eastern Connecticut Dairy Farms

Based on a thesis by Donald O. Hammerberg [1]

Description

Purpose

Many of the farmers' expenses are fixed in character. Taxes and interest on investment in land and buildings are subject to little control by the farmer. On the other hand such expenses as those for labor, fertilizer, seed and machinery are subject to control by the farmer from year to year and even from month to month. Labor is one of the most important of these variable expenditures and it is with labor expenditure that this bulletin is concerned. The general purpose of the study is to determine why varying amounts of labor were used by farmers to achieve the same results. Labor is wasted for many reasons: because enterprises are small, because operations are poorly organized, because the wrong machinery is used, because yields are too low, and for other reasons. The causes are such that in many cases this waste can be eliminated without additional investment. However, before standards of labor efficiency can be set up it is necessary to know the reasons for variation in labor input.

Specifically, the objectives of this study are three:

1. To determine the physical units of labor used in the production of three crops: hay, oats and corn. These data are a part of the basic material necessary for establishing efficiency standards and setting up new forms of adjustment to changing prices.

2. To determine what factors are responsible for the variations in the number of hours used by different farmers in the production of these crops. The increased mechanization of agriculture has made this

---

[1] This bulletin is a digest and summary of a thesis on the same subject offered in partial fulfillment of his requirements for the degree of Master of Science in 1930 by Donald O. Hammerberg. Digested, summarized, and edited by I. G. Davis, assisted by Cecil G. Tilton and Albert E. Waugh.

This bulletin is the second of a series dealing with the economics of Eastern Connecticut agriculture, the first of the series being Bulletin 139 entitled "Soil Type as a Factor in Farm Economy. The Town of Lebanon."

phase of the study particularly important. It is obvious that before the position of an agricultural area or region can be properly determined or evaluated in comparison with other areas or regions it is necessary to know how uniformly these areas have adapted themselves to the practices which result in the greatest net profit. Data are presented in this paper which suggest, at least in regard to the use of human labor, that the farmers of the Eastern Highland of Connecticut have not made the necessary adjustments. Attention in this study is concentrated on the labor expenditures in planting and harvesting operations. The periods of these operations are essentially peak load periods, hence economies effected at such times are relatively more important than comparable savings in operations which are distributed throughout the year.

3. To contrast the results obtained by different methods of statistical approach in the same problem. The third objective appeared after the analysis was well under way. Different methods of approach yielded varying results; hence it appeared desirable to show contrasts wherever possible, especially when certain methods revealed significant facts which had not been disclosed by the attempts previously made. This probably has more significance for the research worker than for the extension teacher, or the farmer, although an appreciation of the limitations of statistical methods is useful to all.

Description of the Area and Types of Farms

The area studied[1] consisted of twenty dairy farms selected by methods of random sampling from eight representative towns in the Eastern Highland of Connecticut. Only farms with five or more head of neat cattle were selected, hence these were predominantly dairy farms on which approximately seventy percent of all labor was spent on cows and feed crops. The balance was devoted to poultry, fruit, forest products, outside labor, and miscellaneous crops. About seventy-five percent of the labor devoted to the care of cows and feed crops was used in the care of cows alone, and twenty-five percent was used in the care of crops. These percentage figures are not necessarily indicative of their relative importance however. The demand for labor on crops is large within short periods of the year, particularly during the spring work, haying and silo-filling operations.

[1] For a detailed description of the area see Appendix, page 43.

Comparison with Other Regions

Another rather important reason for undertaking a study of labor inputs on crops rather than on livestock was that Connecticut farmers have been more conservative in their response to labor-saving changes in the technique of crop production than they have in their response to similar changes in the care of livestock. Some comparisons of the representative efficiency of agricultural labor in dairying in different parts of the United States are given below:

TABLE 1. *Man-Hours per Cow, Milk Production per Cow, and Pounds of Milk Produced per Hour Spent on the Cows for Different Areas in 1926*[1]

Area	Man-Hours per Cow		Milk Production per Cow	Lbs. Milk per Hour Spent on Cows
Northern Vermont	129.9		5,110	39.3
Southeastern Vermont	125.9		4,893	38.9
Maine-New Hampshire	150.6		4,879	32.4
Southern New England	140.9	148.4[2]	6,588	46.8
Southeastern New York	135.4		5,203	38.4
New Jersey-Penn.-Delaware	143.5		5,786	40.3
Ohio-Indiana-Mich.	131.0		5,468	41.7
Wisconsin	141.5	138[3]	6,221	44.0
Iowa-Minn.	117.9		6,004	50.9

It will be observed that the regions which had a large number of man-hours per cow generally had high milk production figures. This probably means that a considerable portion of the extra labor actually represents extra care of the cows and not ineffective use of labor.

On the other hand, a comparison of labor inputs on crops shows very marked differences whether the comparison is made between the man-hours per acre or per ton for the different regions.

[1] Taken from "The Position of Northern Vermont Among American Dairy Farming Regions." Vt. Agr. Expt. Sta. Bul. No. 307.

[2] Average of figures obtained from 115 survey records obtained in study of Soil Type of Dairy Farms. Conn. Agr. Expt. Station. 1929.

[3] From "Farm Costs and Practices," Research Bul. 83. Wis. Agr. Expt. Station.

TABLE 2. *Number of Man-Hours Used per Acre and per Ton in the Production of Hay, Oats, and Corn Silage in Minnesota, Wisconsin, New York, and the Eastern Highland of Connecticut* [5]

Crop	Man-Hours per Acre				Man-Hours per Ton			
	Wis.[1]	Minn.[2]	N. Y.[3]	Conn.[4]	Wis.[1]	Minn.[2]	N. Y.[3]	Conn.[4]
Hay	10.78	6.9	9	6.31	4.07	4.6	5.29	5.89
Oats								
Spring Labor	4.39	3.7		10.55				7.67
Fall Labor	8.06	7.0		7.53				5.70
Total	12.45	10.7	14	18.08				13.37
Corn Silage								
Spring Labor	9.73	12.9		23.58	2.26	2.01		2.56
Fall Labor	7.80	12.8		29.53	1.82	2.00		3.16
Total	17.53	25.7	36	53.11	4.08	4.01	4.39	5.72
Silo Filling Alone	6.18	11.1		19.97	1.44	1.73		2.14

It will be observed that on the spring work Eastern Connecticut farmers used nearly twice as much man labor as Wisconsin and Minnesota farmers. The figures for spring work on oats as compared to corn would seem to indicate that Connecticut farmers were relatively more efficient in doing the spring work on corn than on oats.

The Eastern Connecticut farmers used nearly fifty percent more man-hours per ton of hay than Minnesota and Wisconsin farmers. Comparisons of the *per acre* figures for hay do not show such marked differences. This is primarily because Wisconsin farmers had a very high yield of hay; hence the man-hours per acre were high, but man-hours per ton were low.

[1] Research Bull. 83. "Farm Costs and Practices," by McNall and Ellis. Wis. Agr. Expt. Sta. Page 50, Table XXXIV; Page 30, Table XX; Page 19, Table XIII. The average of the 1924 data was used throughout.

[2] Technical Bull. 44. "A Study of Dairy Farm Organization in Southeastern Minnesota," by George A. Pond. Minn. Agr. Expt. Sta. Table XLVII, Appendix; Table XLV, Appendix; Tables XXXVIII and XLI Appendix. The average of the 1924 data was used throughout.

[3] "Preliminary Statistical Report of the Results of Farm Cost Accounting on Selected Farms in Various Parts of New York. Crop Year 1929," by J. F. Harriott; Cornell Univ. Agr. Expt. Sta.

[4] Survey records of 115 farms in the Eastern Highland of Connecticut in 1929.

[5] Note: The figures for Wisconsin and Minnesota were obtained from cost account records, while the Connecticut figures were obtained from survey records taken from farmers chosen at random. This perhaps raises the question of the comparability of the data, because the cost account farmers are not representative of the average farmer. The data for the Connecticut farmers were obtained in 1929, however, and there have been decided changes in the labor inputs in Connecticut since 1924, so that it is probable that there have also been marked changes in Wisconsin and Minnesota since that time. The averages for the cost account farmers in 1924 is probably fairly representative of the average farmer in those areas in 1929.

On corn silage spring labor the Connecticut farmers used only about twenty-five percent more man-hours per ton than did the Minnesota farmers, and only about twelve percent more than the Wisconsin farmers. This is primarily due to the lower yields in Minnesota and Wisconsin. However, a comparison of *fall* labor input yields more striking differences. In the harvesting operations the Connecticut farmers used 3.35 man-hours per ton as compared with 1.82 for Wisconsin and 2.0 for Minnesota, nearly seventy-five percent more than the average for the two Western states. Anyone who has given thought to the subject might expect that physical conditions such as stoniness and small fields would have much more effect on spring operations which are directly concerned with the soil, such as plowing, disking, planting, and cultivating, than on harvesting operations. To determine the reasons for this seemingly inefficient use of labor in harvesting corn silage was one of the aims in the study.

Acreage of Crops Grown

Before beginning the more detailed analysis of individual operations, it will be well to present some of the general descriptive data. The distribution of crops by towns is shown in the following table:

TABLE 3. *Number of Acres of Hay, Oats, and Miscellaneous Crops on the Farms Studied in Eight Towns of the Eastern Highland of Connecticut in 1929*

Towns	Acres in				
	Total	Hay[1]	Oats[2]	Corn	Misc.[3]
Columbia	428.09	286.40	43.72	54.94	43.03
Coventry	426.70	285.53	31.03	57.41	52.73
Woodstock	915.54	672.45	36.95	75.73	130.41
Brooklyn	944.09	667.38	79.81	85.60	111.30
Canterbury	757.30	542.09	63.79	74.74	76.68
Griswold	767.42	547.92	72.40	65.95	81.15
Stoningtons (two towns)	1161.35	854.88	57.28	162.98	86.21
Grand Total	5400.49	3856.65	384.98	577.35	581.51

[1] Includes Timothy, Mixed Hay, Clover and Alfalfa.

[2] Includes some Rye cut for Hay.

[3] Miscellaneous—includes Potatoes, Sweet Corn, Apples, Small Fruits and Garden Truck. Most of these crops were for family use.

