UNIVERSITY OF MINNESOTA
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TRACTOR COSTS AND RATES OF PERFORMANCE

A preliminary report of data secured in 1936 covering the cost of operation and the rate of performance of farm tractors in Minnesota and summaries for 1933, 1934 and 1935

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Source of Data

The operators of 21 tractors submitted records of the cost of operating their tractors and of the amount and kind of work done by them during the year 1936 to the Minnesota Agricultural Experiment Station. These records were obtained from 15 farms. On six of these farms, two tractors were used. Only 18 of the 21 records cover the use of a tractor for a full calendar year as some of the tractors were purchased during the year. The distribution of the tractors by makes and models was as follows: Case Model CC, 1; Case, Model L, 2; Farmall 20, 4; Farmall 30, 1; McCormick-Deering, Model 10-20, 2; McCormick-Deering, Model 15-30, 1; McCormick-Deering, Model F-12, 2; John Deere, Model A, 2; John Deere, Model D, 2; John Deere, Model GP, 3; and unspecified, 1. The years in which these tractors were purchased ranged from 1928 to 1936. Five were purchased prior to 1930 and 7 in 1935 and 1936. The average years of use per tractor prior to 1936 were two and one-half. The average estimate of the operators as to the total life of these tractors was ten and one-half years. Seven tractors were equipped with rubber tires. The average estimated life of these was six years. These records were supervised and tabulated jointly by the Divisions of Agricultural Engineering and Agricultural Economics.

Cost of Tractor Operation

The cost per hour of operating these tractors is shown in Tables 1 and 2. Only tractors for which records for the full calendar year were available are included in these tables. The separation into two-plow and three-plow tractors is more or less arbitrary. It is based in part on the rating of the tractor and in part on the number of plows used. Two-bottom plows were used with all but two of the tractors listed in Table 1 and three-bottom plows with all listed in Table 2. Fuel and lubricants were charged at the purchase price. Man labor spent in servicing and repairing was charged at 25 cents per hour. Annual depreciation was determined by dividing the purchase price of the tractor by the farmer's estimate of the number of years it would last. Interest is charged at the rate of six per cent on the average value of the tractor in 1936. Costs are shown for each individual tractor for 1936. Average costs are also shown for both size groups in 1936 and for the tractors for which records were kept in 1933, 1934 and 1935.

There is a wide variation among different tractors in each of the items of cost. To a considerable extent, this reflects differences among the operators in their ability to handle their tractors economically and to provide adequate work for them. To a lesser extent it reflects chance differences such as variations in fuel prices in different localities and the irregularity with which repairs and overhauling are necessary. Fuel is the most variable item of operating costs. The amount of fuel per hour varied from 1.0 to 2.0 gallons per hour for the two-plow tractors and from 1.9 to 2.9 gallons for the three-plow tractors. There was also a variation in the kind of fuel used and in the price of each of the three fuels. Gasoline was used exclusively as fuel for six tractors, distillate was used except in starting for six, kerosene for two, and various combinations of fuel for the others. The average price per gallon of these three fuels was gasoline 12.2 cents, kerosene 9.2 cents, and distillate 8.5 cents. The average fuel cost per hour for the three-plow tractors using gasoline was one-third higher than those using distillate or kerosene. The difference was almost altogether a price difference as there was little difference in number of gallons used per hour. Of the total fuel used 47 per cent was distillate, 43 per cent gasoline, and 10 per cent kerosene.

The fixed charges per hour varied relatively more among different tractors than did the operating costs. This variation is largely due to differences in the number of hours of work annually for which the tractors were used. In general, the larger the number of hours of work annually the lower the fixed charges per hour. There is also some variation in the operators' estimates of the length of life of

different tractors. Since this was used as a basis for the depreciation charge, these variations in the operators' judgment are reflected in the fixed charges.

