Bulletin 262 February 1930

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

# SOURCES OF POWER ON MINNESOTA FARMS

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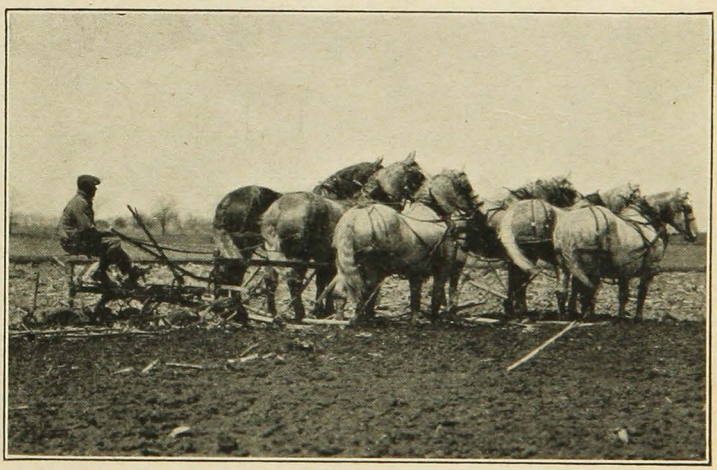

UNIVERSITY FARM, ST. PAUL

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## CONCLUSIONS

The period beginning about 1915 and continuing up to the present, has been accompanied by a revolution in the application of power to farm operations comparable to that of the middle nineteenth century.

This new epoch in the history of farm power is characterized by specialization in kinds of power for particular purposes. The farmer used automobiles for rapid personal and business transportation, trucks for heavy road travel, tractors for heavy field and belt work, horses for light field work, and stationary gas engines and electricity for light belt work.

Of the total power used by the farmer and his family, on 538 Minnesota farms, about 30 per cent was furnished each by the automobile and by horses; nearly 25 per cent by tractors; about 7 per cent by trucks; 5 per cent by stationary gas engines; and less than 3 per cent by electric motors and steam engines.

These changes in farm power indicate that the family farm of the future will be larger and will require more capital. The farmer will be more dependent on market prices as the farm will be a less self-sufficing unit. He will be more of a specialist than at present. These changes will require an abler and better trained farmer.

According to present intentions, 99 per cent of the farmers will be using horses in 1934. Upon the basis of their estimates in 1929, they will, in 1934, require about 95 per cent of the present number of horses.

Federal census reports for 1920 and 1925, data collected by State Tax Commission in Minnesota from assessors' reports and data from 502 farms reporting in this study in 1929, indicate that both in the United States and in Minnesota a further decided reduction in horse and mule numbers is inevitable. This will result in a decided rise in the price of horses and an increased use of tractors and trucks.

Horses reach maximum weight at 5 years and their maximum value at 4 or 5 years. On a per pound basis, there is little change in value between 3 and 8 years. After 8 years of age there is a consistent drop in value with increasing age. Upon the basis of the spring market, the average decline in value is approximately half a cent per pound per year from 8 to 20 years.

The average weight of horses appears to be increasing. Horses 5 years of age average 1,453 pounds compared to 1,287 pounds for those 20 years of age. A part of the difference of 166 pounds is due to the fact that old horses are thinner than young ones, and a part to the fact that the automobile stopped the raising of light horses for road travel.

The value per head of horses consistently increases with additional weight, but the increase in value per pound is not great after 1,200 pounds is reached.

Mares, from 3 to 10 years of age, are worth five to seven tenths of a cent per pound more than geldings. There is no significant difference in weight between mares and geldings.

The horses, driven per team, are increasing on farms not using tractors for drawbar work, especially on the larger farms. There has been no significant change in the number of horses used per team on farms using tractors. Five horses per team are most frequently used with gang plows; 3 horses, with sulky plows; and 2 horses, with walking plows. Gang plows are the main type of horse-drawn plows for farms having 50 crop acres or more.

Four horses per team are most frequently used with disks, spike-tooth drags, and spring-tooth harrows, on farms having 50 crop acres or more.

A wide variation in the number of horses used per team on farms of the same size indicates that there is a decided opportunity to utilize man labor to better advantage by the use of more horses per team as well as by the use of tractors.

Four horses per team are most frequently used for drilling and cutting small grain and flax on farms that have 50 or more acres of these crops.

Fifty-seven per cent of the farmers use a two-row cultivator. Over three fourths of the farmers, with 40 or more acres of corn, use a two-row cultivator.

In the United States in 1921, 1922, and 1923, about 5 one-row, riding cultivators were sold for each two-row cultivator, but in 1926 and 1927, only 2 one-row riding cultivators were sold for each two-row cultivator.

Either 3 or 4 horses are used with the two-row cultivator. A majority of farmers having over 60 acres of corn use 4 horses, and a majority of those with less than 60 acres, use 3 horses.

Three horses per team are most frequently used with corn binders.

Two horses per team are used for hauling manure on 65 per cent of the farms having 49 crop acres and less; on farms of 100 crop acres and over, 55 per cent use four horses per team.

Four horses per team are most frequently used for digging potatoes.

From 1918 to 1929 the number of horses and mules in the United States declined from 26,500,000 to 19,400,000. This decrease is 27 per cent of the number in 1918. There has been a much more drastic decline in the number of city horses. In addition to the decline in

numbers, farm horses are fed less per head than formerly. On farms in New York State, the decrease in grain fed amounted to 21 per cent, and in Minnesota, 42 per cent.

It seems probable that from 1918 to 1929, the 27 per cent reduction in number of horses and reduced rations for those that remain, have released 28,000,000 acres of crop land for other purposes. This is nearly 8 per cent of 365,000,000 acres estimated to be in crops by the United States Department of Agriculture at the close of the war period.

Evidently, the decreasing amount of feed required for horses and mules has been a larger factor in the agricultural depression than has been generally realized.

Before 1915 tractors were an insignificant source of farm power.

Tractors on farms in the United States in 1925 were 206 per cent of the number in 1920. The increase was 361 per cent in the Middle Atlantic states, and 163 per cent in the West North Central states.

A larger proportion of the farm work is done with tractors in the Middle Atlantic states than in the West North Central states. In 1925 the horses per tractor in the Middle Atlantic group were 19, and in the West North Central states, 39. The greater relative prosperity of eastern farmers, since 1920, the greater decrease in the cost of horse labor in the Central West, and the fact that in the post war years farm labor has been higher in price in the East than in the Central West, while previously the reverse was true, have all contributed to the relatively more rapid increase of tractors in the East.

The tractors used in Minnesota are nearly all of the small or medium size type, pulling two, three, or four bottoms. Altho 19 makes of tractors were used, two firms made 71 per cent of them.

The average days of tractor use per farm were 49.6. This is more than has generally been reported for other sections. Of this, 29.4 days were for drawbar work. Over 80 per cent of the drawbar work consists of plowing and other work connected with seedbed preparation. Grinding feed, silo filling, wood sawing, and threshing constituted over 90 per cent of the belt work.

On farms of similar type, the work available for tractors depends largely on the acres of crops raised per farm. On farms of 50 to 99 crop acres, the days of use per tractor were 27.8, compared to 69.1 days of use for farms having 200 or more crop acres.

There is wide variation in the days of drawbar work secured from tractors per farm. It varied from practically nothing to 125 days. Only 16 per cent of the farms having tractors used them for 50 or more drawbar days.

The average number of horses displaced was 2.0. The number dis-

placed varied from 0.2 horses on farms of 50 to 99 crop acres, to 2.7 horses on farms of 200 or more crop acres. In addition to the 2.0 horses already displaced, these tractor owners expect to displace 1.1 additional horses by 1934, making a total past and prospective displacement of 3.1 horses per farm or 39 per cent of the number required to work the same farms without a tractor.

There is no evidence that the number of horses displaced per tractor increased from 1918 to 1929 on farms having the same acres of crops.

There is no important difference in the age, weight, or value of horses on farms with tractors and without tractors.

Two-plow tractors and three- or four-plow tractors each did about 30 days of drawbar work but the larger tractors were used for 23 days of belt work compared to 12 for the two-plow tractors. There is a tendency to favor a larger size than the two-plow tractor.

Tractors that were purchased prior to 1925 are used about ten days less than those purchased in 1925 and subsequent years.

About three fourths of tractor owners prefer horses to tractors for use with hired help.

Steam tractors were found on only 10 of the 538 farms. These were all purchased prior to 1917. Nine of these were used chiefly for threshing. The small separators operated by the gasoline tractor of small or medium size have largely displaced steam tractors for threshing.

The development of the automobile as a significant source of farm power, has occurred since 1914. The high price of labor and prosperity for farmers from 1914 to 1920 caused a rapid increase in farm automobiles. Farm cars are predominantly low-priced cars. Seventy-one per cent of 594 farm-owned cars were Fords, Chevrolets, Overlands, Whippets, and Stars. Less than 10 per cent were both purchased new and in a higher priced class than those just mentioned.

The average yearly mileage per farm was 5,195 miles, of which 2,483 were for farm business and 2,712 for other than farm business.

The automobile has brought far reaching changes in farm life. With the automobile, the farm family purchases clothing and other articles of high value in proportion to bulk at the larger towns where there is a greater assortment.

Without the automobile, county extension work could have achieved but a fraction of its present effectiveness.

With the automobile, the specialized medical talent of the larger centers is more accessible to the farm family than formerly. However, when roads are impassable many farm families are cut off from all medical service, as doctors are no longer available in many small villages.

Among farms having one automobile 70 per cent of the smaller farms

have small cars (Fords, Chevrolets, Overlands, Whippets, and Stars), compared to 38 per cent of larger farms.

Twenty-six per cent of the larger farms have 2 cars, compared to 8 per cent of the smaller farms.

The motor truck has not only largely replaced horses for hauling to and from farms but is to some extent replacing the railroad for the transportation of livestock, fruits, vegetables, and milk from the locality in which they are produced to the terminal markets.

The motor truck developed later than the automobile. In 1915, there was in the United States, 1 truck registered for every 17 passenger cars. During each of the years 1925, 1926, and 1927, there was 1 truck registered for every 7 passenger cars. Eighty-four per cent of the farms that reported the ownership of trucks bought them since 1920.

In 1920, farm trucks were more numerous than tractors in the Middle Atlantic, New England, and Pacific Coast states.

In Minnesota from 1920 to 1927, farm trucks increased 480 per cent compared to an increase of 203 per cent in tractors.

In Minnesota, a larger per cent of the farms near large cities have trucks than those that are beyond a convenient trucking distance to large-city markets.

About two thirds of the trucks on these farms were Fords. Five makes included 93 per cent of the trucks.

The average miles driven per truck were 2,727, of which 696 were custom work.

Under the present system of taxation in Minnesota, a truck that is driven 1,000 miles pays a gasoline and license tax equivalent to a gasoline tax of 18 cents per gallon of gasoline used compared to 4.8 cents for one that is driven 10,000 miles.