Of the total tilled land 71.41 percent was in hay, 7.13 percent in oats, 10.69 percent in corn, and 10.77 percent in miscellaneous crops. The average yield per acre was 1.07 tons for hay, 1.33 tons for oats, 2.08 tons for clover, 1.84 tons for alfalfa, and 9.34 tons for corn silage, showing that acreages used for different crops are not comparable from the standpoint of the contribution which they make to the nutrients available from the farm for cattle feeding. No figures were obtained for corn husked for grain because most of the husking was not yet done when this survey was taken, but very little corn is grown for grain.

Even when the differences in yield per acre for the common crops have been considered, the figures have not been reduced to a common denominator. To be strictly comparable, the yields should be reduced to a basis of nutrients per acre. The composition of mixed hay is so variable that the different grades cannot be classified. About all that can be said is that usually three tons of silage are equivalent to one ton of mixed hay, and hence an acre of silage corn with a yield of more than nine tons per acre is roughly equivalent to three acres of ordinary hay. This changes the aspect of the figures shown in Table 3. Even though the acreage of corn is trebled, in order to weigh it according to its nutrient content, hay is still more than twice as important as any other forage crop. With this expression of the relative importance of these crops before us, we can proceed to the analysis of the factors which affect the efficiency of the production of these crops.

Size of Fields

One of the important features of Eastern Connecticut farms is the relatively small-sized fields. On the 115 farms surveyed, there were 5,400 acres of tilled land, an average of 47 acres per farm. This area was split up by natural or artificial barriers into 1,353 fields, making the average size of the fields 3.99 acres. Only 35.46 percent of the fields were four acres or more in size. Only 80 fields, or 5.91 percent of all fields, were over 10 acres and more in size, although these relatively large fields included 24.10 percent of the tilled land in the area. The distribution of number of fields and acreage by size of fields is shown below.

TABLE 4. *Distribution of Number of Fields and Acreage Included, by Size of Fields in One Acre Intervals*

	Size of Field in Acres											
	0.0 to .99A	1.0 to 1.99A	2.0 to 2.99A	3.0 to 3.99A	4.0 to 4.99A	5.0 to 5.99A	6.0 to 6.99A	7.0 to 7.99A	8.0 to 8.99A	9.0 to 9.99A	10 Acres and Over	Total
No. of Fields	195	252	257	169	145	90	63	47	32	23	80	1353
% of Total	14.41	18.63	19.00	12.50	10.70	6.65	4.66	3.47	2.37	1.70	5.91	100.00
Acreage Included	119.5	379.2	629.2	587.1	649.5	491.9	402.5	350.9	270.0	219.0	1301.94	5400.49
% of Total	2.21	7.02	11.65	10.87	12.03	9.11	7.45	6.50	5.00	4.06	24.10	100.00

These fields are all bounded by more or less permanent natural or man-made barriers, such as roads, brooks, and stone walls,[1] particularly the latter.

Even the figures in Table 4 are an inadequate expression of the extent to which subdivision has taken place. There was a total of 2,338 *field* divisions in this area of 5,400 acres, which makes the average size of the field divisions or units only 2.31 acres. The table on Page 13 shows the distribution of these by size.

The relatively large concentration in the less-than-one-acre class is due to the fact that many of these extremely small field divisions are devoted to the production of garden truck and miscellaneous crops, which are usually grown on a small scale. It has been the writer's observation that even these activities are dispersed, and frequently separated from each other by considerable distance.

Attention should be called to the facts made apparent in Table 5: First, 59.5 percent of all field divisions, containing 21.57 percent of the tilled land in these farms, are less than two acres in size; second, 89.35 percent of all field divisions, containing 62.44 percent of the tilled land, are less than five acres in size. The tables presented later call attention to the extent to which this subdivision has occurred in each of the different crops. To summarize Tables 3, 4, and 5, we may say that the total acreage in hay, oats and corn was 4,818.98 acres. This brings the total number of field divisions used for the production of field crops up to 1,635, or 262 more than the total number of fields bounded by permanent barriers. It makes the average field division used for the production of field crops less than three acres. Nearly one-half the fields of hay and corn and more than one-half the fields of oats contained less than two acres. More than three-fourths of the miscellaneous fields, containing more than one-third of the total acreage, are less than one acre in size.

[1] The removal of stone walls involves a tremendous amount of labor. For the sake of illustration, let us assume that two square fields, each one acre in size, are separated by a stone wall. These walls are usually at least one and one-half feet wide and four feet above the ground, and usually one foot below the ground. The wall separating these two fields would be 209 feet long. This wall would contain 1567 cubic feet of rock, or 58 wagon loads if a cubic yard of rocks were hauled each time. It would probably take two men and a team nearly a week to haul this rock, particularly if it was necessary to haul it any great distance, to say nothing of the time that would be required to pry the bottom stones out of the ground. Occasionally farmers have been fortunate enough to dispose of their stone walls for road building or other construction purposes.

TABLE 5. *Field Divisions and Included Acreage Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
No. of Field Divisions	879	512	347	203	148	84	51	36	29	11	38	2338
% of Total Number	37.60	21.90	14.84	8.68	6.33	3.59	2.18	1.54	1.24	.47	1.63	100.00
No. Acres Included in Above Field Divisions	410.53	754.10	851.15	695.28	660.89	455.55	326.41	269.64	246.76	105.16	625.02	5400.49
% of Total Acres	7.6	13.79	15.76	12.87	12.24	8.44	6.04	4.99	4.57	1.95	11.57	100.00

The tables included in the Appendix show the number of fields of different acreages in hay, corn, oats, and miscellaneous crops and the percent of the number of fields in the different sized crops.

It would be possible to use most of the fields which are less than one acre in size for garden and miscellaneous crops usually occupying a small area. Instead of this, we find that 237 field divisions, or 19 percent of all of the field divisions in hay, are less than one acre; and 61 field divisions, or 33 percent of the field divisions in oats, are less than one acre.

This extreme sub-division cannot be explained as an adjustment to achieve a rotation because there are few evidences of definite rotation systems.

Effect of Size of Fields on Labor Expenditure

It is difficult to obtain quantitative data to show all the effects of these small field divisions on production operations. The table shown on Page 15 illustrates one of them, i.e., the decrease in the number of man-hours required for specific operations as the size of the field increases:

The following charts present these results graphically.

It was impossible to work out corresponding figures for disking and harrowing because the number of times the field was gone over was not specified. There is every reason to believe that the figures for these operations would have exhibited the same general tendency as those contained in Table 6.

The decrease in the number of man-hours used in plowing as the size of the field increases may, it is quite obvious, be accounted for on the ground that smaller fields are shorter, requiring more turning, that the time spent in going to and from the field is the same regardless of field size, and most important of all, that smaller fields have a tendency to break up the day's work. Often the farmer finishes a small field in the middle of the day and may wait until the following day before he begins work on a new field.

TABLE 6. *Relation between Size of Field and Number of Man-Hours Used in Plowing, Cultivating, Mowing, and Raking*

	Size of Field Division in Acres										
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over
Man-Hours per[1] Acre Plowing	9.82	7.90	7.02	6.46	6.02	5.67	5.38	5.10	—	4.70	—
Man-Hours per[1] Acre Cultivating	3.07	2.26	1.89	1.66	1.48	1.33	1.21	1.09	1.01	—	—
Man-Hours per[1] Acre Mowing	2.25	1.75	1.52	1.38	1.26	1.17	1.09	1.02	.97	.92	.88
Man-Hours per[1] Acre Raking	1.26	1.00	.88	.80	.74	.69	.65	.61	.59	.56	.54

[1] These are not simple averages, but are computed from regression equations. See Appendix, Page 46, for discussion of the statistical procedure and **its validity.**