Amount and Kind of Work Done Annually

The annual hours of use of the tractors included in Tables 1 and 2 are shown in Table 3. The three-plow tractors are used for belt work somewhat more than are the two-plow tractors. Silo filling, threshing, corn shredding, corn shelling, and feed grinding were the common belt operations. More power could be used advantageously for these operations than could be supplied by the smaller tractors. On the other hand, it was impossible to utilize the capacity of the large tractors to good advantage at many drawbar operations. Ninety-seven per cent of the tractor-drawbar work is done on the home farm but only 71 per cent of the belt work.

Some information concerning the number of days tractors are used and the hours of tractor use per day is presented in Table 4. There is a wide range among different tractors in both of these items. Most of the days a tractor is used, it is operated only a portion of the day. Only 27 per cent of the days of tractor work were of sufficient length to be considered full days of work. Apparently, the tractors were used much below their maximum capacity. One of the advantages of the tractor over horses is that it can be operated 24 hours a day if necessary. Only half of the tractors included in this study were operated as many as 12 hours a day at any time during the year and of the total work days for all of them less than 2 per cent were 12 hours or more in length. It appears that the potential 24-hour service of tractors is not generally needed or at least not utilized.

Rate of Tractor Performance

The rate at which various operations were performed with these tractors is shown in Tables 5, 6, 7 and 8. The rate of performing drawbar operations varied with the size of implement used, the kind and condition of the soil, the size and shape of field, the distance travelled to work, and the yield of crops. Undoubtedly, the rate for tillage operations varied somewhat with the amount of overlapping in case of such items as disking, harrowing, and field cultivating. In case of feed grinding, the output was expressed in bushels but the kind of grain was not specified. In these cases, the weight per bushel was estimated at 40 pounds. It is quite apparent that the proportion of the capacity of the tractor utilized for belt operations varies widely. These tables include all tractors for which records are available for any portion of the year. They do not include minor operations for which no output is recorded or which are performed by only one tractor or under conditions that vary widely from farm to farm. Average rates of performance in 1933, 1934 and 1935 are shown in comparison with the 1936 average rate.

Use of Data

These summaries should be useful to the individual tractor operator for purposes of comparison with his own figures. They should point out cost items in which economies might well be adopted. They should also indicate to some degree, at least, the effectiveness with which he is securing a satisfactory rate of performance. Furthermore, they may suggest the possibilities of using the tractor for operations for which it is not now used and the advantage of using implements large enough to utilize the capacity of the tractor to best advantage. In some cases, full utilization of the capacity of the tractor may be secured by using a combination of two implements at the same time. Two operations may be performed at the same time at very little additional expense since none of the items of tractor cost except fuel would be materially affected by the heavier load and the rate of travel would probably be about the same.

Table 1

Cost per Hour of Operating Two-Plow Tractors in 1936 with Averages for 1933, 1934 and 1935