There is no consistent relation between crop acres per farm and miles driven per truck, but as the size of the farm increases there is a tendency to buy larger trucks.

Over one third of the farmers owning trucks did some custom work.

There is a distinct tendency toward more trucks of a rated capacity of one ton and a ton and a half.

Of 363 farmers not having trucks, 110 definitely expect to own a truck in 1934, 96 definitely stated that they did not expect to own a truck in 1934, and 157 made no report.

Three hundred sixty-three farms had one or more stationary gas engines. These farms had 1.5 gas engines with 4.1 available horsepower per farm.

An occasional farm had electricity as early as 1909 but few farms

had it prior to 1917. The electrification of farms has made very rapid progress since 1917.

Aside from lights, the most general use of electricity in the home is for running the washing machine. The electric iron is next, followed in order by the battery charger, vacuum cleaner, and toaster.

Separating cream was the most frequent farm use of electricity, followed in order by pumping water, milking cows, fanning grain, and operating grindstones and emery wheels.

One fourth of the farms having electricity use it to lengthen the winter day for the farm poultry flock.

Farmers on power lines are making more use of electricity than those having private plants. Those getting current from a power line have 2.3 motors per farm compared to 1.5 in the case of those with private plants. The electric horse-power of the motors owned per farm is two and a half times greater for those on power lines than for those using private plants. The farms with power line connections are doing an average of 6.5 operations with electrical motors compared to 4.4 in the case of those with private plants.

The present tendency to graduate charges so that the consumer has an inducement to make liberal use of current will encourage the installation of electric motors and household appliances.

Of 334 farms not having electricity, 106 reported that they expected to install it in the next five years, 65 stated that they did not expect to install electricity, and 163 made no report.

Automobiles, tractors, trucks, and electricity are all comparatively new sources of farm power. The exceptional farm that is today equipped with tractors, trucks, and electricity will be the ordinary farm of the future. These new sources of power will increase the investment required in farming, will increase the acres that a farm family can handle, and will make farming a less self-sufficing business than formerly. The new farm business will need better trained men.

These sources of power, judiciously used, increase the income and reduce the drudgery of farm work. They expand the comforts and conveniences of home life. The farm family that has all these sources of power, an all-season road, and that has modern plumbing is able to enjoy a standard of living equal to that offered by the better residential sections of the larger cities.

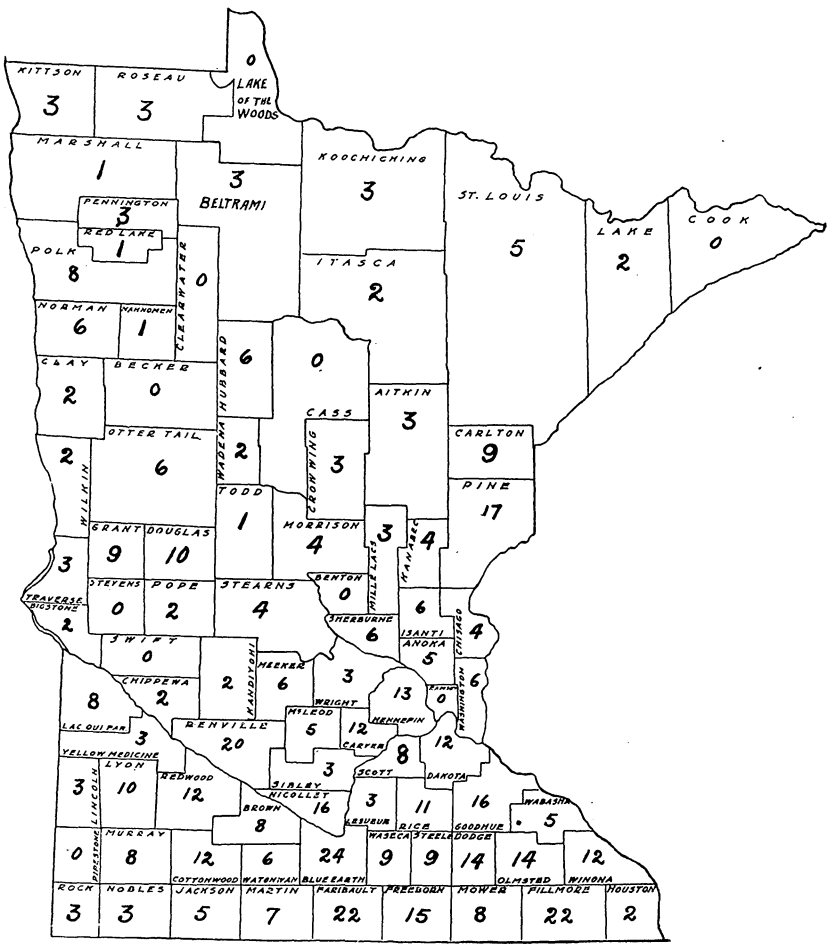


Fig. 1. Location of 538 Minnesota Farms Reporting Sources of Farm Power, 1929

The figures represent the number of reports received from each county. The majority of the reports were obtained from farms in the southern half of the state.

# SOURCES OF POWER ON MINNESOTA FARMS*

W. L. CAVERT

## SCOPE OF STUDY

In March, 1929, a questionnaire was sent to several thousand Minnesota farmers. These lists were representative of the more intelligent and prosperous farmers, rather than of the average. Fairly complete replies were secured from 541 farmers. Three reported no horses and were not used in the tabulation, as they were too few for an adequate study of horseless farms. Figure 1 shows the number of reports received from each county.

### Sources of Power

Estimates of the amount and source of power available on these farms is given in Table I. These data indicate that horses are the most important source of power from the standpoint of horse-power hours actually utilized in the farm business. Next are the tractor, the automobile, the truck, the stationary gas engine, electricity, and the steam engine. Considering the total power used in the farm business, and by the farm family, the automobile is more important than horses. No data were available for the power developed by windmills. Doubtless, a number of farmers use them for pumping water, but windmill power is an insignificant part of the total.

If the total power used for farm business, custom work, and family use is included, each source would furnish the following proportion:

| Source | Per cent |
|---|---|
| Automobiles | 30.9 |
| Horses | 29.7 |
| Tractors | 23.3 |
| Trucks | 7.7 |
| Stationary gas engines | 5.7 |
| Electric motors | 1.5 |
| Steam engines | 1.2 |
| Total | 100.0 |

The most extensive study[1] of the power used by farmers in the United States did not include the horse-power supplied by automobiles. Kinsman estimated that the average horse-power hours utilized annually on farms in the United States are about 2,480 excluding the automobile. While aside from his omission of the automobile, the two calculations are only roughly comparable, it seems probable that these farms use

* This manuscript was submitted to the Graduate Faculty of Cornell University in partial fulfillment of the requirements for the Ph.D. degree, granted September, 1929.

[1] Kinsman, C. D., An Appraisal of Power Used on Farms in the United States. U. S. Dept. of Agr. Bull. 1348, p. 56. 1926.

more than three times as much power as the average for the United States. Kinsman also estimates the total annual horse-power hours for Minnesota farms to be 687,000,000 and the average, 3,860 per farm. This estimate is 37 per cent of the annual horse-power hours for the corresponding sources of power on the 538 farms reported in this study.

TABLE I

SOURCES OF PRIMARY POWER, 538 MINNESOTA FARMS, MARCH, 1929*

| Types of power | No. of farms with specified type of power | No. of units per farm | Estimated primary horse-power per unit | Total primary horse-power per farm | Hours of primary horse-power per year | Total horse-power hours per year per farm | Per cent of total power |
|---|---|---|---|---|---|---|---|
| Horses | 538 | 5.55 | 1.0 | 5.5 | 818† | 4499 | 29.7 |
| Automobiles | | | | | | | |
| Family use | 501‡ | 1.13 | 20.0 | 22.6 | 108 | 2441 | 16.1 |
| Farm use | ... | 1.13 | 20.0 | 22.6¶ | 99 | 2237 | 14.8 |
| Tractors | | | | | | | |
| Drawbar on home farm | 245 | 0.48 | 11.2 | 5.4¶ | 285 | 1539 | 10.2 |
| Belt on home farm | ... | 0.48 | 21.6 | 10.4 | 155 | 1612 | 10.6 |
| Custom | ... | 0.48 | 21.6 | 10.4¶ | 36 | 374 | 2.5 |
| Trucks§ | | | | | | | |
| Farm use | 175 | 0.34 | 25.0 | 8.5 | 102 | 867 | 5.7 |
| Custom | ... | 0.34 | 25.0 | 8.5¶ | 35 | 298 | 2.0 |
| Stationary gas engines | 363 | 1.03 | 2.8 | 2.9 | 300** | 870 | 5.7 |
| Electricity | 204 | 0.69†† | 0.7 | 0.5 | 450** | 225 | 1.5 |
| Steam engines | 10 | 0.02 | 47.0 | 0.9 | 200** | 180 | 1.2 |
| Total farm, family, and custom power | ... | ... | ... | 51.3 | ... | 15142 | 100 |

* The number of horse-power hours actually developed is less than reported in the table, as the engines are calculated at rated capacity and one horse has been assumed to develop one horse-power per hour of use. However, both motors and horses are used for a large number of operations in which only a fraction of the rated power is used. The data should be used to show the power available and to compare the relative amount of power obtained from different sources rather than as an absolute measure of power actually developed.

† The average hours of work a year per horse are from cost records in Steele, Cottonwood, and Jackson counties. See Pond, G. A., and Tapp, J. W., Minn. Expt. Sta. Bull. 205, p. 64, 1923; Pond, G. A., Minn. Expt. Sta. Tech. Bull. 44, p. 39, 1926.

‡ The autos were used an average of 2,483 miles for farm use and 2,712 miles for family use. The average rate of travel was estimated to be 25 miles per hour and the average horse-power developed at this speed was estimated to be 20.

§ Trucks had an average capacity of 0.88 tons and traveled 2,031 miles for farm use and 697 miles for custom work. The average speed was estimated to be 20 miles and the horse-power developed at this speed was estimated to be 25.

¶ These figures are not included in the total of 51.3 horse-power available for farm and family use as the same autos are used for farm and family; the same tractors are used for drawbar and belt work on the home farm and for custom work, and the same trucks are used for farm business and custom work.

** The hours of use per year of stationary gas engines, electric motors, and steam engines are arbitrary estimates.

†† Electrical installation for one farm is regarded as a unit.

In 1919, the primary horse-power available per wage earner in manufacturing industries[2] was from 3.2 to 3.5. No data were given of the extent to which this available power was used, but it was much

[2] Calculations are based on reports to the 1920 United States census from 82 per cent of the manufacturing establishments.

higher than in agriculture, as the farmer is restricted by the seasonal nature of his work. If all the power on the 538 farms were developed to capacity at one time, about 51 horse-power would be available (Table I). If the automobile is excluded, 29 horse-power would be available. As there are probably about two and one-half workers per farm on these farms, about 20 horse-power per man would be available if the automobile is included, and 12 if it is excluded.