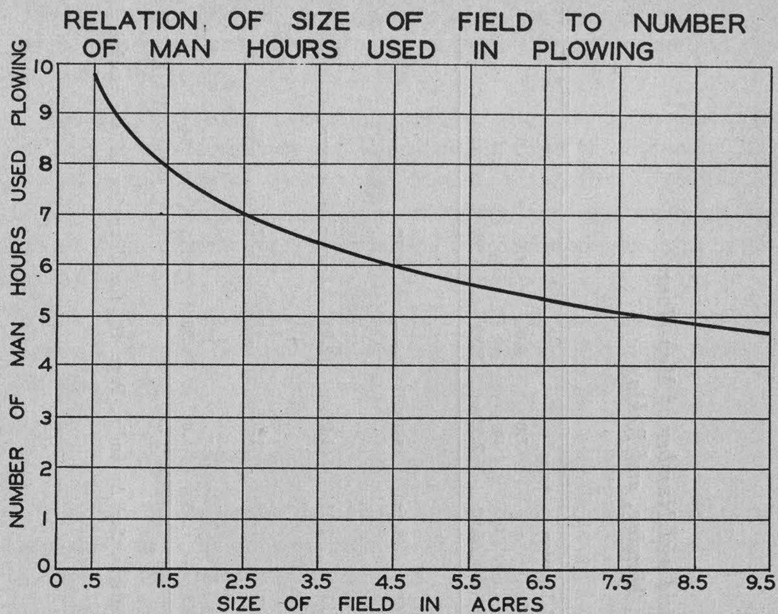

Figure 1

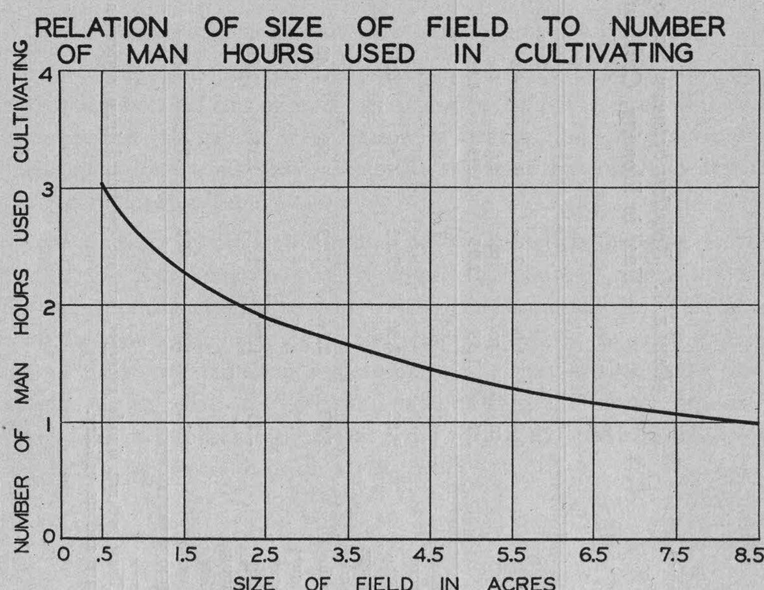

Figure 2

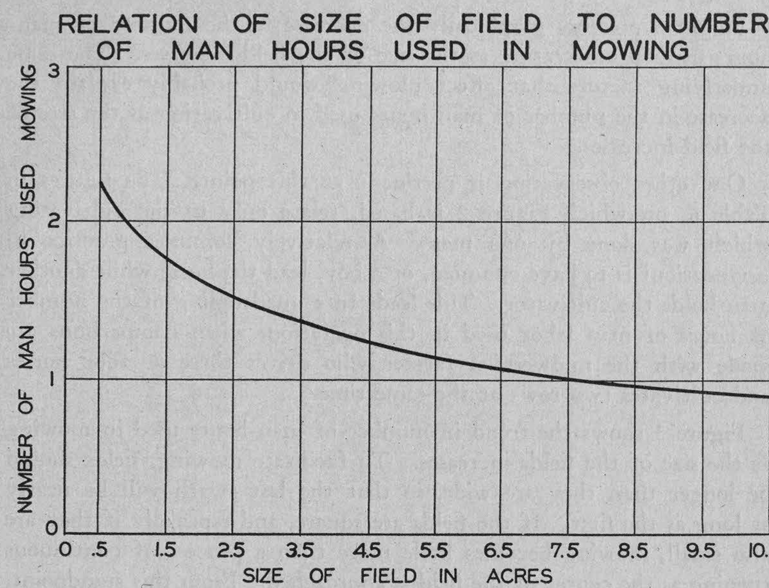

Figure 3

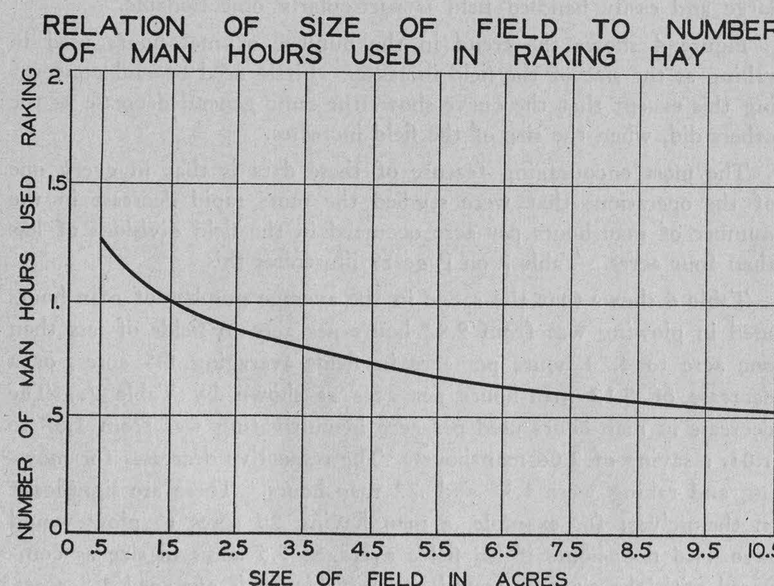

Figure 4

Figure 2 presents graphically the decrease in the number of man-hours used in cultivating as the size of the field increases. The same underlying factors that affect plowing would probably explain the decrease in the number of man-hours used in cultivating as the size of the field increases.

One other observation is pertinent at this point. The figures in Table 6, on which Figure 2 is based, relate only to the cultivating which was done by one man. A relatively common practice in Connecticut is to have one man, or a boy, lead the horse while another man holds the cultivator. This leads to a quadrupling of the number of hours of man labor used in this operation, when comparisons are made with the midwestern farmer who drives three or four horses and cultivates two rows at the same time.

Figure 3 shows the trend in number of man-hours used in mowing as the size of the fields increases. To facilitate mowing, fields should be longer than they are wide, so that the last swath will be nearly as long as the first. If the fields are square, and especially if they are also small, mowing becomes little more than a process of continuous turning as the center of the field is approached. From this standpoint, the practice of using a small area in what would otherwise be a fairly large and easily handled field is particularly objectionable.

Figure 4 shows the trend in the number of man-hours used in raking as the size of the field increases. Little need be said concerning this except that the curve shows the same general decrease as the others did, when the size of the field increases.

The most encouraging feature of these data is that in every one of the operations that were studied the most rapid decrease in the number of man-hours per acre occurred in the field divisions of less than four acres. Table 7 on Page 19 illustrates this.

Table 6 shows that the range in the average number of man-hours used in plowing was from 9.82 hours per acre in fields of less than one acre to 4.70 hours per acre in fields averaging 8.5 acres, or a decrease of 5.12 man-hours per acre as shown by Table 7. The decrease in man-hours used per acre in cultivating was from 3.07 to 1.01, a saving of 2.06 man-hours. The respective decreases for mowing and raking were 1.37 and .72 man-hours. These are significant in themselves; for example, a man having 20 acres to plow would save 44.6 man-hours if his fields averaged 5.5 acres in size as compared with the time he would spend if his fields averaged 1.5 acres. This would represent nearly a week's work in plowing alone.

TABLE 7. *The Decrease in the Number of Man-Hours Used per Acre in Plowing, Cultivating, Mowing, and Raking as the Size of the Fields Increases from 0.5 to 1.5, and from 1.5 to 2.5 Acres, etc.*

	Decrease in Number of Man-Hours Used per Acre as the Average Size of Field Increased from:										
	0.5 to 1.5	1.5 to 2.5	2.5 to 3.5	3.5 to 4.5	4.5 to 5.5	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	Total Decrease
Plowing	1.92	.88	.56	.44	.35	.29	.28		.40[1]		5.12
Cultivating	.81	.37	.23	.18	.15	.12	.12	.08			2.06
Mowing	.50	.23	.14	.12	.09	.08	.07	.05	.05	.04	1.37
Raking	.26	.12	.08	.06	.05	.04	.04	.02	.03	.02	.72

[1] This represents the decrease in time between fields averaging 8.5 acres in size and those averaging 6.5 acres, since the only fields between 7.0 and 8.0 acres in size were plowed with a tractor and were therefore not included.

Of more importance, however, is the consideration of where the greatest decreases occur. Table 7 shows that in each of the operations listed the decreases occur in going from the 0.5-acre group to the 1.5-acre group, and that the decrease in the number of man-hours becomes less as the size of the fields increases. This becomes tremendously significant when we consider that it is in precisely these groups that a great deal of subdivision occurs. Of the decrease of 5.12 man-hours noted in plowing, 3.36 hours or 65.6 percent of the total decrease occurred in fields less than four acres. Sixty-nine percent of the total decrease of 1.43 man-hours for cultivating occurred in fields of less than four acres, and 64 percent of the decrease for both mowing and raking occurred in this group. Table 5 shows that there were 873 more or less permanent fields which were less than four acres, but Table 19 of the Appendix reveals that there were 1,260 field divisions in the three crops, hay, oats, and corn, which were less than four acres, to say nothing of the number of field divisions in these groups which were used for other crops. This demonstrates both the possibility and the desirability of eliminating much of the subdivision of fields which has taken place on these farms.

The foregoing constitutes an explanation of part of the losses of labor time incurred on Eastern Connecticut farms and points the way to the remedy. There is no reason to believe, however, that these losses which can be quantitatively demonstrated are the most important part of the total loss of time incurred. The time used in making trips to and from a large number of fields and in conveying machinery and equipment to and from these fields has not been taken into account. Most important of all, extreme subdivision itself indicates lack of planning in many cases and gives rise to conditions in which careful planning of labor operations to utilize completely the labor time available is very difficult, if not impossible. While the contention cannot be supported by figures, it is the opinion of the research workers who have been in close touch with these farms for two years that the indirect causes of loss of time just mentioned are even more important than the direct causes of loss which have been measured in the foregoing tables.

As has already been pointed out, Table 7 shows that the important decreases in man-hours per acre for the specific operations listed in the table occur mainly in the groups of the smaller field sizes. The fact that there are no substantial decreases beyond this point does not preclude the possibility of such decreases; it simply means that with the methods now in general use, eight or ten acres are as efficient a unit as any larger, and that the number of natural divisions larger than this has not been sufficiently great to constitute an incentive for employing new methods adapted to larger acreages. In the meantime competition from areas capable of making use of machines and methods adapted to reducing labor costs on larger acreages will compel continuous adjustment in the direction of reducing the number of small fields and field divisions. The survival of our Eastern Connecticut farm types depends to a considerable degree on our ability to make adjustments of this kind.

Falconer in his Ohio Extension Bulletin No. 85, 1928-1929[1], shows that as the size of field increases from less than 10 acres to more than 20 acres, the number of acres plowed in 10 hours increases from 1.82 to 2.27. If the number of acres is from under 8 to over 18, the acres cultivated by a one-row cultivator in 10 hours increases from 5.1 acres to 6.7, and the acres cultivated by a two-row cultivator in 10 hours increases from 9.8 to 13.5. Falconer also finds that the county having the largest fields—16.8 acres per field—has 55 crop acres per man, while the county having the smallest fields has 30 crop acres per man. In general in the intermediate counties the crop acres per man vary with the size of the field. Falconer's work makes it plain that as field divisions increase beyond 10 acres, changes in labor efficiency accompany the increases in the size of fields.

The Effect of Other Physical Conditions on Labor Expenditures

The subject of the effect of physical condition on labor inputs is by no means exhausted when the influence of the size of fields has been discussed. Drainage, slope of the land, soil series, soil type, shape of the field, and stoniness all have some effect, although probably no one of them, with the exception of stoniness, has as much effect as has size of the field.

Many of the physical factors such as stoniness, slope of land, and streams have their effect in determining the size and shape of fields. The direct effect of some of these factors on labor efficiency we are not able to measure. The data on drainage are extremely poor and consequently the effect of drainage has been omitted. Neither were measurements made of the steepness of slope which are at all com-

[1] J. I. Falconer: "The Arrangement of Farm Fields," Ohio Extension Bulletin No. 85, 1928-1929.

parable from one farm to another. Soil type undoubtedly has an influence on labor expenditure per unit of output through its effect on yields. This problem is so involved that it is left for another study. It is undoubtedly true that soil type has more influence on labor expenditure than soil series. Stoniness, also, has a distinct effect on the labor expenditure and will be considered later.