Tractor number:	4191*	3122	1152	2112	1112	1012	2132	4122	1082	1062	2192	Average 1936	Average 1935	Average 1934	Average 1933
Operating Cost:															
Fuel	$.173	$.193	$.142	$.129	$.169	$.156	$.119	$.154	$.149	$.162	$.161	$.153	$.137	$.154	$.141
Lubricants	.033	.032	.038	.034	.038	.043	.032	.054	.031	.029	.029	.036	.031	.050	.037
Labor	.048	.032	.007	.014	.015	.011	.021	.030	.035	.016	.010	.019	.014	.018	.019
Cash repairs	.036	.108	-	.016	.014	.003	.023	.093	.100	-	-	.036	.026	.028	.025
Total	.290	.365	.187	.193	.236	.213	.195	.331	.315	.207	.200	.244	.208	.250	.222
Fixed Charges:															
Depreciation	.131	.301	.497	.342	.201	.141	.175	.121	.114	.130	.096	.212	.159	.214	.233
Interest at 6% on avg. value	.035	.028	.173	.143	.066	.068	.015	.007	.027	.036	.037	.060	.056	.066	.083
Total	.166	.329	.670	.485	.267	.209	.190	.128	.141	.166	.133	.272	.215	.280	.316
Total cost per hour	.456	.694	.857	.678	.503	.422	.385	.459	.456	.373	.333	.516	.423	.530	.538
Hours of work per year	229¼	184¼	231½	252	350¾	589¾	694½	755¾	879¼	951¾	1190¾	574	728	516	587
Labor & Materials per 100 Hours:															
Servicing, hrs.	8.0	8.0	2.7	5.8	3.6	4.2	4.8	5.8	4.3	4.4	4.0	4.8	4.5	5.5	5.1
Repairing, hrs.	11.3	4.9	-	-	2.4	-	3.7	6.2	9.7	2.2	-	2.9	1.1	1.1	3.1
Fuel: Gasoline, gal.	128.7	90.4	118.8	99.2	39.3	73.0	15.7	27.9	16.5	35.2	8.2	52.4	25.0	40.0	54.0
Kerosene, gal.	-	-	-	-	-	-	117.6	33.9	-	-	-	15.2	13.5	35.0	22.0
Distillate, gal.	-	102.6	-	-	165.4	79.8	-	99.3	166.9	139.9	172.5	92.6	121.6	95.0	92.0
Total	128.7	193.0	118.8	99.2	204.7	152.8	133.3	161.1	183.4	175.2	180.7	160.2	160.1	170.0	168.0
Cylinder oil, gal.	4.6	5.7	16.5	4.0	6.4	8.9	5.5	8.3	4.5	3.8	4.8	6.8	3.9	7.1	5.8
Transmission oil, gal.	1.3	-	-	-	.1	-	1.0	1.0	1.7	1.1	.4	.5**	-	-	-
Grease, lb.	-	-	-	.2	14.3	-	4.0	3.3	5.7	2.6	1.8	3.2**	3.2**	16.1**	12.9**

*One-plow tractor not included in averages.
**Average of farms reporting.

Table 2

Cost per Hour of Operating Three-Plow Tractors in 1936 with Averages for 1933, 1934 and 1935

Tractor Number:	3013	1033	1153	2013	2123	2183	2133	Averages 1936	1935	1934	1933
Operating Cost:											
Fuel	$.336	$.348	$.299	$.247	$.272	$.237	$.187	$.275	$.246	$.256	$.160
Lubricants	.023	.053	.069	.012	.045	.085	.032	.045	.041	.057	.036
Labor	.017	.070	.008	.004	.024	.051	.021	.028	.016	.022	.015
Cash repairs	.255	.067	-	.010	.043	.186	.039	.086	.039	.045	.033
Total	.631	.538	.376	.273	.384	.559	.279	.434	.342	.380	.244
Fixed Charges:											
Depreciation	.432	.307	.363	.240	.245	.221	.216	.289	.254	.308	.227
Interest at 6% on average value	.130	.166	.120	.072	.114	.043	.039	.098	.099	.110	.075
Total	.562	.473	.483	.312	.359	.264	.255	.387	.353	.418	.302
Total cost per hour	1.193	1.011	.859	.585	.743	.823	.534	.821	.695	.798	.546
Hours of work per year	231½	274¾	344½	439¼	441¾	560¾	606¼	414	564	406	664
Labor and Materials per 100 Hours:											
Servicing, hrs.	2.8	8.1	3.2	1.3	5.9	5.5	5.9	4.7	4.5	5.4	4.5
Repairing, hrs.	4.0	19.8	-	.6	3.7	15.0	2.3	6.5	1.8	3.2	1.5
Fuel: Gasoline, gal.	275.2	285.0	240.7	189.2	43.8	11.0	27.7	153.2	135.1	83.0	17.0
Kerosene, gal.	-	-	-	-	-	-	180.4	25.8	17.1	65.0	-
Distillate, gal.	-	-	11.6	-	250.5	255.0	-	73.9	95.7	123.0	201.0
Total	275.2	285.0	252.3	189.2	294.3	266.0	208.1	252.9	247.9	271.0	218.0
Cylinder oil, gal.	2.3	7.6	13.1	1.5	7.6	11.6	5.4	7.0	8.0	9.7	7.5
Transmission oil, gal.	.6	1.8	-	.3	-	.6	1.2	.6	-	-	-
Grease, lb.	3.2	-	-	1.7	-	5.3	4.0	2.0	6.3*	19.3*	20.1*

*Average of farms reporting.