A comparison of these figures with state averages derived from recent official reports indicates that these farmers are using more power of all kinds than the average Minnesota farmer.

TABLE II

POWER ON 538 FARMS COMPARED WITH STATE AVERAGE

| Item | Average for 538 farms | Average for Minnesota |
|---|---|---|
| Crop acres | 148 | 95 * |
| Horses 3 years old and older | 5.5 | 4.0 |
| Tractors, per cent of farms | 45 | 17 † |
| Trucks, per cent of farms | 35 | 10 † |
| Electricity, per cent of farms | 39 | 4 ‡ |

* From the 1925 United States census.

† The percentage of farms with tractors and trucks is based on the tractors and trucks reported in the 1927 state census of agriculture and the number of farms reported in the 1925 United States census.

‡ The percentage of farms with electricity is based on the estimate for 1924 by Kinsman, C. D., An Appraisal of Power Used on Farms in the United States. U. S. Dept. Agr. Bull. 1348, p. 54. 1926.

The farms reported in this study are 56 per cent larger than the average for the state. As a group they have 38 per cent more horses, three years old and older; 165 per cent more tractors; 250 per cent more trucks; 875 per cent more electricity than the average for the state.

TABLE III

HOURS OF MAN LABOR PER FARM, MINNESOTA COST ROUTE FARMS, 342 RECORDS, 1920-27*

| County | Years | No. of records | Hours of man labor per farm |
|---|---|---|---|
| Steele | 1920-24 incl. | 110 | 8,774 |
| Cottonwood-Jackson | 1920-24 incl. | 115 | 5,720 |
| Pine | 1925-27 incl. | 81 | 6,463 |
| Polk | 1926-27 | 36 | 9,119 |
| Total or average | | 342 | 7,519† |

* Mimeographed reports published by the College of Agriculture, University of Minnesota, as follows:

Pond, G. A., Preliminary Report of the Steele County Statistical Route, 1924, p. 7.

Pond, G. A., Preliminary Report of the Cottonwood-Jackson County Statistical Route, 1927, p. 7.

Hoverstad, T. A., A Preliminary Report of the Farm Accounting Route at Askov, Pine County, 1928, p. 3.

Mumford, D. C., Sallee, G. A., Pond, G. A., and Ruud, C. O., A Preliminary Report on the Farm Accounting Route at Crookston, Polk County, 1928, p. 3.

† The average is a simple arithmetical average of the figures for the four localities.

To the industrial engineer it may appear that the farmer uses his power very inefficiently, but he does not realize that the farmer must provide power for many operations, most of which demand power for relatively few days in the year.

The average hours of man labor per farm in four sections of Minnesota are shown in Table III.

If these 538 farms are similar to those on the accounting routes, each hour of man labor has at its disposal 1.7 horse-power hours (not including the use of automobile for family purposes), assuming horses and motors to be used at rated capacity when in use. Based on 300 nine-hour days per year, 138,510 horse-power hours were available, but only 12,701 hours were utilized aside from the use of the automobile for other than farm business. This represents 9.2 per cent of the available power.

The tractor, the truck, and electricity are all comparatively new sources of farm power and it is probable that with increasing experience they will be used more efficiently in the future than at present; but the seasonal nature of his work will always prevent the farmer from attaining the efficiency of the industrialist in the use of power.

## Further Changes in Prospect

These recent changes in the power available for farming will have far reaching effects on the future of agriculture. The extensive use of gasoline power is rapidly increasing the acreage that one farm family can operate, hence it is likely that gasoline power will considerably increase the size of farms. The farmer will require more working capital in the future than in the past, because the average farm will need to be equipped with about the same machinery as at present and will have more tractors, trucks, and electrical equipment.

Under the new order, the farmer will be more affected by changes in markets than in the past, for when he buys petroleum products for power and the machines with which to use them, he is more affected by changes in market prices of both machinery and farm products than if his power is largely derived from his corn, oats, and hay fed to horses raised on the farm.

It is probable that one result of the changes in farm power will be increased specialization. For example, the combine and tractor-drawn machinery may make it increasingly difficult for the general farmer. who has formerly raised a few acres of wheat, to compete with the farmers of Kansas, North Dakota, and the Canadian prairies.

Finally, farming will require a different type of farmer. The successful farmer of the future will find a thoro training both in schools and in practical farm operation, more essential than in the past. He will

need to know practically everything that was necessary in the past. In addition, he will need to be a better mechanic. He will need a better understanding of the biological sciences and their applications to the control of diseases and pests and to the breeding of animals and plants. He will need to know more soil science and its application to the economical maintenance of soil fertility. Last, but not least, he will need to be a better business man. He will find, more than formerly, that the years spent in high school and college pay dividends.

## THE HORSE SITUATION

Excluding custom work and the automobile for family use, the horse furnishes 43 per cent more horse-power hours than the tractor and twice as many as the automobile (Table I). Horses do about three times as much drawbar work as the tractor. As these farms are using much more gasoline power than the average, it is evident that for the average Minnesota farmer the horse is the major source of power for other than belt work.

Horses differ from mechanical motors in that they do not reach working age in less than four years from the time the mare is bred; while mechanical motors may be had in a few weeks from the time the orders are given.

TABLE IV

RELATION OF FARMS WITH AND WITHOUT TRACTORS TO THE NUMBER OF HORSES ESTIMATED TO BE REQUIRED IN 1934 ON 450 MINNESOTA FARMS, 1929

| | No. of farms | Crop acres | No. of horses March, 1929 | No. of horses March, 1934* | Per cent horses required in 1934 are of no. in 1929 | Average horses per farm 1929 | Average horses per farm 1934* | Crop acres per horse 1929 | Crop acres per horse 1934 |
|---|---|---|---|---|---|---|---|---|---|
| Farms having horses, but no tractor ..... | 230 | 115 | 1171 | 1165 | 99 | 5.1 | 5.1 | 22.6 | 22.6 |
| Farms having horses and one or more tractors | 217 | 188 | 1322 | 1111 | 84 | 6.1 | 5.1 | 30.8 | 36.9 |
| Farms having tractor and no horses..... | 3† | 36 | .... | .... | .. | .. | .. | ... | ... |

* Estimated number of horses required in 1934.

† The three farms reporting no horses had 30, 39, and 40 crop acres, respectively. These three farms are not included in the tables that follow.

Of 245 farmers now using tractors,[3] 24 indicate that in five years they will be using tractors for all the heavy work. Of the 24, 3 will use no horses. Of 293 farmers not now using tractors, only 7 plan to do all the heavier work with tractors in five years, and one plans to

[3] The figure is the total number using tractors, while 217 farms are reported in Table IV. The discrepancy is due to the fact that 28 of these farmers did not give estimates of horse requirements for 1924.

farm without horses. According to present plans, 99 per cent of these farmers will be using horses in five years. If horses are to be used, the number needed and the number available are important questions.

Reports from 450 farmers indicate that they will use 2,276 horses in 1934 as compared to 2,493 in 1929 (Table IV). The 230 farmers not now using tractors report that in the next five years there will be no change in the number of horses; those using both horses and tractors plan to reduce the horses to 84 per cent of the present number. On the average, 92 per cent of the present number of horses will be needed in 1934. As 45 per cent of these farmers use tractors as compared to 17 per cent for the state, it seems probable that if reports from all the farmers in the state were available, about 95 per cent of the present number of horses will be required in 1934.

## The Future Supply of Horses

The expansion of gasoline motor power and the cyclical overproduction of horses in the decade 1910-19 has resulted in very low prices for horses since 1918. This has discouraged the raising of colts. In Minnesota, in 1918-19, there was only one colt for each 15.5 horses. This would just about maintain the number of Minnesota horses. In 1923-24, Minnesota farmers produced only one colt for every 34.4 horses (Table V). This is probably less than half the colts required to maintain the present number.

TABLE V

NUMBER OF HORSES OR MULES TWO YEARS OLD OR OLDER ON FARMS FOR EACH HORSE OR MULE COLT RAISED IN MINNESOTA AND THE UNITED STATES

| Year | United States | | Minnesota | |
|---|---|---|---|---|
| | Horses | Mules | Horses | Mules |
| 1918-19* | 13.6 | 11.8 | 15.5 | 7.8 |
| 1923-24† | 30.3 | 28.3 | 34.4 | 8.0 |

* The 1920 census reports colts under one year and between one and two years. The total of the two classifications was divided by two to give the number raised per year in 1918-19.

† The 1925 census reports colts under two years, those raised in 1923 and 1924. The number reported was divided by two to give the average per year.

In the United States during 1923 and 1924, about 544,000 horse colts were raised per year, or one for each 30.3 horses two years old and older. If horses live to an average age of 16 years, the number of colts raised in the United States in 1923 and 1924 would maintain a horse population of slightly over 8,700,000. If mules live to an average age of 18 years, the average of 187,400 mule colts raised in 1923 and 1924 would maintain a mule population of slightly under 3,400,000, or a total horse and mule population of 12,100,000. The total number of horses and mules reported in January, 1929, by the United States Department of Agriculture was 19,400,000. Basing the calculation on

the number of colts raised in 1923 and 1924 it is possible to maintain about 62 per cent of the present number of horses and mules.

In Minnesota 26 per cent more colts were raised in 1926 and 1927 than in 1923 and 1924 (Table VI). No data since 1924 for states other than Minnesota have come to the author's attention. The United States Department of Agriculture makes the following estimate of the future number of horses: "The total number of horses and mules has decreased nearly one-fourth since January, 1920, when about 25,000,000 were on farms. Unless the number of colts is increased above the number produced during the last few years, the number of horses and mules will be reduced to about 11,000,000 within the next 10 years, based on the assumption that the average horse lives about 15 years and the average mule about 18 years."[4]

The Minnesota State Department of Agriculture has compiled the number of horses and mules of various ages in Minnesota for the 11 years, 1917 to 1927, from reports furnished by the Minnesota Tax Commission.[5]

TABLE VI

HORSES AND MULES OF VARIOUS AGES IN MINNESOTA, 1917 TO 1927, INCLUSIVE*

| Year | No. of horses and mules | | | | Per cent of horses 3 yrs. and older that are over 16 yrs. | Horses 3 yrs. and older per colt under one year |
|---|---|---|---|---|---|---|
| | Under one year | Three to 16 years | Over 16 years | Total 3 years and older | | |
| 1917 | 52,107 | 619,493 | 124,940 | 744,433 | 16.7 | 14.2 |
| 1918 | 47,526 | 629,143 | 132,508 | 761,651 | 17.3 | 16.0 |
| 1919 | 44,242 | 633,949 | 130,686 | 764,635 | 17.1 | 17.2 |
| 1920 | 31,790 | 645,880 | 133,392 | 779,272 | 17.1 | 24.5 |
| 1921 | 18,314 | 648,639 | 141,845 | 790,484 | 17.9 | 43.1 |
| 1922 | 15,188 | 637,277 | 158,392 | 795,669 | 19.9 | 52.4 |
| 1923 | 15,037 | 616,149 | 169,667 | 785,816 | 21.5 | 52.2 |
| 1924 | 17,233 | 582,672 | 182,246 | 764,914 | 23.8 | 44.4 |
| 1925 | 16,312 | 567,353 | 189,933 | 747,286 | 25.4 | 45.8 |
| 1926 | 19,913 | 540,645 | 203,378 | 744,023 | 27.3 | 37.4 |
| 1927 | 20,760 | 519,830 | 217,732 | 737,562 | 29.5 | 35.5 |

* The number of horses and mules reported to the Minnesota tax commission by assessors in 1920 was about 92 per cent of the number reported by the United States census for the same year if one allows for the fact that the census was taken as of January 1, as compared to May for the assessors' reports.