Shape of Field

1. The factor of the shape of field has been mentioned before. Largely because of the difficulty of classification, the influence of this factor was studied only in relation to the operation of mowing. Three classes were defined, oblong, square, and irregular. A field was considered oblong if it had four sides and length at least one and one-half times its width. A field had to have four sides to be considered square, and one dimension could not exceed the other by more than 49 percent. All the other fields were thrown into the class of "irregular."

TABLE 8. *Showing the Effect of Size and Shape of Field Division on Number of Man-Hours Used in Mowing*[1]

Size of Field in Acres	Man-Hours Oblong Field	Square Field	Irregular Field
0.0— .99	1.58	2.18	2.10
1.0—1.99	1.43	1.50	1.67
2.0—2.99	1.33	1.35	1.22

This illustrates what has already been said, that if field divisions are to be small they should by all means be long and narrow rather than square or irregular. The objection to square or irregular field divisions grows less as the size of the division increases, until in the 2.0 to 2.99-acre group no significant difference is seen. The figures do not indicate any decided advantage one way or the other between "square" and "irregular" fields, probably because the latter group includes such a multitude of shapes. Irregularity is probably considerably more important in plowing, disking, harrowing, planting, and cultivating than it is in mowing.

[1] No attempt was made to determine the effect of a field larger than three acres because a square field of more than three acres would probably be cut into two oblong strips and hence the purpose of the classification would be defeated.

Stoniness

An attempt to measure the effect of stoniness was also made. This involves difficulties of classification, and no fine conclusion can be drawn from the data; but certain general conclusions are possible. When these farms were mapped each field was described as being stone-free, slightly stony, stony or very stony. This classification obviously rests upon a subjective evaluation by the man who did the mapping; but although no formal definitions were set up, it was felt that at least two classes, stony and stone-free, could be made with reasonable accuracy. There were 203 fields out of the total of 1,353 fields which were designated as stony. Fifty-three of these had occasional boulders, or relatively few stones, 138 were definitely stony, and 12 were exceedingly stony. There is probably a considerable overlapping in this classification, as some of the fields which were called slightly stony should have been called stony and vice versa, and there probably is nearly as much overlapping in the last two classes; but the total probably represents the degree of stoniness fairly well.

When the fields were classified on this basis the following results appeared:

TABLE 9. *Showing the Relation between Stoniness, Hand Mowing, and Man-Hours per Acre for Mowing*[1]

Method of Mowing	Stoniness	Acres	Man-Hours per Acre
1. Fields on Which Hand Mowing Was Done.			
a. Machine and Hand Mowing	Stony	55.8	2.86
b. Machine Mowing Only	Stony	55.8	1.80
2. Fields on Which no Hand Mowing Was Done.			
a. Machine Mowing	Stony	190.55	1.32
b. Machine Mowing	Stone-Free	208.02	1.30

Perhaps the most important conclusion to be drawn from the figures presented in this table is that there was no appreciable difference between the number of man-hours used in mowing fields that were classed as stone-free and those that were classed as stony, unless the field was stony enough to require some hand mowing. It will be

[1] These figures are based upon records of those farmers who had both stony and stone-free fields. The data for those farmers who had only stone-free fields are not included. Only two-horse mowing is included.

observed that the stony fields required 1.32 man-hours for mowing, while those that were stone-free required 1.30 man-hours.

There were only 13 fields or field divisions on which some hand mowing was done along with machine mowing. These, of course, required considerably more time. Most of the hand mowing was done around rocks and rock piles, so that it did not appreciably affect the acreage mowed with the machine. It will be observed that even if the labor spent in hand mowing is disregarded, the number of man-hours per acre for machine cutting is still higher than for either the stony fields that were mowed only with a machine or the fields that were free of stone. When hand mowing is included, the difference of course becomes appreciable. The encouraging feature of these data is that there were so few fields in which hand mowing was done. Of the 3,856.65 acres in hay, only 246.35 acres were stony, and of this area, 190.55 acres were apparently mowed in approximately the same length of time as the stone-free area on the same farms, which leaves only 55.8 acres that were stony enough to offer any serious obstacles to the operation of mowing.

An attempt was also made to determine the influence of stoniness in plowing. On the average it took 8.37 hours of man labor per acre to plow stony fields, and 7.32 hours per acre for stone-free fields. The same criteria of stoniness were used as above. These are probably quite inaccurate because they consider only visible stoniness. Although it is probable that a field which has a great deal of surface stone also has stone beneath the surface, it does not follow that a field which does not have surface stone does not have stone beneath the surface. If these fields had been accurately classified on a basis of stoniness, whether stones were above or below the surface, the difference between the number of man-hours used in plowing would undoubtedly have been considerably greater.

The foregoing represents an attempt to measure the direct effects of stoniness. There are some reasons for believing that the indirect effects of stoniness are more important. Some of the indirect effects are measured in the data showing the effect of the size of the fields on cultural and harvesting operations. Unquestionably, fields would have been much larger in this area if there had not been such an abundance of stone. Another indirect effect of stoniness is its influence on the use of machinery. This cannot be demonstrated except by contrast between areas, because many of the practices which are common in stone-free areas are not found at all in the Eastern Highland of Connecticut.

Location of Fields

The location of the fields is another factor responsible for considerable variation in the amount of time used to accomplish a specific task. This factor is particularly important in hauling hay. On the average, the center of each hay field was about 1,100 feet from the barn. When the effect of the variations in all the other factors was eliminated in so far as possible, it was found that an increase of 100 feet in distance from the barn was accompanied by an increase of .044 man-hours per ton in the time for hauling. The difference in time for hauling hay from a field adjoining the barn, whose center is about 100 feet from the barn, and from one whose center is a quarter of a mile away would be about 0.5 of a man-hour per ton. It is probable that the importance of the variation in distance is not so great when the distance is relatively short as when it is long. For example, it is entirely possible that just as many loads of hay are hauled in an afternoon when the field is 1,000 feet from the barn as when it is 500 feet. Increasing the distance by an additional 500 feet may make it impossible to haul more than four loads in an afternoon, whereas if the distance had been 500 feet less, five might have been hauled. It simply means that from the farmer's point of view minor variations in distance are not so important. Increasing the length of the working day by 15 minutes or even half an hour is not as serious as preventing him from hauling that extra load.

This is illustrated in the data on hauling silage corn. The following table shows the effect of distance on this operation:

Table 10. *Showing Relation between Distance and Man-Hours Used per Ton in Filling Silos*

	Distance in Feet			
	0—999	1,000—1,999	2,000—2,999	3,000—3,999
Man-Hours per Ton	2.06	2.05	2.04	2.69

The slight decreases in the first three groups are immaterial; and in this operation it appears as if the distance must be considerably over 0.6 of a mile, in fact, before it makes any appreciable difference. There is apparently very little that can be done to improve the situation in this respect except possibly to refrain from raising such bulky feed as silage on fields extremely far removed from the barn.

Effect of Yield Per Acre on Labor Expenditure

Of the factors which influence labor inputs, there is none that is more important in its direct effects than yield per acre. In contrast to many of the other factors, the influence of yield per acre is direct.

Hay

The size of field divisions is relatively unimportant in contrast to yield per acre as a determinant of labor cost per ton of hay. The average yield was 1.07 tons per acre. The average number of man-hours used in mowing a ton was 1.659. With each increase of one-half ton per acre in yield, the number of man-hours used in mowing a ton of hay was reduced by .552 hours on any particular field size.[1] Reducing the yield by half a ton increased by .552 hours the number of man-hours used in mowing. One of the most significant results of this correlation was that apparently yield per acre had little or no effect on the number of man-hours per acre for mowing.

The computed range in the number of man-hours used per acre in mowing with an average yield was 1.32, from this correlation, while reference to Table 6 shows a range of 1.37 man-hours per acre. This is extremely significant from the standpoint of saving labor. From these results it may be said with reasonable certainty that with a given size of field the number of man-hours used per ton in mowing is inversely proportional to the yield per acre. The farmers in the Eastern Highland now have an average yield of 1.07 tons of hay per acre. If they could double this yield, as many of them have done, twice the quantity of hay could be mowed with the same amount of man labor that is now being used.

No correlations were computed for raking, but there is every reason to believe that the same sort of relationships exist in this operation as in mowing. Raking, however, takes less time than mowing, hence the savings to be effected are proportionately less.

Yield per acre also had some effect on the number of man-hours used in hauling hay. Each increase of one-half ton in yield per acre was accompanied by a decrease of .175 man-hours per ton for hauling.[2] An increase of one ton per acre was accompanied by a decrease of .35

[1] Derived from a multiple correlation between the log of 10 times the size of the field, yield per acre, and number of man-hours per ton for mowing. See Appendix, page 47 for presentation of correlation results.

[2] Derived from a correlation between use of hay loader, number of horses used in hauling, number of men used in hauling, distance from the barn, size of field and man-hours per ton for hauling. See Appendix, page 48 for correlation results.

man-hours per ton and vice versa. There are also some evidences of relationships in the data that are difficult to demonstrate. For example, it is probable that the effect of yield per acre on the number of man-hours used per ton in hauling is more pronounced in small fields than it is in larger ones.

There is also some reason for believing that there is a joint relationship between yield and the number of men used in hauling. A high yield is probably more important when three men are used than when only two are used. The reasons for this will be taken up later in the discussion of the influence of the size and organization of the crew.

The relationships just discussed are somewhat difficult to demonstrate. None of the ordinary correlation methods has brought out what we believe to be the the true effects, and when there is a multiplicity of causal factors operating in data collected by the survey method, and when these causal factors have curvilinear and joint as well as straight line relationships, presentation of effects and relationships becomes complicated.

Silage

The same general effects were noted in studying the influence of yield per acre on man-hours per ton for cutting silage corn. The range in yield for silage corn was from 4.31 to 14.02 tons per acre, with an average yield of 9.47[1] tons per acre.