Table 3

Amount of Drawbar and Belt Work per Tractor and Proportion of Home and Custom Work

Tractor number	Hours of Work			Hours Custom Work			Per cent Custom Work		
	Drawbar	Belt	Total	Drawbar	Belt	Total	Drawbar	Belt	Total
Two-Plow Tractors									
4191	220¼	9	229¼	49¾	0	49¾	23	-	22
3122	161½	22¾	184¼	6½	0	6½	4	-	4
1152	231½	0	231½	0	0	0	-	-	-
2112	201½	50½	252	3	0	3	1	-	1
1112	264¼	86½	350¾	0	0	0	-	-	-
1012	480½	109¼	589¾	41	2	43	9	2	7
2132	671	23½	694½	0	0	0	-	-	-
4122	716¼	39½	755¾	3½	5	8½	-	13	1
1082	687¾	191½	879¼	68	98	166	10	51	19
1062	750¼	201½	951¾	0	31¼	31¼	-	16	3
2192	979	211½	1190½	16	119½	135½	2	57	11
Avg. hours	488	86	574	-	-	-	-	-	-
Percentage	85	15	-	-	-	-	3	27	6
Three-Plow Tractors									
3013	30¾	200¾	231½	0	96	96	-	48	41
1033	208½	66¼	274¾	23¾	32¼	56	11	49	20
1153	167½	177	344½	0	60½	60½	-	34	18
2013	439¼	0	439¼	9¾	0	9¾	2	-	2
2123	327¼	114½	441¾	13¾	42	55¾	4	37	13
2183	377½	183¼	560¾	27¼	32	59¼	7	17	11
2133	569½	36¾	606¼	0	0	0	-	-	-
Avg. hours	303	111	414	-	-	-	-	-	-
Percentage	73	27	-	-	-	-	4	34	12
All Tractors									
Avg. hours	416	96	512	-	-	-	-	-	-
Percentage	81	19	-	-	-	-	3	30	8

Table 4

Number of Days Tractors Are Operated and Hours of Tractor Work Per Day

Tractor number	Distribution by Days According to Hours of Work per Day						Total days operated	Average hours per day
	Under 2 hours	2 - 3¾ hours	4 - 5¾ hours	6 - 7¾ hours	8 - 9¾ hours	10 and over		
4191	20	21	9	9	6	-	65	3.5
1033	11	26	19	11	4	-	71	3.9
2123	23	29	28	22	5	2	109	4.1
3122	6	9	15	9	3	-	42	4.4
1012	38	27	18	32	13	5	133	4.8
1082	31	45	35	40	22	12	185	4.9
2112	6	13	11	12	5	4	51	4.9
2132	28	31	19	26	30	4	138	5.0
1112	9	14	12	13	12	6	66	5.4
3013	1	17	4	7	6	6	41	5.6
2133	19	19	11	14	27	13	103	5.9
1062	12	34	31	29	41	13	160	5.9
2183	8	20	17	14	18	15	92	6.1
1153	-	9	11	10	23	1	54	6.4
2013	3	7	14	30	13	2	69	6.4
4122	11	16	18	32	27	14	118	6.4
1152	-	3	10	6	16	-	35	6.6
2192	4	13	20	27	34	53	151	7.9
Average	13	20	17	19	17	8	94	5.4
Percentage	14	21	18	20	18	9	100	-

Table 5

Size of Implement and Acres Covered per Hour for Drawbar Operations with Two-Plow Tractors in 1936 with Averages for 1933, 1934 and 1935