In 1917, there were 52,000 colts under one year of age in Minnesota (Table VI) and 744,000 horses and mules 3 years old and older—14.2 horses and mules for each colt. There has been a marked decrease in the number of colts and a marked increase in the number of horses more than 16 years of age. The proportion of mature horses to colts has increased from 14.2 horses to one colt, in 1917, to 35.5 to one in 1927. In 1917, 16.7 per cent of the mature horses were more than

[4] Agricultural Outlook, 1929. U. S. Dept. Agr. Misc. Pub. No. 44. p. 26. 1929.

[5] Kirk, P. H., and Bodin, R. A. Minnesota Annual Crop and Livestock Statistics, 1926-27. Bull. 63, Minn. State Dept. of Agr., p. 73.

16 years old and in 1927, 29.5 per cent. If it is assumed that the colts reported in 1928, 1929, and 1930 would be 24,000 per year, the total number raised for the 14 years from 1917 to 1930, inclusive, would be 370,000. The number of horses from 3 to 16 years, inclusive, in 1933 would be only 370,000 compared to 520,000 for the same age group in 1927. This is 71 per cent of the number in 1927. This assumes that none of the horses born in 1917 and the following years will die before 1933.

TABLE VII

RELATION OF THE NUMBER OF COLTS TO THE NUMBER OF HORSES ON FARMS WITH AND WITHOUT TRACTORS, 502 MINNESOTA FARMS, MARCH, 1929

| Farms | No. of farms reporting | No. of horses 3 yrs. and older | Colts living March 1, 1929, foaled in | | | | Per cent av. no. of colts raised is of horses 3 yrs. and older | Horses 3 yrs. and older per colt |
|---|---|---|---|---|---|---|---|---|
| | | | 1926 | 1927 | 1928 | Average | | |
| With tractor..... | 241 | 1442 | 52 | 62 | 49 | 54 | 3.7 | 27 |
| Without tractor..... | 261 | 1394 | 46 | 57 | 47 | 50 | 3.6 | 28 |
| Total or average.. | 502 | 2836 | 98 | 119 | 96 | 104 | 3.7 | 27 |

The number of colts foaled in 1926, 1927, and 1928 on 502 farms was one per year for 27 horses 3 years old and older (Table VII). This indicates that with an average life of 16 years, the colts raised on these farms in 1926, 1927, and 1928 would maintain a horse population of 53 per cent of the present number. The colts expected on these farms in 1929 were 119; the average was 104 in the preceding three years. After allowing for losses at foaling time, no significant increase in the number of colts raised is in prospect in 1929.

All the data indicate that a further significant reduction in number of horses is inevitable. Upon the basis of present intentions, 92 per cent of the present number of horses will be required five years hence, therefore an acute shortage is in prospect. However, it is likely that the shortage will be less acute than these reports indicate as the tractors now being sold are much more adaptable for cultivating, mowing, cutting of grain, and similar operations than the models that most of the farmers are using. There probably will be a decided rise in the price of horses which, combined with the improvements in tractors, will cause less use to be made of horses and more of tractors than farmers anticipate.

## Factors Affecting Value of Horses

Reports were received giving the age, weight, and value of 2,287 horses. The weight and value per head and per pound for horses from 3 to 30 years of age are shown in Table VIII.

In Minnesota, horses reach full weight at 5 years of age and have their maximum value per head at 4 or 5 years. On a per pound basis,

there is little change in value between 3 and 8 years; after 8 years, there is a consistent drop in value with increasing age. The values for horses more than 20 years of age would probably have been nearly zero if the inquiry had been made in the fall. The average decline in value on the basis of the spring market is approximately half a cent per pound per year, from 8 to 20 years of age.

In March, 1929, the Minnesota farm price of 5- and 6-year-old horses was $9.10 per hundredweight; of hogs, $9.10; and of beef cattle, $8.80. Probably the farm price of horses on a pound basis must be 20 to 25 per cent above that for beef cattle and hogs to stimulate production sufficiently to maintain the number of horses needed.

TABLE VIII

RELATION OF AGE OF 2,287 MINNESOTA HORSES TO WEIGHT AND VALUE, MARCH 1, 1929

| Age, years | No. of horses | Average weight | Value | |
|---|---|---|---|---|
| | | | Per head | Per pound |
| | | lbs. | | |
| 3 | 80 | 1,239 | $111 | $0.089 |
| 4 | 88 | 1,389 | 137 | .099 |
| 5 | 110 | 1,453 | 133 | .091 |
| 6 | 136 | 1,426 | 129 | .091 |
| 7 | 124 | 1,414 | 125 | .089 |
| 8 | 165 | 1,394 | 126 | .090 |
| 9 | 150 | 1,400 | 117 | .083 |
| 10 | 222 | 1,403 | 108 | .077 |
| 11 | 116 | 1,372 | 101 | .073 |
| 12 | 229 | 1,375 | 90 | .065 |
| 13 | 93 | 1,385 | 87 | .062 |
| 14 | 115 | 1,389 | 78 | .056 |
| 15 | 144 | 1,342 | 70 | .052 |
| 16 | 125 | 1,359 | 58 | .043 |
| 17 | 54 | 1,315 | 49 | .037 |
| 18 | 91 | 1,353 | 52 | .038 |
| 19 | 40 | 1,278 | 39 | .030 |
| 20 | 102 | 1,287 | 38 | .029 |
| 21–25 incl. | 90 | 1,234 | 27 | .022 |
| 26–30 incl. | 13 | 1,227 | 12 | .010 |
| Total or average | 2,287 | 1,367 | $93 | $0.068 |

The average weight of horses appears to be increasing. Horses 5 years of age average 1,453 pounds, those 20 years of age 1,287 pounds, or a difference of 166 pounds. Part of this decrease may be attributed to the fact that old horses are thinner than young ones; part to the fact that the automobile has eliminated the light horses for road work, consequently, practically none have been raised in recent years.

That the average weight of horses is increasing is confirmed by an inquiry made by the United States Department of Agriculture[6] in 1918, which reported the average weight of Minnesota horses to be

[6] Monthly Crop Reporter, Vol. 4, p. 10, February, 1918.

1,305 pounds as compared to 1,367 for those in this study. In 1918, the only states reported as having heavier horses than Minnesota were Washington, 1,350 pounds; Maine, 1,325 pounds; Iowa, 1,320 pounds; and Ohio and Oregon, each 1,310 pounds. At that time, the average weight of horses in the United States was estimated at 1,203 pounds.

**Relation of weight to value of horses.**—The farmer puts a substantial premium on extra weight in horses, if the comparison is based on the value per head, but on a pound basis, the premium is not so significant, particularly for horses above 1,200 pounds. The heavier horses are enough younger to account for most of the difference in price per pound in the groups weighing over 1,200 pounds (Table IX). The value per pound decreases about half of a cent per year (Table VIII).

TABLE IX

RELATION OF WEIGHT OF 2,287 MINNESOTA HORSES TO VALUE AND AGE, MARCH, 1929

| Weight, lbs. | No. of horses | Av. weight, lbs. | Av. age, yrs. | Value | |
|---|---|---|---|---|---|
| | | | | Per head | Per pound |
| 600– 949..... | 32 | 839 | 13.5 | $ 33 | $0.039 |
| 950–1,049..... | 64 | 998 | 13.0 | 46 | .046 |
| 1,050–1,149..... | 129 | 1,095 | 12.1 | 61 | .056 |
| 1,150–1,249..... | 321 | 1,196 | 13.1 | 73 | .061 |
| 1,250–1,349..... | 416 | 1,289 | 11.9 | 84 | .065 |
| 1,350–1,449..... | 566 | 1,392 | 11.5 | 95 | .068 |
| 1,450–1,549..... | 375 | 1,490 | 11.0 | 107 | .072 |
| 1,550–1,649..... | 255 | 1,593 | 10.3 | 123 | .077 |
| 1,650–1,749..... | 87 | 1,684 | 9.2 | 131 | .078 |
| 1,750–2,000..... | 42 | 1,796 | 10.0 | 159 | .088 |
| Total or average.... | 2,287 | 1,367 | 11.5 | $ 93 | $0.068 |

Ladd[7] found in New York State that horses weighing 1,400 pounds and more were worth 9.7 cents per pound; those weighing from 1,200 to 1,399 pounds, 8.9 cents; and those weighing 1,000 to 1,199 pounds, 7.4 cents. The average age of each group is not given, but if the heavier horses were also somewhat younger, his data agree with these to the effect that the premium per pound for extra weight is not large after 1,200 to 1,300 pounds is reached.

**Relation of sex to value of horses.**—Mares 3 to 10 years of age are worth 0.5 to 0.7 cent per pound more than geldings. There seems to be no significant difference in weight (Table X). The mares, for the whole group, average practically the same as the geldings in value per head and per pound. This is because the mares average 0.7 of a year older than the geldings.

In a study of farm horses in New York in 1927, Ladd found that the mares weighed 1,219 pounds; the geldings 1,259 pounds, a differ-

[7] Ladd, C. E., The Farm Horse Situation in New York State. Cornell Ext. Bull. 169, p. 24. 1928.

ence of 40 pounds.[8] The value per head was $117 for mares, and $112 for geldings. The mares were worth 9.8 cents per pound, the geldings 8.9 cents, a difference of 0.9 cent in favor of the mares. However, the geldings averaged 0.6 of a year older than the mares, so only about 0.4 cent difference could be attributed to a preference for mares. From 5 to 8 years, there was a difference of a cent a pound in favor of the mares.