The following table shows the effect of increasing the yield on the number of man-hours used per acre and per ton in cutting corn:

TABLE 11. *Showing Relation between Yield per Acre and Number of Man-Hours Used per Acre and per Ton in Cutting Corn by Hand or by Machine*

Number of Fields	Hand Cutting			Machine Cutting		
	Av. Yield per Acre	Hrs. per Acre	Hrs. per Ton	Av. Yield per Acre	Hrs. per Acre	Hrs. per Ton
4.0— 6.99	5.72	8.27	1.45	——	——	——
7.0— 9.99	9.00	8.52	.95	7.86	2.56	.33
10.0—12.99	11.14	9.32	.84	11.06	2.50	.23
13.0—15.99	13.34	12.51	.94	——	——	——

Although there were relatively few cases of machine cutting, there was a considerable volume. The figures indicate an appreciable

[1] This differs slightly from the figure average given in Table 11. This was because yield data were collected from some farmers from whom no labor data were obtained.

decrease in the number of man-hours used per ton as the yield increases. The figures for machine cutting do not indicate any increase in man-hours per acre as the yield increases. There is a slight decrease, although this is so small that it may be simply an accidental variation. This indicates that within the ranges given an increase in yield is accompanied by an almost proportionate decrease in the man-hours used per ton in cutting. Using one man, three horses and a binder, it would take a farmer approximately one whole day's labor less to cut eighty tons of corn if he had a yield of eleven tons than it would if he had a yield of eight tons.

Most of the corn in this area was cut by hand, however, so that for the present, at least, the influence of yield on man-hours per ton for hand cutting is probably of more immediate concern. There is a strong contrast in this table between the number of man-hours per acre for machine and for hand cutting. It is to be noted that there is no material change in the time for cutting an acre with a binder as yield increases. The increase in man-hours per acre for hand cutting with increasing yield is very strongly marked, particularly in the upper groups. Material decreases in man-hours per ton are effected by increasing the yield from an average of 5.72 tons per acre to a yield of 9.00 tons per acre; but after this yield is attained, the heavier corn apparently becomes correspondingly difficult to cut, so that no appreciable savings are effected. The difference between the time for cutting a ton with an average yield of 5.72 tons per acre and with an average yield of 9.00 tons per acre is of decided importance. The saving of 0.5 man-hours per ton which this represents would mean that one man could cut eighty tons of silage in about five days less with the former yield than with the latter. The effect of yield per acre on hauling corn is difficult to determine because so many factors are involved. There is little or no question but that it is possible to handle a ton of corn with less labor when the yield is high than when the yield is low because the horses do not need to be started and stopped as often and the bundles are closer together, which involves less walking. At exactly what point the corn becomes so heavy that it is extremely difficult to handle is another question. Within the range of yields in the present data there was no indication that the heaviest yields required more man labor per ton. With an average yield of 9.67 tons per acre, and the effects of all the other factors eliminated (so far as possible), each increase of a ton in yield per acre caused a decrease of .06 man-hours per ton in the time for hauling corn for silage. Each decrease of a ton in yield caused an

increase of .06 man-hours per ton. The difference between a six and a ten-ton yield on a farm with seventy tons of silage—an average amount—would cause a difference of approximately two eight-hour days of man labor.

An analysis of harvesting operations must proceed along different lines than an analysis of spring labor. In the former it is obviously desirable to harvest a ton of hay or oats or corn with the smallest possible amount of labor. This is not quite true of spring operations. If the marginal inputs of labor have not yet been reached it is entirely possible that additional labor inputs, even though accompanied by decreasing physical output per unit of input, may be economically desirable. Analysis of these operations can not well ignore prevailing prices and alternative uses of the input elements nor the prices of the product. The effect of yield is correspondingly qualified. Certain spring operations such as plowing and planting are somewhat in the nature of fixed inputs. With reasonably favorable physical conditions little if any more time is required to do a good job in these operations than to do a poor job. To a certain extent, then, yield is independent of the amount of time spent in these operations, and the output per unit of input varies almost directly with the yield. This is not true of such operations as disking, harrowing, or cultivating, which are performed a varying number of times in addition to the qualitative differences found in plowing and planting. There is some evidence that the number of times a corn field is cultivated has a direct bearing on yield. Simple classification by the number of times a field was cultivated gave the following results:

TABLE 12. *Showing Relation between the Number of Times a Field was Cultivated and Yield per Acre in Tons*

	Number of Times Cultivated					
	1	2	3	4	5	6
Yield per Acre (tons)	8.26	8.83	10.25	9.76	11.06	13.20

This is, of course, rather flimsy evidence, especially in the last two classes where there is a paucity of cases; but unless there is an extremely high intercorrelation between the number of times that a field was cultivated and the amount of fertilizer or manure applied, which are probably the chief determinants of yield, the data appear conclusive enough to justify the statement that in certain operations labor inputs play an important role in determining yields, as well as the converse. It was impossible to draw any conclusion as to what the optimum number of cultivations would be, because of the lack of data at hand in the upper groups. Moreover, over 60 percent of the acres that were cultivated only once were hoed by hand, thereby adding on the average 1.87 man-hours per acre. 9.0 percent of the acreage that was cultivated three times was hoed by hand. None of the fields that were cultivated four times or more was hoed by hand.

It was impossible to draw any conclusion with regard to the effect of disking or harrowing on yield because the number of times a field was disked or harrowed was not given. For the same reason, it was not possible to show the effect of yield on labor inputs in these operations. To the extent that yields are not dependent upon these cultural operations, high yields naturally reduce the labor inputs per ton for any of them.

Although an analysis of the effect of yields on all labor inputs has not been possible, enough has been said and illustrated to justify the conclusion that the labor-saving aspect of high yield has not been sufficiently emphasized, and that the farmer who overlooks this possibility is neglecting one of the most favorable opportunities for increasing the effectiveness of his own or his hired labor.

Effect of the Use of Machinery

Thus far in our analysis we have been considering only such factors as involve little or no initial capital outlay. In contrast to this, the use of machinery calls for considerable cash outlay. The decision in regard to the use of machinery rests almost entirely on the basis of the saving of labor which it makes possible.

Tractors

Unfortunately there are not enough data available from this study to draw any conclusions with relation to tractors. Not only is the number of farmers who had tractors few, but the figures on tractor operations are not comparable with the figures on horse operations and the whole question is sufficiently complicated to justify separate study.

If only one man is used with a one-row planter, it is possible to plant corn with less man labor than when it is done by hand, but more than one-half of the farmers who use a one-row planter use two men to run it. This is an extremely inefficient use of labor, and it is difficult to believe that farmers can persist in it. Two-row cultivators

TABLE 13. *Showing Man and Horse-Hours per Acre for Planting Corn by Hand with a One-Row Planter and with a Two-Row Planter*

Method of Planting		Man-Hours	Horse-Hours
Hand Planting		3.79	——
	Average [1]	4.07	2.58
One-Row Planter	Two Men and One Horse	4.83	2.42
	One Man and One Horse	3.13	3.13

were not used, and between the three types of one-row cultivators, the one and two horse-walking cultivators and the two horse-riding cultivator, there is little choice. The waste involved in using two men with a one-row cultivator is extremely important, very expensive, and seems to indicate that farmers have not developed a consciousness of the importance of labor economy as they have of the importance of using feed and fertilizer economically.

Plows

As with cultivators, so with plows. There is little choice between the walking plow and the sulky plow from the standpoint of labor efficiency.

Corn Binders [2]

Of the 56 farms with silos included in the study, only 11 used corn binders.

Table 9 shows the great difference between the amount of labor used when the corn is cut with a machine and the amount used in hand cutting.

With a yield of slightly over eleven tons per acre, the farmers who cut their corn by hand used on the average 9.32 man-hours per acre, while those who cut the corn with a machine used only 2.50. The respective figures per ton were .84 and .23 man-hours, or a difference of .61 man-hours per ton. If a farmer had 70 tons of silage it would take one man approximately five days longer to cut the corn by hand than it could be done with a machine. There should also be an

[1] This average is not the average of the figures that appear in the table. There were more farmers who used two men and one horse than there were who used one man and one horse, and this average is the total time for all men who used the one-row planter divided by the total acreage planted in this way.

[2] For a refutation of argument against the use of binder for silage corn see N. H. Extension Bul. 80, Mar. 1928, "Silo Filling with Less Labor," by H. C. Woodworth and M. F. Abell.

appreciable saving in handling the corn afterward, since it is much easier to handle bound corn than loose corn. The usual practice in using a binder is to cut lanes in the field by hand before going in with the binder. This need not be done. All that is necessary is to cut the row that was tramped down from the opposite direction with the machine. Woodworth and Abell have computed that the value of the corn lost as a result of this method will in most instances be less than 10 percent of the labor cost of cutting the land by hand.

The labor saved in the use of a corn binder is not, of course, in itself a proof that all farmers should own binders. Whether or not to purchase a binder depends on the amount of labor that would be saved, the cost of the machine, its annual maintenance including depreciation, and the availability and cost of the labor for hand cutting. General observations by the field workers on this study indicate that there are no farms producing corn for silage at the present time that would find stoniness an obstacle to the use of a corn binder.

Hay Loaders

Seventeen out of these one hundred and fifteen farmers used hay loaders. The savings in man labor which can be attributed to the use of hay loaders, after the effects of all the other factors are eliminated in so far as possible, amount to approximately 0.65 man-hours per ton.[1] If a farmer had forty tons of hay together, it would require approximately three days more of man labor to gather this hay by hand than it would if a loader were used. The same considerations apply to the purchase of a loader that were mentioned with regard to a corn harvester. The availability of harvest labor and the alternative uses of a farmer's time are equally important. There is one other factor that needs to be considered in this connection, the fact that it is much more important to get as much work as possible accomplished during fair weather in the haying season than at any other time of the year. A hay loader may enable a man to harvest in a few days of favorable weather a large quantity of hay which would otherwise have been exposed to rain and would, therefore, have been of appreciably poorer quality. Most of the desirable varieties of hay need to be harvested in relatively short time, too, or they will become too mature and fibrous to make good feed. To many farmers the latter inducement is probably as important as the labor-saving feature. Under

[1] From a correlation showing effects of use of hay loaders, number of horses used in hauling, number of men used in hauling, distance from the barn, yield per acre, on man-hours per ton for hauling hay. See page 48 for presentation of correlation results.

most circumstances a farmer would probably need to have at least 35 tons of hay to justify the purchase of a hay loader from the standpoint of labor saving alone. In particular circumstances, the purchase could, of course, be justified with a much smaller tonnage.

It does appear that it would be very desirable for many of these farmers to own some of their machines cooperatively with a neighbor. This is very commonly done in some regions, and enables the farmers with a small acreage to use machines which they could not afford to own alone. This requires some give and take on the part of the joint owners.

The need for cooperative ownership and operation of the more expensive labor-saving tools is greater in Eastern Connecticut and in the upland regions of Southern New England than in most areas, because physical conditions make many farms too small to carry the overhead expenses of owning a full complement of labor-saving machinery and because it is more difficult to combine these farms into more economical units.