Operation:	Plowing		Disking		Harrowing Spiketooth		Harrowing Springtooth		Field Cultivator		Seeding Grain	
Tractor No.	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres
4191	1-18"	.54*	8'single	3.23	20'	7.24	8'	3.31	7'	2.50	-	-
3122	2-14"	.98	-	-	10'	3.33*	8'	2.75	-	-	-	-
1152	-	-	-	-	20'	5.26	-	-	9½'	2.48	-	-
2112	2-14"	.68	7'tandem	1.69	-	-	-	-	-	-	-	-
1112	3-14"	1.28*	-	-	20'	10.40	8'	3.04	-	-	-	-
1012	2-14"	.66	8'tandem	2.61	26'	5.71	7'	1.59	-	-	-	-
2132	2-14"	.71	-	-	22'	9.33	-	-	9'	2.82	14'	3.59
4122	2-14"	.59	8'single	3.06	20'	7.14	-	-	7½'	1.87	-	-
1082	2-14"	.68	15'single	3.44	20'	5.75	-	-	-	-	10'	3.36
1062	2-14"	.85	14'single	5.50	20'	10.88	8'	4.07	-	-	-	-
2192	2-14"	.72	11'single	3.99	23'	7.00	7'	1.57	-	-	10'	3.79
3192	2-14"	.70	11'single	2.56	23'	6.36	7'	1.66	-	-	10'	3.11
2112	3-14"	1.28*	15'single	4.67	20'	13.76	8'	4.42	-	-	11'	4.05
							14'	6.17				
2182	3-16"	1.04*	9'tandem	3.60	20'	7.79	11½'	2.77	-	-	11'	3.22
Average 1936		.73		3.44		8.05		3.14		2.42		3.52
Average 1935		.83		3.21		7.87		3.44		2.99		2.84
Average 1934		.83		3.21		7.45		2.97		2.58		3.33
Average 1933		.85		3.30		8.02		-		2.60		3.32

*Not included in average.

(Table 5 continued)

Operation:	Cutting Grain		Planting Corn		Cultivating Corn		Cutting Corn		Picking Corn		Mowing Hay	
Tractor No.	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres
4191	8'	2.34	-	-	2-row	2.13	-	-	-	-	-	-
3122	-	-	-	-	-	-	1-row	.57	-	-	-	-
1152	8'	2.04	-	-	2-row	2.00	1-row	1.73	-	-	-	-
2112	8'	1.70	-	-	-	-	-	-	-	-	-	-
1112	8'	2.00	-	-	-	-	-	-	1-row	1.00	-	-
1012	-	-	2-row	1.65	3-row	2.40	1-row	.87	-	-	7'	2.03
2132	-	-	4-row	2.37	2-row	1.78	-	-	1-row	.73	7'	2.97
4122	7'	1.69	-	-	2-row	1.91	-	-	-	-	-	-
1082	8'	1.64	3-row	2.72	3-row	3.22	1-row	.85	1-row	.78	-	-
1062	10'	2.05	-	-	2-row	2.49	1-row	1.00	2-row	1.25	-	-
2192	10'	2.75	-	-	2-row	2.27	1-row	1.00	2-row	1.73	-	-
3192	-	-	-	-	-	-	1-row	.92	-	-	-	-
2112	8'	2.00	-	-	2-row	2.88	1-row	.97	1-row	1.00	-	-
2182	10'	2.35	-	-	2-row	2.39	-	-	1-row	1.00	-	-
Average 1936		2.06		2.25		2.35		.99		1.07		2.50
Average 1935		1.92		2.60		2.60		1.12		.92		2.33
Average 1934		1.97		2.41		2.19		1.33		1.03		2.58
Average 1933		1.45		2.73		2.29		.82		.80		-

Table 6

Size of Implement and Acres Covered per Hour for Drawbar Operations of Three-Plow Tractors in 1936 with Averages for 1933, 1934 and 1935