TABLE X

RELATION OF SEX OF HORSES TO AGE, WEIGHT, AND VALUE, 1,060 MINNESOTA MARES AND GELDINGS, MARCH, 1929

| | Age | | | | |
|---|---|---|---|---|---|
| | 3 to 6 years, incl. | 7 to 10 years, incl. | 11 to 14 years, incl. | 15 to 30 years, incl. | Total or av. |
| Mares | 98 | 144 | 147 | 166 | 555 |
| Geldings | 107 | 146 | 126 | 126 | 505 |
| Mares, av. age, yrs. | 4.9 | 8.9 | 12.5 | 18.2 | 11.8 |
| Geldings, av. age, yrs. | 4.7 | 8.7 | 12.3 | 18.3 | 11.1 |
| Mares, weight, lb. | 1,418 | 1,381 | 1,394 | 1,320 | 1,372 |
| Geldings, weight, lb. | 1,393 | 1,441 | 1,394 | 1,324 | 1,390 |
| Mares, value per head | $140 | $121 | $90 | $52 | $96 |
| Geldings, value per head | 130 | 117 | 92 | 47 | 96 |
| Mares, value per lb. | 0.099 | 0.088 | 0.064 | 0.040 | 0.070 |
| Geldings, value per lb. | 0.094 | 0.081 | 0.066 | 0.035 | 0.069 |

## HORSES PER TEAM USED FOR VARIOUS OPERATIONS

In 1927 and 1928 numerous demonstrations were held in various parts of Minnesota by the Agricultural Extension Division in co-operation with the Horse Association of America for the purpose of calling attention to hitches for 5, 6, 7, and 8 horses, whereby one person could control them with one pair of lines, and at the same time eliminate side draft. From the reports, it is possible to study the changes in the teams used on farms of various sizes.

### Horses Used per Team on Farms With and Without Tractors

In 1924 farms of from 100 to 199 crop acres without tractors used 4.6 horses per team. It is estimated that in 1934 they will use 5.1 horses per team. In 1924 farms of similar size with tractors used 4.7 horses per team and estimated that in 1934 they would use the same number.

On the farms without tractors the tendency is to use larger teams. Farms with tractors are using teams of about the same size as five years ago and expect to use teams of the same size five years hence.

[8] Ladd, C. E., The Farm Horse Situation in New York State. Cornell Ext. Bull. 169, pp. 17, 23. 1928.

If present intentions are carried out, in 1934 the farms of 49 crop acres and less, without tractors will be using 3 horses per team for the heavier work, as compared to 2.5 in 1924; those of 50 to 99 crop acres, 3.9 horses per team, as compared to 3.6; those of 100 to 199 crop acres, 5.1 horses per team, as compared to 4.6; and those with more than 200 crop acres, 6 horses per team, as compared to 4.7 (Table XI).

TABLE XI

RELATION OF CROP ACRES PER FARM TO CHANGES IN SIZE OF TEAMS USED FOR THE HEAVIER FARM OPERATIONS, 407 MINNESOTA FARMS 1924, 1929, AND 1934

| Crop acres per farm | Year | Farms without tractors | Farms with tractors | Horses per team on farms | |
|---|---|---|---|---|---|
| | | | | Without tractors | With tractors |
| | | No. | No. | | |
| 49 and less | 1924 | 34 | * | 2.5 | .. |
| | 1929 | 34 | ... | 2.7 | .. |
| | 1934 | 34 | ... | 3.0 | .. |
| 50 to 99 | 1924 | 76 | 24 | 3.6 | 4.0 |
| | 1929 | 76 | 24 | 3.6 | 3.6 |
| | 1934 | 76 | 24 | 3.9 | 3.8 |
| 100 to 199 | 1924 | 95 | 100 | 4.6 | 4.7 |
| | 1929 | 95 | 100 | 4.6 | 4.5 |
| | 1934 | 95 | 100 | 5.1 | 4.7 |
| 200 and more | 1924 | 26 | 52 | 4.7 | 5.2 |
| | 1929 | 26 | 52 | 4.9 | 4.8 |
| | 1934 | 26 | 52 | 6.0 | 4.9 |
| Total or average | 1924 | 231 | 176 | 4.0 | 4.7 |
| | 1929 | 231 | 176 | 4.0 | 4.5 |
| | 1934 | 231 | 176 | 4.5 | 4.6 |

* Only one farm reported.

## Horses per Team Used with Plows

Twenty-two per cent of the farms with 50 to 99 crop acres use teams of 5 and 6 horses to pull a gang plow; 65 per cent of those with 100 to 199 crop acres, and 86 per cent of the farms of 200 crop acres

TABLE XII

NUMBER OF TEAMS OF DIFFERENT SIZES USING 3 TO 7 HORSES WITH GANG PLOWS, 330 MINNESOTA FARMS, 1929

| No. of horses used with gang plows | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 3 | 4 | 0 | 2 | 2 | 0 |
| 4 | 112 | 1 | 40 | 61 | 10 |
| 5 | 138 | 0 | 11 | 87 | 40 |
| 6 | 73 | 0 | 1 | 38 | 34 |
| 7 | 3 | 0 | 0 | 2* | 1* |
| Total | 330 | 1 | 54 | 190 | 85 |

* It is probable that the three farmers reporting 7 horses per team are using gang plows having three bottoms.

and more use 5 and 6 horses. Most of the farms with 50 to 99 crop acres used 4 horses and about 20 per cent used 5 horses (Table XII). If the plowing lasts only a few days, a 4-horse team may be satisfactory, but for 25 or 30 days it would be inadequate.

There is a large variation in the power required for plowing according to the heaviness of the soil and the depth of plowing. The draft on heavy clay is reported as 600 to 1,000 pounds per foot of width, and on sandy clay loam 350 to 500 pounds.[9] Also four 1,600-pound horses may furnish as much power as five 1,200-pound horses.

Most farmers use 3 horses with a sulky plow. Of the 36 farms having more than 100 crop acres, 12 used 4 horses; of 21 farms having 49 acres or less, only 4 used 2 horses (Table XIII).

TABLE XIII

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 5 HORSES ON SULKY PLOWS, 97 MINNESOTA FARMS, 1929*

| No. of horses used with sulky plows | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 5 | 4 | 1 | 0 | 0 |
| 3 | 75 | 17 | 35 | 21 | 2 |
| 4 | 16 | 0 | 4 | 9 | 3 |
| 5 | 1 | 0 | 0 | 1 | 0 |
| Total | 97 | 21 | 40 | 31 | 5 |

* Farms also reporting the use of gang plows were not included.

Fifty-one farmers reported their principal horse-drawn plows to be one-bottom walking plows. Of these, 37 used a 2-horse team; 12, a 3-horse team; and 2, a 4-horse team. Only 6 farms of 100 crop acres or more used the walking plow as their principal horse-drawn plow (Table XIV).

TABLE XIV

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 4 HORSES ON WALKING PLOWS, 51 MINNESOTA FARMS, 1929*

| No. of horses used with walking plows | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 37 | 22 | 10 | 5 | 0 |
| 3 | 12 | 6 | 5 | 1 | 0 |
| 4 | 2 | 1 | 1 | 0 | 0 |
| Total | 51 | 29 | 16 | 6 | 0 |

* Farms reporting also the use of gang and sulky plows were not included.

Gang plows are the main type of horse-drawn plows for all groups except those having 49 crop acres or less (Table XV). Only 2 per

[9] Kinsman, C. D., An Appraisal of Power Used on Farms in the United States. U. S. Dept. Agr. Bull. 1348, p. 57. 1926.

cent of 51 farms with less than 50 acres used a gang plow; 41 per cent used a sulky plow; and 57 per cent used a walking plow. On farms having 50 to 99 crop acres, 49 per cent used the gang plow as the principal horse-drawn plow; 36 per cent, the sulky; and 15 per cent, the walking plow. Of 227 farms having 100 to 199 crop acres, 83 per cent used gang plows; 14 per cent, sulky plows; and 3 per cent, walking plows. Of 90 farms having 200 crop acres and more, 94 per cent used gang plows, and 6 per cent sulky plows. Sixty-nine per cent of all farms are using gang plows; 20 per cent sulky plows; 11 per cent walking plows, as the principal type of horse-drawn plows. Apparently, many farmers are using both horses and tractors for plowing, as 191 of the 245 farmers having tractors reported the size of team used for plowing.

TABLE XV

NUMBER OF FARMERS USING WALKING, SULKY, AND GANG PLOWS AS THEIR MAIN HORSE-DRAWN PLOW, 478 MINNESOTA FARMS, 1929

| Kind of plow | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| Walking | 51 | 29 | 16 | 6 | 0 |
| Sulky | 97 | 21 | 40 | 31 | 5 |
| Gang | 330 | 1 | 54 | 190 | 85 |
| Total | 478 | 51 | 110 | 227 | 90 |

## Horses per Team Used for Seedbed Preparation

The principal implements used in Minnesota for seedbed preparation are the spike-tooth drag, the disk, and the spring-tooth harrow. The spike-tooth drag is used on practically every farm. The disk was formerly used almost as generally as the drag, but in recent years the spring-tooth harrow has to a considerable extent supplanted the disk on farms that are infested with quack grass.

With the disk large teams may be used advantageously, as it can be adjusted to the available horse-power without changing the size of

TABLE XVI

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 7 HORSES PER TEAM WITH SPIKE-TOOTH DRAGS, 458 MINNESOTA FARMS, 1929

| No. of horses used with spike-tooth drags | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 59 | 33 | 16 | 10 | 0 |
| 3 | 62 | 10 | 35 | 16 | 1 |
| 4 | 298 | 0 | 56 | 169 | 73 |
| 5 | 19 | 0 | 1 | 10 | 8 |
| 6 | 18 | 0 | 0 | 10 | 8 |
| 7 | 2 | 0 | 0 | 1 | 1 |
| Total | 458 | 43 | 108 | 216 | 91 |

the implement. Set at a sharp angle, the disk requires more power and the seedbed is correspondingly better.

The spring-tooth harrow is similar to the disk—its effectiveness is greatly increased by an abundance of power. If there is considerable quack grass, the draft is particularly heavy.

The four-horse team is most generally used with the spike-tooth drag, disk, and spring-tooth harrow for all farms except those with less than 50 crop acres (Tables XVI, XVII, and XVIII). For the latter group, 77 per cent use 2 horses with the spike-tooth drag. Among 51 farms in this same group, 31 per cent use 2 horses per team with the disk; 61 per cent 3 horses; and 8 per cent 4 horses (Table XVII).

TABLE XVII

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 7 HORSES PER TEAM WITH DISKS, 429 MINNESOTA FARMS, 1929

| No. of horses used with disks | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 22 | 16 | 5 | 1 | 0 |
| 3 | 52 | 31 | 16 | 5 | 0 |
| 4 | 279 | 4 | 59 | 157 | 59 |
| 5 | 42 | 0 | 1 | 24 | 17 |
| 6 | 33 | 0 | 0 | 21 | 12 |
| 7 | 1 | 0 | 0 | 0 | 1 |
| Total | 429 | 51 | 81 | 208 | 89 |

TABLE XVIII

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 8 HORSES PER TEAM WITH SPRING-TOOTH HARROWS, 338 MINNESOTA FARMS, 1929

| No. of horses used with spring-tooth harrows | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 24 | 17 | 5 | 1 | 1 |
| 3 | 42 | 17 | 20 | 5 | 0 |
| 4 | 187 | 1 | 50 | 109 | 27 |
| 5 | 40 | 0 | 0 | 30 | 10 |
| 6 | 39 | 0 | 1 | 23 | 15 |
| 7 | 2 | 0 | 0 | 1 | 1 |
| 8 | 4 | 0 | 0 | 1 | 3 |
| Total | 338 | 35 | 76 | 170 | 57 |

Twelve per cent of the farms with more than 100 crop acres used 5-, 6-, and 7-horse teams on the spike-tooth drag; 25 per cent on the disk; and 35 per cent on the spring-tooth harrow. Among the farms with more than 100 crop acres, only 2 per cent used 8 horses with the spring-tooth harrow, and none used 8 horses with the disk or spike-tooth drag. The wide variation in the number of horses per team used with these three implements on farms of the same size indicates that

there is an opportunity to utilize man labor to better advantage by using more horses per team as well as by using tractors.