Wagons and Racks

The use of high-wheeled wagons with short, narrow racks for hauling hay is extremely common. In general, the racks used for hauling hay are too small and too high. The same criticism applies to the wagons and racks use for hauling silage. Even dump carts are used for this purpose. Woodworth and Abell found in their silo study that on some of the New Hampshire farms the men lifted the corn an average height of seven feet in loading dump carts. Such practices still further confirm the opinion that Eastern Connecticut farmers, while efficient in many respects, have not yet turned their attention to the possibilities of more economical use of their labor.

Over 30 percent of the farmers used tipcarts for hauling silage corn. A great many more used high wheel wagons. Still others used trucks on short hauls. All in all, at least 50 percent of the farmers used a machine which was very poorly adapted to the task at hand. The following table illustrates the difference in man-hours per ton for hauling corn silage with the type of equipment mentioned above:

TABLE 14. *Showing Man-Hours Used Per Ton for Filling Silos When Hauling is Done with a Wagon, Truck, or Tipcart*

	Wagon	Truck	Tipcart	Average
Man-Hours per Ton	1.90	2.39	2.53	2.32

These figures would have been greatly modified if an accurate description of the wagons had been made as well as of the racks that were used with them, because some of these wagons were probably no better than tipcarts. But the comparison is striking enough as it is. On the average, there are .63 man-hours wasted for every ton that is hauled to the silo on a tipcart. On a farm having 70 tons of silage, 45 hours of man labor would be wasted. The statement has been made and is repeated that tipcarts are one of the most inefficient implements with which Connecticut farms are burdened, and it should be repeated that tipcarts should *not* be used in hauling silage corn.

Trucks are apparently not much better, especially on short hauls. The reasons are obvious: one man is required to drive the truck, the loading surface is high, and one man is needed on the load. Further discussion of this question will be presented later in this paper.

Size and Organization of the Crew

No labor efficiency analysis would be complete without some consideration of the effects which differences in the size as well as in the organization of the crews have upon labor expenditure. To be really effective, such a study should be carried on painstakingly and methodically throughout the seasons of the year, so as to determine the effects of planning and organization, not only upon the major operations, such as have been described thus far, but also upon the daily tasks. Extreme variations in the efficiency and dispatch with which even the simplest of them are accomplished are probably just as usual as the variations in the operations that have been considered.

To the extent that this is true, it is to be expected that inefficiencies would be found in every operation. Many of the effective practices are the expression of superior managerial ability. Many of them are specific adaptations to particular conditions. As such they are not easily duplicated on other farms. But a great many of them are equally applicable to practically all farms, and it is thought that these important contributions can be made by study and detailed observations.

It is precisely because farm work is not continuous like work in a factory, for instance, that a study of a large number of different tasks needs to be made. In the first place, it is necessary to convince people that inefficiencies are not confined to any one operation; and in the second place, economies in any one operation do not appear as significant as do the results when a large number are analyzed and it is

found that variations are the rule. The decrease in the amount of labor that is used, which accompanies general efficiency in all tasks, is very important. In fact there are a considerable number of farm businesses where the effective use of labor is the explanation of success.

In Haying

In hauling hay, after the effects of the variations in all the other factors had been eliminated in so far as possible, the two-man crews used .94 man-hours per ton less than the three-man crews.[1] This is not due to any inherent inefficiency of the three-man crews, but simply to the fact that they were not properly organized and were used under conditions where three men could not be used to advantage. Three men should not be used on long hauls where the time spent in going to and from the field makes up the largest part of the time spent in hauling. It has already been mentioned that there may be something of a joint relationship between yield per acre and the number of men used in hauling hay. When the field is low and the windrows are far apart, if the farmer drives between two windrows, so as to have one man loading on each side of the wagon, both of the men must carry the hay some distance. If the hay is carried any distance beyond the step or two needed to get the momentum to throw the hay up on the wagon, the process becomes exceedingly laborious and time-consuming. Observations of this sort may appear trifling, but these practices persist and are common. One other rather important reason why three men are less effective than two is that while three men can undoubtedly haul in a ton of hay in less time than two, they cannot haul it in so much faster as to permit hauling an extra load in an afternoon.

The most effective three-man crew was just as effective as the best crew of two men. The fact that on the average they accomplished less work with a given number of man-hours of labor does mean, however, that the conditions in which this crew should be used must be very carefully considered. A comparison of the records of those farmers who used both sizes of crews reveals the surprising fact that in very few cases did they haul more hay in a given unit of time with the crew of three men than they did when they used only two.

There were a few cases where one man accomplished his haying alone. The average number of man-hours used per ton by these

[1] Taken from multiple correlation. See page 48. The figures included only crews of two or three men. The results referred to later concerning one and four-men crews were obtained by simple subsorting.

men was considerably below the average for either of the others. In four-man crews, the time of the fourth man is wasted.

In Silo-filling

The size of the crew also has some effect on the amount of man-labor used per ton in silo-filling. The following table illustrates this:

TABLE 15. *Relation between Size of the Crew and Number of Man-Hours Used per Ton in filling Silos*

	Number of Men Used in Hauling and Filling		
	1-4	5-8	9-12
Man-Hours per Ton	2.17	1.89	2.95

The crews of one to four men are the family sized crews where little or no outside help is hired. These crews are apparently not as effective as crews of five to eight men, probably because there are not enough men to keep the cutter supplied with corn continuously, and as a result some time is lost between loads in starting and stopping the machines. To many farmers this system recommends itself, even though it is not the most efficient, because it calls for no cash outlay.

The extremely large crews of nine men or more were decidedly inefficient, at least with the types of machines that were used to fill the silos in this region, the crew probably exceeding the capacity of the cutter and engine. The additional men, therefore, aside from making the job easier for the rest of the crew, represent so much waste labor.

Silo-filling on the Test Farms

The planning and organization of the work on these test farms is considerably more important than the size of crew. Eastern Highland farmers do too much carrying. They carry the hay and they carry the corn instead of exercising care and forethought so that the wagon can be placed exactly where the work is to be done. This is particularly true of silo-filling. In this operation they not only carry the corn in the field, but since they frequently haul the corn on tip-carts from which it is dumped somewhere in the vicinity of the cutter, it is also necessary to carry the corn to the silage cutter.

To determine whether material economy in the use of labor would accompany the use of different types of equipment and a detailed supervision of the crew, silo-filling tests were made by members of the Departments of Agricultural Economics and Farm Management of this college in cooperation with these farmers. On one of these farms, the only one where the work was actually supervised, a silo 12 feet by 29 feet in size was filled by a crew of eight men in an hour less than it was filled the previous year by a crew of seventeen men. On the second farm a silo 14 feet by 26 feet was filled by the same crew of eight men in one hour more time than it was filled the previous year with a crew of 19 men. The third farmer had a 14 by 28 foot silo which was filled to a height of 26 feet. This man did not remember how much labor was used the year previous, but he did know that his costs were about twenty-three dollars less than they were the previous year in spite of the fact that at least nine feet, or about 25 tons more silage, had been put into the silo.

The corn on all three farms was cut with a corn harvester so that the bundles were all bound. Special low-slung racks were constructed to effect a minimum of human effort in loading. They were built as follows: Two 4-inch by 8-inch timbers, 16 feet long, were bolted together in the form of a V at the front axle, while the other ends were fastened to the under side of the rear axle; on these timbers were nailed 2-inch by 6-inch planks, laid flat and crosswise to serve as a platform which when completed was about four and a half feet wide and ten feet long. The rack was adapted from the illustration in New Hampshire Extension Bulletin No. 80 to which reference has already been made.

The crews on these farms consisted of eight men distributed as follows: Three teamsters, each with a wagon as described above, one man who helped unload, one man tending the engine and cutter, one man in the silo, and two who helped load in the field. On one of the farms there were four teamsters with one man less in the field. The farm owners and their neighbors made up the entire personnel. The average haul from the field to the silo on these farms was about forty rods.

Table 16 illustrates the difference between the amount of man labor used on the average Connecticut farm and the amount used on these test farms.

TABLE 16. *Average Amount of Labor Used in Cutting Corn and Filling Silos in 50 Connecticut Farms Compared with Amount Used on the Three Test Farms*

	Hours per Acre		Hours per Ton	
	Average Farms	Test Farms	Average Farms	Test Farms
Man-Hours	30.86	10.18	3.28	1.22
Horse-Hours	14.27	10.35	1.42	1.24

The table shows a very decided contrast between the amount of labor used on the average farm and on the test farms. The latter used considerably less horse labor, in spite of the fact that the cutting was all done with horses; less than a third as much man labor was used per acre, and a little over a third as much was used per ton. These figures include the time for cutting. It should be noted that only one of the 50 farmers used less than two hours of man labor per ton. This man used 1.79 man-hours per ton. The distribution is shown in Figure 5.

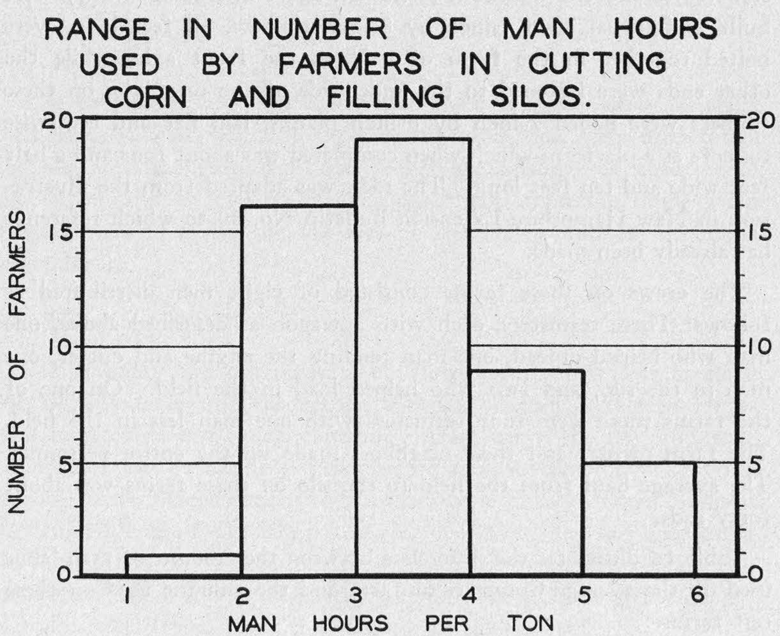

Figure 5

The following table presents the figures for filling silos:

TABLE 17. *Amount of Labor Used in Filling Silos on Connecticut Farms Compared with Amount Used on the Three Test Farms*

	Hours per Acre		Hours per Ton	
	Average Farms	Test Farms	Average Farms	Test Farms
Man-Hours	22.54	8.12	2.40	.97
Horse-Hours	12.26	6.23	1.30	.75

It should be noted that even after the labor used in cutting the corn is taken out, the differences are still marked. Each farmer used at least 65 percent more labor than the average of the test farms, and the majority of them used 100 percent more labor. The average of the 50 farms is just about two and one-half times as high as the average of the test farms. The average farms used nearly twice as much horse labor as was used on the test farms. These figures illustrate that it is not always possible to study an area and discover the best practices. A study of the practices in this area would have revealed an extreme amount of variation both in the methods that were followed and in the amount of time used, but it would not have revealed that there were other methods equally applicable and far more efficient than any actually in use.