Operation:	Plowing		Disking		Harrowing Spiketooth		Harrowing Springtooth		Field Cultivating		Seeding Grain		Cutting Grain		Cultivating Corn		Picking Corn	
Tractor No.	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres	Size	Acres
1033	3-14"	1.41	10'*	4.00	-	-	11'	4.55	-	-	-	-	-	-	-	-	-	-
1153	3-16"	1.32	8'*	2.65	-	-	-	-	10'	3.57	-	-	-	-	-	-	-	-
2013	3-14"	1.17	-	-	26'	10.20	12'	4.63	-	-	12'	3.22	8'	2.28	2-row	2.02	-	-
2123	3-14"	1.13	15'**	7.34	-	-	-	-	8½'	2.77	-	-	10'	2.55	-	-	2-row	1.76
2183	3-16"	1.32	17'**	5.01	20'	6.00	11½'	3.51	-	-	-	-	10'	2.50	-	-	-	-
2133	3-16"	1.31	10'*	3.33	-	-	-	-	-	-	-	-	-	-	2-row	1.87	-	-
Average 1936		1.28		4.47		8.10		4.23		3.17		3.22		2.44		1.95		1.76
Average 1935		1.10		3.46		6.98		3.16		3.04		3.64		2.19		1.92		1.44
Average 1934		1.22		3.33		8.62		3.71		3.25		4.00		2.12		1.69		1.14
Average 1933		1.36		3.16		-		-		3.11		3.52		1.70		2.17		.99

*Indicates tandem.
**Indicates single.

Table 7

Size of Implement and Rate of Performance per Hour of Belt Operations of Two-Plow Tractors

Operation:	Grinding Feed		Shelling Corn		Filling Silo	Threshing	
Tractor No.	Mill	Pounds per hour	Type	Bushels per hour	Tons per hour	Size	Bushels per hour
4191	-	-	-	-	9.6	21"-33"	52.0
3122	-	-	-	-	6.2	-	-
2112	8" burr	889	Cyl.	37.9	5.7	-	-
1112	10½"burr	2121	Cyl.	95.0	-	22"-38"	82.8
1012	10" burr	1281	-	-	-	-	-
2132	Hammer	1825	Cyl.	90.0	-	-	-
4122	8" burr	1735	-	-	6.3	-	-
1082	10" burr	2270	-	-	-	26"-46"	60.5
1062	10" burr	1978	Cyl.	97.3	7.7	22"-38"	69.1
2192	10" burr	1992	-	-	4.0	28"-50"	103.3
3192	10" burr	1853	-	-	-	28"-50"	14.3*
2112	10½"burr	2630	Cyl.	68.9	-	-	-
2182	Hammer	3267	-	-	5.6	28"-50"	79.5
Average 1936		1986		77.8	6.4		74.5
Average 1935		1786		68.8	8.1		82.5
Average 1934		1544		50.4	8.1		76.6
Average 1933		2254		93.0	8.7		128.0

*Not included in average.

Table 8

Size of Implement and Rate of Performance per Hour of Belt Operations of Three-Plow Tractors

Operation:	Grinding Feed		Shelling Corn		Filling Silo	Threshing		Shredding Corn	
Tractor No.	Mill	Pounds per hour	Type	Bushels per hour	Tons per hour	Size	Bushels per hour	Type	Bushels per hour
3013	10" burr	2171	-	-	5.9	32"-54"	122.2	4-roll	18.4
1033	8" burr	1280	-	-	11.0	-	-	-	-
1153	Hammer	2623	-	-	18.1	28"-46"	173.3	4-roll	53.9
2123	8" burr	4094	Cyl.	90.5	5.6	28"-46"	109.8	-	-
2183	Hammer	3677	-	-	7.2	28"-50"	121.5	-	-
2133	Hammer	1636	Cyl.	95.3	-	-	-	-	-
Average 1936		2580		92.9	9.6		131.7		36.2
Average 1935		2146		83.8	10.2		102.3		27.8
Average 1934		1666		104.9	10.2		73.3		-
Average 1933		1889		160.0	12.4		138.0		-