## Horses per Team Used for Drilling and Cutting Small Grain

Four horses per team are most frequently used for drilling small grain and flax and for cutting grain. Of the 47 farms having 19 or less acres of small grain and flax, 72 per cent used 2 horses for drilling, 13 per cent 3 horses, and 15 per cent 4 horses (Table XIX). It is probable that those using 4 horses for drilling less than 20 acres of grain have in the past raised a larger acreage but for some reason had only a few acres in 1928. Of the farms with more than 79 acres of grain 90 per cent used 4 horses with the drill.

TABLE XIX

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 5 HORSES PER TEAM FOR DRILLING SMALL GRAINS AND FLAX, 397 MINNESOTA FARMS, 1929

| No. of horses used with drills | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 19 or less | 20–49 | 50–79 | 80–450 |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 75 | 34 | 29 | 7 | 5 |
| 3 | 53 | 6 | 28 | 10 | 9 |
| 4 | 267 | 7 | 55 | 81 | 124 |
| 5 | 2 | 0 | 0 | 1 | 1 |
| Total | 397 | 47 | 112 | 99 | 139 |

Practically all farmers use either 3 or 4 horses for cutting grain (Table XX). The 6-foot binder is the smallest one in common use and ordinarily requires 3 horses. If farmers do not have 3 horses, they hire the grain cut or hire extra horses. With larger acreages of grain, the 8-foot binder is most common and this is almost invariably operated with 4 horses or a tractor.

TABLE XX

NUMBER OF FARMS OF DIFFERENT SIZES USING 2 TO 5 HORSES PER TEAM WITH GRAIN BINDERS, 461 MINNESOTA FARMS, 1929

| No. of horses used with grain binders | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 19 or less | 20–49 | 50–79 | 80–450 |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 7 | 5 | 2 | 0 | 0 |
| 3 | 101 | 34 | 57 | 2 | 8 |
| 4 | 351 | 13 | 82 | 117 | 139 |
| 5 | 2 | 0 | 0 | 0 | 2 |
| Total | 461 | 52 | 141 | 119 | 149 |

## Horses per Team Used for Cultivating and Harvesting Corn

In Minnesota the ordinary six-shovel, one-row, two-horse riding cultivator and the two-row cultivator operated by 3 or 4 horses are com-

monly used. The percentage of farmers using the two-row cultivator increased as the acreage of corn increased. Thirteen per cent of those with 19 acres or less used the two-row machine; 42 per cent of those with 20 to 29 acres; 65 per cent of those with 30 to 39 acres; 75 per cent of those with 40 to 45 acres; and 86 per cent of those with more than 60 acres. All the 30 farms raising more than 100 acres of corn used a two-row cultivator (Table XXI).

TABLE XXI

NUMBER AND PER CENT OF FARMS HAVING TWO-ROW CORN CULTIVATORS, 476 MINNESOTA FARMS, 1929

| | No. of farms | Acres of corn per farm | | | | |
|---|---|---|---|---|---|---|
| | | 19 or less | 20–29 | 30–39 | 40–59 | 60–320 |
| | | No. of farms | No. of farms | No. of farms | No. of farms | No. of farms |
| Farms using two-row cultivator | 271 | 15 | 31 | 45 | 73 | 107 |
| Farms not using two-row cultivator | 205 | 97 | 42 | 24 | 25 | 17 |
| Per cent of farms using two-row cultivator | 57 | 13 | 42 | 65 | 75 | 86 |

Annual reports on the manufacture and sale of farm equipment show the extent to which the two-row cultivator and the motor-drawn cultivator have found favor during the period of relatively high prices for labor since the war. In 1925, 1926, and 1927, about twice as many two-row cultivators were sold in proportion to the one-row machines as in 1921, 1922, and 1923. No noteworthy increase in the proportion of tractor-drawn cultivators occurred until 1927, when five horse-drawn cultivators were sold for each tractor cultivator, more than twice the relative number sold annually from 1921 to 1926 (Table XXII).

TABLE XXII

NUMBER OF ONE-ROW RIDING CULTIVATORS SOLD IN THE UNITED STATES, 1921-27, FOR EACH TWO-HORSE CULTIVATOR AND EACH TRACTOR-DRAWN CULTIVATOR, 1921-27*

| Year | No. one-row riding cultivators sold for each two-row horse cultivator | No. two-row horse cultivators sold for each tractor-drawn cultivator |
|---|---|---|
| 1921 | 4.3 | 11.4 |
| 1922 | 5.4 | 14.0 |
| 1923 | 4.9 | 11.6 |
| 1924 | 2.6 | ... |
| 1925 | 2.5 | ... |
| 1926 | 2.2 | 9.6 |
| 1927 | 2.2 | 5.4 |

* Annual reports on "Manufacture and Sale of Farm Equipment," U. S. Dept. of Commerce.

Only eleven farmers among 233 having tractors used them for cultivating corn. The recent models to which cultivators are readily attached and detached are rapidly increasing the esteem in which the

tractor is held for cultivating corn. This is shown by the increased sales in 1927. In the next few years there is likely to be a rapid increase in the use of the tractor for this operation. Some four-row planters and cultivators are being introduced. If they meet with favor, the capacity of the farm family to handle the corn crop will be increased, and the size of farms in the corn belt will tend to increase.

Either 3 or 4 horses are used with the two-row cultivator (Table XXIII). The proportion using 4 horses per team increases with the increase in the corn acreage per farm. Only 25 per cent of the farms having 39 acres or less used 4 horses per team. Apparently, for day-after-day work on large fields, the 4-horse team is most satisfactory.

TABLE XXIII

NUMBER OF FARMS WITH DIFFERENT ACREAGES OF CORN USING 3 AND 4 HORSES PER TEAM WITH THE TWO-ROW CULTIVATOR, 271 MINNESOTA FARMS, 1929

| No. of horses used with two-row cultivator | No. of farms | Acres of corn per farm | | | | |
|---|---|---|---|---|---|---|
| | | 19 or less | 20–29 | 30–39 | 40–59 | 60–320 |
| | | No. of farms | No. of farms | No. of farms | No. of farms | No. of farms |
| 3 | 155 | 14 | 21 | 33 | 44 | 43 |
| 4 | 116 | 1 | 10 | 12 | 29 | 64 |
| Total | 271 | 15 | 31 | 45 | 73 | 107 |

More than 80 per cent of the farms use 3 horses on the corn binder; nearly all the others use 4 horses (Table XXIV).

TABLE XXIV

HORSES PER TEAM USED WITH CORN BINDERS, 445 MINNESOTA FARMS, 1929

| Horses per team | No. of farms |
|---|---|
| 2 | 12 |
| 3 | 368 |
| 4 | 63 |
| 5 | 2 |
| Total | 445 |

No report was received as to the number of acres of corn cut per farm. The number grown is no guide as to the number harvested with the binder, as farms having a large acreage of corn usually cut none or only a small fraction of the corn—those having only a few acres frequently cut all.

During the era of relatively high-priced labor that has accompanied the agricultural depression, the mechanical corn picker has found increasing favor. Reports as to the sale of corn pickers are available for only 1921 and 1927.[10] In 1921, only 399 were sold in the United States; in 1927, 7,145 were sold. In 1921, one picker was sold for each 21

[10] Manufacture and Sale of Farm Equipment, U. S. Dept. of Commerce, 1921 and 1927.

binders; in 1927, one for each 2.5 binders. However, the usual alternative to mechanical picking is picking from the standing stalks by hand rather than the binder.

Reports were secured from 48 farmers as to the horses per team used with the mechanical corn picker. Apparently, if the corn picker is to be operated by horses, 6 are more satisfactory than any smaller number (Table XXV). If 6 horses are used on the picker, this means that 10 are required to pick corn, as one wagon is needed to receive the corn from the picker and at least one to haul it to the crib. Operating the corn picker with horses requires co-operation among neighbors, except on the largest farms. Thirty-seven farmers reported using the tractor to haul the corn picker. The recent development of the power take-off has made the tractor much more satisfactory than formerly as a source of power for the mechanical picker.

TABLE XXV

HORSES PER TEAM USED WITH THE MECHANICAL CORN PICKER, 48 MINNSOTA FARMS, 1929

| Horses per team | No. of farms |
|---|---|
| 4 | 4 |
| 5 | 19 |
| 6 | 25 |
| Total | 48 |

## Horses per Team Used for Hauling Manure

Hauling manure with horses is an operation on nearly every Minnesota farm. Among 538 farmers, 519 reported the horses per team used for hauling manure. Forty-five per cent of the farms use 4 horses; 27 per cent, 3 horses; and 28 per cent used 2 horses (Table XXVI). On farms of 100 crop acres and more, 55 per cent used 4 horses per team. On farms of 49 crop acres and less, 65 per cent used 2 horses. It is probable that on the small farms many spread manure by hand from a 2-horse wagon. In some cases, if a spreader is used, it is a small one drawn by 2 horses, because the farm has only 2 horses.

TABLE XXVI

HORSES PER TEAM USED FOR HAULING MANURE, 519 MINNESOTA FARMS, 1929

| No. of horses per team used for hauling manure | No. of farms | Crop acres per farm | | | |
|---|---|---|---|---|---|
| | | 49 or less | 50–99 | 100–199 | 200 and over |
| | | No. of farms | No. of farms | No. of farms | No. of farms |
| 2 | 145 | 31 | 39 | 50 | 25 |
| 3 | 138 | 16 | 43 | 63 | 16 |
| 4 | 236 | 1 | 37 | 137 | 61 |
| Total | 519 | 48 | 119 | 250 | 102 |

### Horses per Team Used for Digging Potatoes

Reports for 93 farms, having three or more acres of potatoes, indicate that 4 horses per team is the usual number for digging potatoes (Table XXVII). Probably some of those reporting 2 horses, used a plow digger without an elevator. Eleven farms reported digging potatoes with a tractor.

TABLE XXVII

HORSES PER TEAM FOR DIGGING POTATOES, 93 MINNESOTA FARMS, 1929

| Horses per team | No. of farms |
|---|---|
| 2 | 14 |
| 3 | 3 |
| 4 | 73 |
| 5 | 0 |
| 6 | 3 |
| Total | 93 |

## DECLINE IN THE NUMBER OF HORSES AND MULES AS A FACTOR IN THE AGRICULTURAL DEPRESSION

In discussions concerning the causes of the agricultural depression, little attention has been given to the decline in the amount of feed required for the decreasing numbers of horses and mules.