It was believed at the time that at least one man might have been eliminated even from the test crew. If a little care is taken at the time of loading, the teamster should be able to unload fast enough to keep the silage cutter busy without the extra man to help him.

A number of other methods by which the labor efficiency in the test crews might have been increased are worth consideration. When three wagons are used and two men help load in the field, there are times when all three men must be loading on one wagon. This lowers their efficiency appreciably. Care should always be taken in planning the planting to see that the corn rows are long enough, if possible, so that two rows taken the whole length of the field will at least make a load. Only two rows should be loaded at once and there should never be more than two men loading on one wagon at the same time.

The efficiency of the test crews as compared with the usual methods of harvesting and ensiling corn is largely to be attributed to the following factors:

1. Greater ease in handling bound corn. Bound corn is both loaded and unloaded more easily than the unbound.

2. The greater efficiency of using long, low-slung racks on which to load the corn and haul it to the silo rather than high, small-bodied tipcart or truck. The inefficiency of the tipcart or truck from the standpoint of height of load, size of load, and the labor required in loading have already been sufficiently emphasized.

3. Attention to details in the organization of the work. The more important of these are:

a. The importance of loading but two rows at a time, to eliminate carrying. One man can load two rows in practically the same time that the second man can load a third row.

b. Planning the shape and size of the fields as far as possible so that the fields will be long enough to permit a full load to be secured from two rows.

c. Starting to load near the edge of the field and stopping the horses or truck frequently so that there will be no unnecessary carrying. Often the first ten or fifteen bundles are carried twenty or thirty feet. This means a minute or two of wasted time and hard effort for each man; and when three men are working in a crew of this kind, it may constitute a total loss of three and one-half hours for one man in a day. If two minutes were wasted in this way, the loss would amount to nearly a day's work for one man. The changes made possible by such an organization of labor are easily applicable to most farms with little expense. This statement should not be construed as a recommendation of a particular method. In fairness to the plan, however, it should be said that the use of these, in preference to the present methods, would result in very material reduction in the cost of corn silage on Eastern Connecticut farms.

GENERAL CONCLUSIONS

The efficient organization and application of labor at periods of peak load is important not only from the standpoint of the savings directly effected but also because of its effect on size of business and efficiency of farm operations as a whole.

Marked savings can be effected without increased capital investment by reducing the extent of field subdivision, planting in large fields rectangular in shape where possible, and increasing yield per acre. Even more significant economies can be effected through more efficient organization of some of the main planting and harvest operations, particularly corn planting and cultivating, haying, and silo-filling. The wastefulness of using tipcarts and trucks for hauling corn to the silo and the loss of labor efficiency resulting from using two men with a one-row corn cultivator deserve special mention. The capital outlays involved in these changes are relatively small and the results are to be obtained not through increasing human effort but through better organization of labor and equipment. Certain machines can be used under proper conditions with increased saving of labor. This study has not attempted to define exactly under what conditions such use is profitable. The possibility, however, of cooperation in the use of larger and more expensive machines is worthy of serious attention. The results of the study and the experience of the field men in obtaining data on these farms over a period of four years make it plain that Connecticut dairy farmers are not as sensitive to inefficiency and waste in the use of labor as they are to waste of feed and fertilizer and to unproductiveness of their livestock. The layout of the farms is not particularly well adapted to efficient use of labor. This condition could be quite largely overcome through systematic efforts to make farmers conscious of the importance of labor efficiency, particularly in the peak load periods, and to help in developing methods of increasing the efficiency in the use of labor. If Connecticut dairy farmers are capable of meeting the competition of areas where labor operations are so much more efficiently organized, then in this territory under proper conditions we should be optimistic about the possibilities of improving our competitive position through more effective organization of these operations. It does not appear unreasonable to conclude that a region which can meet competition despite a large number of such unnecessary handicaps should be able to hold its own if these were eliminated.

In addition to the improvements in labor efficiency which can be effected along the lines specifically indicated in this bulletin, there are possibilities of combining under a single management a number of farms into larger and more efficiently organized units and there are possibilities of farmers' cooperating in the use of large-scale machinery. Farm management experts, and especially those in our agricultural colleges interested in farm machinery problems, might well study the possibilities of devising new types of machines particularly adapted to efficient use of labor under the conditions which prevail in farms like those in Eastern Connecticut.

APPENDIX

Description of the Area and the Method of Obtaining the Data.

The data which have been presented in this paper were obtained as part of the study of the influence of soil type on farm organization which has been conducted by the Department of Agricultural Economics of the Connecticut Agricultural College. This study is now in its fourth year.

The towns in which these farms were located were selected, first, as being representative of the various physical conditions that are commonly found in the Eastern Highland, and second, as being so located as to have the advantage of nearness to market and social centers without being subject to the influences of proximity to any large cities. The towns were Woodstock, Brooklyn, Canterbury, Griswold, North Stonington, and Stonington, which make up a tier of towns extending between Massachusetts and the coast. This tier is unbroken except between Woodstock and Brooklyn. Two other towns, Coventry and Columbia, were included. These towns are west of the others but are nevertheless distinctly representative of the agriculture to be found in the Eastern Highland.

Twenty farmers were selected in each town except Woodstock, Stonington and North Stonington. Thirty farms were selected in the first and fifteen in each of the other two. Ten alternates were also chosen in each town, since there were always some farmers who could not cooperate for various reasons. The names of all the farmers in the town who had at least five head of neat cattle were obtained from the town clerk. A random selection was then made by drawing names from a hat.

These farms were mapped on a scale of one inch to three hundred feet. It was felt that a high degree of accuracy was attained, particularly in determining the size of the cultivated areas, since on these areas numerous checks could be used. Each map was built up by mapping one field or small area at a time. Each of these was automatically checked because it was necessary for the starting and stopping points to coincide. Farm buildings, fences, cultivated areas, brooks, swamps, and a great many other permanent features were indicated. The tillage, drainage, and slope of each field were described on maps. The man who made the map estimated how much 100 percent open pasture there was in each acre of the pasture land that was being mapped. A five percent open pasture meant, in his estimation, that twenty acres of the sort of land that he was mapping would be equivalent to one acre of 100 percent open pasture.

Two men from the Soils Department of the Connecticut Agricultural Experiment Station at New Haven then made detailed soil maps of these farms.

Detailed farm records have been obtained from nearly all of these farmers for two years, and from some of them for three years. These records include all expenses and receipts including inventory changes as well as an evaluation of family labor and farm privileges. Other items of economic interest were also determined.

Most of these records have been taken by the survey method although a considerable number of the farmers are keeping the farm account books with which the college provides them.

In order to obtain accuracy, data on the various crops and fields were collected as soon after the harvesting of these crops as possible. The input-output data on these crops were gathered at the same time. The data were gathered during the months of July and August, 1929, during and immediately after the haying season, and therefore at a time most favorable to accuracy. All of the figures were obtained from farmers' estimates except in the silo-filling tests on the three farms where the operations were actually timed.

Accuracy of the Data

Questions naturally arise as to the accuracy of the data collected by the survey method. It was found that the data collected early in the season were more accurate than those collected later. The following table brings out the comparison between the coefficients of variation in the time for mowing per acre in the different groups in the first 149 fields on which data were collected and the last 140.

TABLE 18. *Relation between the Coefficients of Variation and the Date of Record Taking and Size of Field*

Coefficients of Variation	Size of Field in Acres 0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 and over
Records Taken First	41.91	39.60	30.09	20.30	24.23	24.40
Records Taken Last	49.77	39.06	26.79	39.48	45.42	30.57

It should be noted that in four of the six groups here represented the coefficient of variation is larger on those records taken late in the season than it is on those taken early. In the 1.0 to 1.99-acre group

there is no essential difference, and in the 2.0 to 2.99-acre group the coefficient of variation is smaller for the last records. There are a number of other considerations involved in this besides errors of estimate. Chief among these are differences in the speed with which the horses walk, differences in shape of the field and in other physical obstructions, qualitative difference in mowers, etc. There is no evidence that over-estimates were either more or less common than under-estimates, and we conclude from the table merely that the farmer's memory was more accurate soon after harvest than it was later.

The reason for the decrease in the size of the coefficients as the size of the fields increase is obvious. An error of 15 minutes is not serious in a field of five acres, since it makes a difference of only three minutes per acre. In a field of 0.5 acres a similar error of estimate would make a difference of 30 minutes per acre. This should not be taken to mean that the difference in the time for mowing a five-acre field compared with the time for mowing a 0.5-acre field, as expressed in terms of averages, is not accurate. It simply means that there was more deviation around the mean in the latter case.

Where dispersion, as in this case, is largely the result of errors in estimate, it constitutes an important source of difficulty in interpreting correlation results. The first coefficients of correlations which were computed were between size of field and man-hours per acre for mowing. The computation on 120 cases, one-fifth of the total number picked at random from all of the records, yielded a coefficient of correlation of —.3877 ± .0524, low but significant. Examination of the original data suggested that the first records taken were more accurate. A second computation based only on the records taken by one enumerator in the first two towns and including 149 cases, yielded a coefficient of correlation of —.4534 ± .0439. Both of these were straight-line correlations.