From 1918 to 1929, in the United States, the decrease in horses and mules was 7,500,000, or 28 per cent of the number in 1918. Since 1920, the decrease has been 6,000,000, or 24 per cent of the number in 1920 (Table XXVIII). There has been an even more drastic decline in the number of city horses. In 1910, there were 3,453,000 horses and mules not on farms; in 1920, the number was 2,084,000.[11]

TABLE XXVIII

HORSES AND MULES ON FARMS IN THE UNITED STATES, 1918-29

| Year | Horses and horse colts | Mules and mule colts | Total |
|---|---|---|---|
| 1918 | 21,600,000 | 4,900,000 | 26,500,000 |
| 1919 | 21,500,000 | 5,000,000 | 26,500,000 |
| 1920 | 19,800,000 | 5,500,000 | 25,300,000 |
| 1921 | 19,100,000 | 5,600.000 | 24,700,000 |
| 1922 | 18,600,000 | 5,600,000 | 24,200,000 |
| 1923 | 17,900,000 | 5,700,000 | 23,600,000 |
| 1924 | 17,200,000 | 5,700,000 | 22,900,000 |
| 1925 | 16,500,000 | 5,700,000 | 22,200,000 |
| 1926 | 15,800,000 | 5,700,000 | 21,500,000 |
| 1927 | 15,100,000 | 5,700,000 | 20,800,000 |
| 1928 | 14,500,000 | 5,500,000 | 20,000,000 |
| 1929 | 14,000,000 | 5,400.000 | 19,400,000 |

* Annual Estimates of Livestock on Farms, U. S. Dept. of Agr.

[11] United States Census, 1920.

In 1929, horses have almost disappeared on the streets of many cities. It seems likely that the 1930 census will show only about 750,000 not on farms. The loss of a million horses is more important in the cities than on farms, as city horses are fed heavier.

### Farm Horses Are Fed Less Than Formerly

In addition to the decline in numbers, farm horses are fed less than formerly. Records for 158 farm years in New York, 1914-18 to 1922-26, show that the grain fed per horse decreased from 3,134 to 2,485 pounds, a decrease of 649 pounds per horse, or 21 per cent. The amount of hay fed decreased from 7,203 to 6,329 pounds, or 874 pounds,[12] a decrease of 12 per cent.

Accounting records for 60 farm years on southern Minnesota farms, 1904 to 1907,[13] showed a feed consumption per horse of 5,213 pounds of grain and 7,073 of roughage except straw. For 1920 to 1924, records for 110 farm years show that each horse consumed 3,015 pounds of grain and 4,835 pounds of roughage,[14] a decrease of 2,198 pounds of grain, or 42 per cent; and of 2,238 pounds of roughage, or 32 per cent. Farms co-operating with agricultural colleges in the keeping of cost records may have reduced their horse feed more than the average as they are more highly motorized, but they give some indication of the decided effect that the introduction of gasoline power for road travel and for some of the heavier farm work has had on the feed requirements of farm horses. The roughage is probably decreased in part because horses are pastured more now than formerly. To the extent that pasture replaces roughage, there may be no saving in the amount of land required to support a horse.

### Estimates of the Crop Land Released by Decreased Feed Requirements of Work Animals

In 1926 Warren and Pearson[15] prepared an estimate of the acres of crop land that would be required to support the horses and mules on farms and in cities in 1918 and 1926. They estimated that from 1919 to January 1, 1926, the reduction in horses and mules had released 18,000,000 crop acres, or 5 per cent of the 365,000,000 acres estimated to be in crops at the close of the war.[16] These estimates were based on the comparative percentages of crops fed to horses in 1919 and on the

[12] Harriott, J. F., Unpublished data of the Department of Agricultural Economics and Farm Management, New York State College of Agriculture.

[13] Cooper, T. P., The Cost of Keeping Horses. Minn. Agr. Ex. Div. Bull. 15, p. 11. 1911.

[14] Pond, G. A., A Study of Dairy Farm Organization in Southeastern Minnesota. Minn. Agr. Expt. Sta. Tech. Bull. 44, p. 38. 1926.

[15] Warren, G. F., and Pearson, F. A., Effect of the Gasoline Engine. Farm Economics, No. 31, New York State College of Agriculture, pp. 385-86.

[16] Yearbook of the United States Department of Agriculture, 1921, p. 430.

assumption that the reduction in horses had proportionately reduced the percentage of the crop required.

Baker,[17] in 1928, estimated that 15,000,000 acres of crop land had been released for other purposes by the decline in numbers of horses and mules between 1918 and 1928. Apparently, this estimate was prepared by estimating the crop land required to feed the horses and mules in 1919, and then assuming that the decline in numbers was proportionate to the decrease in acres needed for horse feed.

King[18] estimates that between 1920 and 1928 the decline in horses and mules released nearly 21,000,000 acres of crop land. He assumed that each horse or mule required 1⅓ acres of hay land, 1⅓ acres of oat land, ⅔ acre of corn land—a total of 3⅓ acres. The estimates of Warren and Pearson and of King agree closely. They did not estimate the number of crop acres released by the decreased amount of feed required for the horses that remain.

If the same method of calculation is used as that by Warren and Pearson[19] and the calculation is based on a 28 per cent reduction in the number of horses and mules from 1918 to January 1, 1929, the acres displaced would be nearly 22,000,000, or 6 per cent of the total.

If the decrease of 21 per cent in grain fed per horse on cost accounting farms in New York is applicable to all the horses and mules in the United States, then, using the same base data as Warren and Pearson,[20] the more than 6,000,000 additional acres were displaced from 1918 to

[17] Baker, O. E., Changes in production and consumption of our farm products and trend in population. Annals American Academy, 142:101. March, 1929.

[18] King, W. I., The Gasoline Engine and the Farmer's Income. Journal of Farm Economics, 11, No. 1:64-73.

[19] Warren, G. F., and Pearson, F. A., Effect of the Gasoline Engine. Farm Economics, No. 31, New York State College of Agriculture, 1926, footnote on page 385.

[20] Warren and Pearson based their estimate of acres of corn displaced by the reduced number of farm horses and mules, on the fact that 20 per cent of the corn crop in 1918 was estimated by the United States Department of Agriculture to have been fed to horses and mules on farms. If 72 per cent of the horses remain and were fed at the same rate, 14.4 per cent of the crop would have been fed in 1929, but if they were fed 21 per cent less, then 21 per cent of 14.4 per cent, or 3 per cent of 104,000,000 acres, or 3,120,000 acres of corn land would have been released by the decrease in the average horse ration.

These authors based their estimates of acres of oats displaced upon the Census Reports of 1909 and 1919, that 26 per cent of the oat crop was sold; and upon the estimate of the United States Department of Agriculture (Monthly Crop Reporter, August, 1919, p. 77) that 68 per cent of the oats fed on farms went to horses and mules. If 10 per cent of the total crop is allowed for seed, then 68 per cent of the 64 per cent fed on farms, would give 44 per cent eaten by farm horses and mules in 1919. A 28 per cent reduction in numbers of horses and mules would give 31.3 per cent of the crop fed to horses in 1929, if no reduction in the ration had occurred. Twenty-one per cent of 31.3 per cent would give 6.6 per cent of 44,000,000 acres displaced by the reduction in rations, or 2,900,000 acres.

If 10 per cent of the 1918 barley crop is estimated as eaten by farm horses and mules, 72 per cent of the 1918 number of horses and mules would eat 7.2 per cent of the crop, if no reduction in rations had occurred; with a 21 per cent reduction in ration, 21 per cent of 7.2 per cent would be 1.5 per cent of the 1918 barley acreage displaced by reduced rations. One and one-half per cent of the 9,700,000 acres raised in 1918, is 146,000 acres.

1929, a total reduction of 28,000,000 acres of crop land—nearly 8 per cent of the total. If an estimate of the acres displaced by reduced rations for the horses that remain is based on the 42 per cent reduction in grain fed, as reported in the Minnesota cost records, then more than 12,000,000 crop acres would be displaced and the total acres of grain displaced up to 1929 would be 34,000,000 or 9.3 per cent of the 365,000,000 acres. The last figure is doubtless too high, as Minnesota horses have always been fed more heavily than those in most other sections of the United States, hence a larger reduction in the ration was possible. In the estimates of feed saved by feeding less per animal, no account has been taken of the decreased hay fed, as it is impossible to tell how much of the reduction in hay is due to the use of more pasture and how much to the replacement of hay with straw. Also none of these estimates has taken account of the extra acres of pasture that would have been needed if the number of horses had been the same as in 1918.

It seems probable that about 28,000,000 acres are displaced by reduced numbers of horses and mules and by reduced rations for those that remain, or 8 per cent of the 365,000,000 acres in crops at the close of the war.

Evidently, the decreasing amount of feed required for horses and mules has been a more important factor in the agricultural depression than has been generally realized. Also, it is a factor that will operate for several years in the future, as a further material reduction in the number of horses and mules on farms is in prospect.

## THE TRACTOR AS A SOURCE OF FARM POWER

Gasoline and kerosene tractors were not an important source of farm power until about 1915. Reports from 225 farmers indicate that 9 per cent bought their first tractor prior to 1916; 30 per cent, between 1916 and 1920; 33 per cent, between 1921 and 1925; and 28 per cent, between 1926 and March 1, 1929.

Tractors on farms in the United States in 1925 were 208 per cent of the number in 1920 (Table XXIX). In 1920 there were 15,500 tractors in Minnesota. In spite of the agricultural depression, the number had increased by 78 per cent to 26,700 in 1925 and by 203 per cent to 31,500 in 1927. In 1920 there was one tractor to each 12 farms, in 1925, one to each 6 farms. This rapid increase in spite of the fact that horses were a drug on the market, and the leading horse feeds—corn, oats, and hay—were very cheap, indicates that the new type of power met a real need of many individuals, altho for farmers as a whole the displacement of horses was increasing the agricultural surplus.

## Increase Relatively Greater in Eastern States Than West of the Mississippi

While the increase in the number of tractors in Minnesota has been surprisingly rapid since 1920, it has been even more rapid in the eastern states. Between 1920 and 1925, the increase per 100 farms was 340 per cent in the New England states, 361 per cent in the Middle Atlantic group, 257 per cent in the East North Central, and only 163 per cent in the West North Central states. In Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Michigan, Ohio, Wisconsin, West Virginia, North Carolina, and Florida, the increase was more than 300 per cent (Table XXIX). The North Central states west of the Mississippi are conspicuous by their absence from the list.