It then became apparent that even if each farmer experienced the same difficulty in mowing small fields and if his time for mowing was affected to exactly the same extent by the influence of the size of the field, there would still be a considerable scatter around the regression line simply because one farmer mows faster than another on all fields. In an attempt to eliminate the variation caused by this factor which could not be measured, an average time for mowing an acre was computed for each farmer, based on his average mowing time on all fields more than three acres in size. Mowing time on each field was then expressed as a percentage obtained by dividing the actual mowing time per acre for each field by this average time. The correlation between the size of the field and these percentage figures was —.5076 ± .0410. The average on which this ratio is based is, of course, subject to criticism. Most farmers had at least 10 acres in fields more than three acres in size, and those that did not were dropped from this list. A farmer's average mowing time was, of course, influenced by the character of the fields which were included in computing the average. All fields which were extreme variations in mowing time from the average were excluded in computing the average, but not in the computation of the correlation. Stony fields had been eliminated from the start.

Statistical Methods Employed

It was apparent throughout that a straight line was an imperfect means of expressing the relationship between size of field and man hours per acre for mowing. Several curves were now fitted to the data. Of those tried, the line which best described the relationship was found to be described by the formula $\overline{X} = 2.97669 - 1.04003A$ in which $\overline{X}$ is the man-hours used per acre in mowing and A is the logarithm of ten times the size of the field in acres. The coefficient of correlation between the time for mowing and the log of ten times the size of the field in acres was —.5979 ± .0355.

An attempt was then made to eliminate the effects of the differences in the rapidity with which different farmers mow regardless of the size of the field. A combination of the logarithmic method and the ratio method explained earlier was therefore tried. The coefficient of correlation between the ratio of the number of man-hours used per acre, determined by dividing the actual time for a particular field by the average mowing time for all fields over three acres in size on each farm, and the logarithm of ten times the size of the field in acres was found to be —.6990 ± .0305. This coefficient of correlation indicates that, with this sample, almost 49% of the squared variation in mowing time was associated with variations in size of field. Taken in conjunction with the probable error, we find that the size of field in other similar groups of farms might be expected, in 50% of the cases, to account for from 45% to 53% of the squared variation in mowing time. In both of these last statements, the term "variation in mowing time" refers to the percentage which the time taken on a given field is of the average time per acre taken by the particular farmer on fields of three acres and over.

The size of the coefficient of correlation in all these cases is undoubtedly materially reduced by errors of estimate. There was much more scatter about the line of regression in the small fields. It is to be expected that there would actually be more variation in these groups, so it seems reasonable to conclude that a large part of this variation is due to errors of estimate.

The regression equation was found to be in substantial agreement with the averages obtained by simple sorting except that there was less range between the time per acre for the small fields and the large ones. The regression equation rather than the averages was used in Table 7.

For the operations of plowing, cultivating, and raking, the same principles were applied. The averages displayed the same characteristics as the averages for mowing, hence no coefficients of correlation were computed. Regression lines were fitted to the line of averages by the method of least squares, and these regression lines have been presented numerically in Table 7. The regression lines were used because it was possible through their use to smooth apparently meaningless fluctuations in the line of averages.

The second correlation to which reference has been made was the correlation between yield per acre, size of field, and man-hours per ton for mowing hay. The results are briefly presented below:

$R = .610$

$S_e = 1.0428$

$M_x = 1.6593$

$X = 3.98388 - .770900 \log 10\,A - 1.104315\,B$

Net Determination of A = .036

Net Determination of B = .336

Total Determination = .372

A refers to the size of the field, B refers to the yield per acre, and X is the number of man-hours per ton.

The same criticism can be made of this correlation that was made in regard to the others, that it does not take into consideration the effect of shape of field or other physical obstructions. Stony fields were not included in these data. Nor do they take account of the difference in the rapidity with which different farmers mow regardless of these factors. Errors of estimate are probably just as important in reducing the size of the coefficient of correlation in this analysis as they were in the others. Errors in estimating the yield as well as the time for mowing are possible, and probably do not give rise to any bias. A slight upward bias may have been introduced into these data because extremely small fields which also had low yields were not included in the original data. More variation in yield per acre occurred on small fields than on large fields, which again suggests errors of estimate.

The results of the computations listed above indicate that, with this sample, 37 percent of the squared variation in mowing time per ton was associated with variations in the size of the field and in yield per acre.

The standard error of estimation of X is 1.04283, which indicates that in 67 percent of similar fields the mowing time per ton would be approximately within an hour of the time estimated by the formula.

The next coefficient of correlation to which reference has been made was computed in an effort to determine the effect of the use of a hay loader, and the effect of the number of horses used in hauling, number of men used in hauling, distance of the field from the barn, size of the field, and yield per acre, on the number of man-hours used per ton in hauling hay. Subsorting had been tried, but, although there were more than 1,200 field divisions in hay, even this was not enough for purposes of detailed subsorting. Six variables were used in this correlation. The distance from the barn and the size of the field in acres had the greatest influence of any of the factors measured in the correlation on the labor cost of harvesting hay. The net determination in the case of distance from the barn was .094 and in the case of size of field, .075. The whole procedure is subject to a number of criticisms:

1. No data were collected on what is believed to be the most important factor—type of wagon and size of rack.

2. The factors apparently have little influence on labor efficiency in hauling hay.

The results of the computation are presented below:

$R = .534022$

$E_r = .027837$

$S_e = 1.27075$

$X = 3.01303 - .643746\,A - .827661\,B + .940560\,C + .044821\,D - .034651\,E - .350412\,F.$

Net Determination of A = .026249
" " " B = .005030
" " " C = .055413
" " " D = .094329
" " " E = .075300
" " " F = .028858

A refers to whether or not a hay loader was used; not using a hay loader was coded 0, and using a loader was coded 1; B refers to the number of horses used in hauling; C refers to the number of men used; D refers to the distance from the barn expressed in terms of 100 feet; E refers to the size of the field in acres; and F refers to the yield per acre in tons; and X is the number of man-hours used per ton in loading, hauling, and unloading hay.

These data indicate that, with this sample, 29 percent of the squared variation in time for hauling per ton was associated with variations in the factors indicated.

Taken in conjunction with the probable error, we find that in other similar groups of farms these factors might be expected to explain, in 30 percent of the cases, from 26 to 32 percent of the squared variation in the time for hauling hay.

The standard error of estimation indicates that in 67 percent of similar fields the time per ton for hauling hay would be within 1.27 hours of the time estimated by the formula.

The statement was made early in this paper that different methods of statistical approach yielded varying results. Simple sorting of these data on the basis of size of field showed that apparently this factor had considerable influence on the time for hauling hay, although no reason could be given for this. Reference to the net determination coefficients shows that only 0.5 of one percent of the squared variation in time for hauling was associated with variations in this factor. Similarly, even after all cases of one-horse hauling and all cases in which hay-loaders were used had been excluded, and on records in which the yield per acre varied less than one ton, subsorting yielded a difference of 0.7 hours between two and three man crews in the time for hauling, while the correlation which eliminated the effects of the variations in the other factors as well showed a difference of 0.94 hours per ton. On the other hand, subsorting within this same range in yields attributed a gain of 1.20 hours per ton to the use of a hayloader with the effects of differences in the crews eliminated, while the correlation results indicated that the saving which could be attributed to the use of a hayloader was only .64 hours per ton.

Distinct differences in method, such as the difference between using a hay-loader and not using a hay-loader, can usually be handled fairly well by subsorting, but when there are a large number of other factors it is necessary to be extremely careful. When such a large number of causal factors are operating as were evidenced in this material, the data can be subsorted on the basis of a few factors only, and the results become erratic because of the scarcity of numbers. Correlation analysis combined with good judgment becomes the only possibility.

TABLE 19. *Number of Hay, Oats, Corn, and Miscellaneous Field Divisions, and Number of Acres Producing These Crops Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
No. Field Divisions in Hay	237	296	242	134	97	65	43	32	24	9	37	1216
No. Acres in Hay	145.48	441.63	599.54	462.58	435.82	351.18	275.61	240.33	203.69	85.88	614.92	3856.65
No. Field Divisions in Oats and Rye	61	52	27	17	14	3	4		3	1	1	183
No. Acres in Oats and Rye	37.51	76.12	62.56	59.48	61.81	15.88	25.84		25.74	9.94	10.10	384.98
No. Field Divisions in Corn	52	62	45	35	25	7	4	4	1	1		236
No. Acres in Corn	32.71	91.41	110.11	121.61	110.20	39.01	24.96	29.31	8.69	9.34		577.35
No. Field Divisions in Misc.	529	102	33	17	12	9			1			703
No. Acres in Misc.	194.83	144.94	78.94	51.61	53.06	49.48			8.65			581.51
Total No. of Field Divisions	879	512	347	203	148	84	51	36	29	11	38	2338
Total No. Acres	410.53	754.10	851.15	695.28	660.89	445.55	326.41	269.64	246.76	105.16	625.02	5400.49

TABLE 20. *Percent of Total Number of Field Divisions and Number of Acres Used in Hay Production, Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
Percent of Total No. of Hay Fields	19.49	24.34	19.90	11.02	7.98	5.35	3.54	2.63	1.97	.74	3.04	100.00
Percent of Acreage in Hay	3.77	11.45	15.55	11.99	11.30	9.11	7.15	6.23	5.28	2.23	15.94	100.00

TABLE 21. *Percent of Total Number of Field Divisions and Number of Acres Used in Oat and Rye Production, Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
Percent of Total No. of Oat and Rye Fields	33.33	28.42	14.75	9.29	7.65	1.64	2.19		1.64	.55	.55	100.00
Percent of Acreage in Oats and Rye	9.74	19.77	16.25	15.25	16.06	4.12	6.71		6.69	2.58	2.62	100.00

TABLE 22. *Percent of Total Number of Field Divisions and Acres Devoted to Corn, Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
Percent of Total No. of Corn Fields	22.03	26.27	19.07	14.83	10.59	2.97	1.69	1.69	.42	.42		100.00
Percent of Acreage in Corn	5.67	15.83	19.07	21.06	19.09	6.76	4.32	5.08	1.51	1.62		100.00

TABLE 23. *Percent of Total Number of Field Divisions and Number of Acres Used in Production of Miscellaneous Crops, Classified by Size of Field Divisions*

	Size of Field Division											
	0.0 to .99	1.0 to 1.99	2.0 to 2.99	3.0 to 3.99	4.0 to 4.99	5.0 to 5.99	6.0 to 6.99	7.0 to 7.99	8.0 to 8.99	9.0 to 9.99	10.0 and Over	Totals
Percent of Total of Misc. Fields	75.25	14.51	4.96	2.42	1.71	1.28			.14			100.00
Percent of Acreage in Misc.	33.50	24.92	13.58	8.88	9.12	8.51			1.49			100.00