TABLE XXIX

NUMBER OF TRACTORS PER 100 FARMS, 1920 AND 1925*

| State or region | Tractors per 100 farms† | | Increase from 1920 to 1925 |
|---|---|---|---|
| | 1920 | 1925 | |
| | | | Per cent |
| United States | 3.8 | 7.9 | 208 |
| New England | 1.5 | 5.1 | 340 |
| Middle Atlantic | 3.3 | 11.9 | 361 |
| East North Central | 5.4 | 13.9 | 257 |
| West North Central | 8.9 | 14.5 | 163 |
| South Atlantic | 1.0 | 2.8 | 280 |
| East South Central | 0.5 | 1.4 | 280 |
| West South Central | 2.0 | 3.4 | 170 |
| Mountain | 7.2 | 8.5 | 118 |
| Pacific | 8.4 | 15.1 | 180 |
| New England | | | |
| Maine | 1.3 | 3.5 | 269 |
| New Hampshire | 1.0 | 2.5 | 250 |
| Vermont | 1.5 | 5.6 | 373 |
| Massachusetts | 1.8 | 6.6 | 367 |
| Rhode Island | 1.9 | 8.1 | 426 |
| Connecticut | 1.9 | 6.2 | 326 |
| Middle Atlantic | | | |
| New York | 3.9 | 13.6 | 349 |
| New Jersey | 3.2 | 14.8 | 462 |
| Pennsylvania | 2.8 | 9.9 | 354 |
| East North Central | | | |
| Ohio | 4.1 | 12.6 | 307 |
| Indiana | 4.5 | 12.0 | 267 |
| Illinois | 9.7 | 19.2 | 198 |
| Michigan | 3.0 | 10.0 | 333 |
| Wisconsin | 5.0 | 15.3 | 306 |
| West North Central | | | |
| Minnesota | 8.7 | 14.2 | 163 |
| Iowa | 9.5 | 17.4 | 183 |
| Missouri | 3.0 | 4.9 | 163 |
| North Dakota | 16.7 | 23.0 | 138 |
| South Dakota | 17.3 | 21.9 | 127 |
| Nebraska | 8.9 | 14.6 | 164 |
| Kansas | 10.3 | 18.8 | 183 |

TABLE XXIX—*Continued*

NUMBER OF TRACTORS PER 100 FARMS, 1920 AND 1925*

| State or region | Tractors per 100 farms† | | Increase from 1920 to 1925 |
|---|---|---|---|
| | 1920 | 1925 | |
| | | | Per cent |
| South Atlantic | | | |
| Delaware | 2.4 | 6.8 | 283 |
| Maryland | 3.2 | 8.2 | 256 |
| Virginia | 1.3 | 3.5 | 269 |
| West Virginia | 0.7 | 2.1 | 300 |
| North Carolina | 0.8 | 2.8 | 350 |
| South Carolina | 0.7 | 1.7 | 243 |
| Georgia | 0.7 | 1.7 | 243 |
| Florida | 1.3 | 4.7 | 362 |
| East South Central | | | |
| Kentucky | 0.8 | 1.9 | 238 |
| Tennessee | 0.7 | 1.9 | 271 |
| Alabama | 0.3 | 1.0 | 333 |
| Mississippi | 0.3 | 0.7 | 233 |
| West South Central | | | |
| Arkansas | 0.8 | 1.6 | 200 |
| Louisiana | 2.1 | 2.6 | 124 |
| Oklahoma | 3.2 | 5.6 | 175 |
| Texas | 2.1 | 3.6 | 171 |
| Mountain | | | |
| Montana | 13.3 | 14.1 | 106 |
| Idaho | 3.8 | 4.7 | 124 |
| Wyoming | 6.8 | 8.5 | 125 |
| Colorado | 8.3 | 11.5 | 139 |
| New Mexico | 1.6 | 2.9 | 181 |
| Arizona | 9.3 | 11.5 | 124 |
| Utah | 2.3 | 3.3 | 143 |
| Nevada | 6.6 | 5.7 | 14‡ |
| Pacific | | | |
| Washington | 4.0 | 6.1 | 152 |
| Oregon | 6.1 | 10.3 | 169 |
| California | 11.8 | 21.6 | 183 |

* Based on United States census reports.

† This is not quite the same as per cent of farms having tractors as a few farms reported more than one tractor.

‡ A decrease.

If the importance of tractors is measured by the number in proportion to the number of farms in 1925, tractors were most numerous in the Pacific Coast states, where there were 15.1 to each 100 farms. The West North Central states were second with 14.5 (Table XXIX). North Dakota had 23 tractors to each 100 farms, or more than any other state; South Dakota was second with 22 to each 100 farms. The Southern states had the fewest tractors, the number varying from less than one to each 100 farms in Mississippi to 8.2 in Maryland (Table XXIX).

The relative proportion of the total farm work done by tractors may be measured by the number of horses per tractor. A larger proportion of the farm work is done with tractors in the East-

ern states than in the Central West, as is indicated by the fewer horses per tractor in the East. In 1925, in the United States, there were 41 horses and mules two years old and older for each tractor. Mississippi had 236, California 12, New Jersey 14, New York 17, Ohio 20, Wisconsin 20, Iowa 30, North Dakota 39, South Dakota 38, and Nebraska 48, compared to 30 in Minnesota. The number of horses per tractor decreased from 123 to 33 in the New England states, from 79 to 19 in the Middle Atlantic states, and from 66 to 39 in the West North Central states (Table XXX). Whether the increase of tractors is measured by the number in proportion to the number of farms or in proportion to the number of horses it was much more pronounced in the Eastern states than in the Central states west of the Mississippi. The tractor is most widely used in orchard regions. In Niagara County, New York, a leading fruit county, there are only 5.6 horses per tractor. The Eastern states have fewer horses per tractor in spite of the facts that they have a much larger proportion of farms with a small acreage of crops, and that hay constitutes a much larger proportion of the total crop acreage.

TABLE XXX

HORSES AND MULES TWO YEARS OLD AND OLDER PER TRACTOR, 1920 TO 1925

| State or region | Horses and mules per tractor | | Decrease |
|---|---|---|---|
| | 1920 | 1925 | |
| | | | Per cent |
| United States | 88 | 41 | 53 |
| New England | 123 | 33 | 73 |
| Middle Atlantic | 79 | 19 | 76 |
| East North Central | 68 | 23 | 66 |
| West North Central | 66 | 39 | 41 |
| South Atlantic | 179 | 58 | 68 |
| East South Central | 381 | 138 | 64 |
| West South Central | 171 | 99 | 42 |
| Mountain | 97 | 85 | 12 |
| Pacific | 47 | 20 | 57 |
| New England | | | |
| Maine | 143 | 46 | 68 |
| New Hampshire | 177 | 59 | 67 |
| Vermont | 169 | 40 | 77 |
| Massachusetts | 83 | 20 | 76 |
| Rhode Island | 81 | 17 | 79 |
| Connecticut | 86 | 24 | 76 |
| Middle Atlantic | | | |
| New York | 69 | 17 | 75 |
| New Jersey | 81 | 14 | 83 |
| Pennsylvania | 92 | 23 | 75 |
| East North Central | | | |
| Ohio | 73 | 20 | 72 |
| Indiana | 78 | 26 | 66 |
| Illinois | 54 | 26 | 52 |
| Michigan | 97 | 25 | 75 |
| Wisconsin | 67 | 20 | 71 |

TABLE XXX—*Continued*
HORSES AND MULES TWO YEARS OLD AND OLDER PER TRACTOR, 1920 TO 1925

| State or region | Horses and mules per tractor | | Decrease |
|---|---|---|---|
| | 1920 | 1925 | |
| | | | Per cent |
| West North Central | | | |
| Minnesota | 54 | 30 | 53 |
| Iowa | 62 | 30 | 48 |
| Missouri | 132 | 77 | 42 |
| North Dakota | 55 | 39 | 29 |
| South Dakota | 52 | 38 | 27 |
| Nebraska | 79 | 48 | 39 |
| Kansas | 62 | 35 | 44 |
| South Atlantic | | | |
| Delaware | 146 | 40 | 70 |
| Maryland | 104 | 34 | 67 |
| Virginia | 156 | 51 | 67 |
| West Virginia | 293 | 80 | 73 |
| North Carolina | 181 | 51 | 72 |
| South Carolina | 222 | 84 | 62 |
| Georgia | 220 | 96 | 57 |
| Florida | 112 | 25 | 78 |
| East South Central | | | |
| Kentucky | 296 | 114 | 61 |
| Tennessee | 307 | 118 | 62 |
| Alabama | 606 | 155 | 74 |
| Mississippi | 721 | 236 | 67 |
| West South Central | | | |
| Arkansas | 285 | 145 | 49 |
| Louisiana | 118 | 84 | 29 |
| Oklahoma | 142 | 82 | 42 |
| Texas | 182 | 104 | 43 |
| Mountain | | | |
| Montana | 67 | 78 | 15* |
| Idaho | 153 | 111 | 27 |
| Wyoming | 137 | 129 | 6 |
| Colorado | 72 | 54 | 24 |
| New Mexico | 342 | 173 | 49 |
| Arizona | 132 | 85 | 36 |
| Utah | 174 | 117 | 33 |
| Nevada | 173 | 204 | 18* |
| Pacific | | | |
| Washington | 104 | 55 | 47 |
| Oregon | 77 | 38 | 50 |
| California | 31 | 12 | 61 |

* Increase.

## Factors Favoring the More Rapid Increase of Tractors in the East

The leading factor in the more rapid shift to tractors in the East than in the Central West has probably been the difference in relative prosperity of the two regions. Between 1915 and 1920 the rapid rise in prices favored farmers in the interior more than those in the East as the rise in freight rates and handling charges lagged behind the rise in grain and livestock prices. With deflation, the situation was reversed. The prices of grain and livestock decreased promptly, freight rates declined relatively little, and the cost of distributing food in

April, 1929, was 202 per cent of the cost in 1910-14 and the same as the average for 1920.[21] Changes in freight and distribution charges have the greater effect on the farm price of products the farther from market they are produced.

As a result of the greater decrease of prices in the Central West than in the East, the cost of horse labor in Minnesota, 1921-26, was only 59 per cent of that in New York State as compared to 73 per cent in 1914-17 (Table XXXI). Therefore, in addition to the greater shortage of capital, horses in the Central West were better able to compete with tractors, as compared to those in the East, than they were in 1914-17.

TABLE XXXI

COMPARATIVE COST OF HORSE LABOR PER HOUR, NEW YORK AND MINNESOTA*

| | Cost of horse labor per hour | | Per cent Minnesota is of New York |
|---|---|---|---|
| | New York† | Minnesota‡ | |
| Cost per hour, 1914-17 | $0.169 | $0.124 | 73 |
| Cost per hour, 1921-26 | $0.179 | $0.105 | 59 |
| Hours per horse, 1914-17 | 978 | 947 | 97 |
| Hours per horse, 1921-26 | 873 | 817 | 94 |

* The costs per hour and hours per horse per year are simple averages of the yearly cost records.

† Published and unpublished data by Harriott, J. F., Dept. of Agr. Econ. and Farm Mgt. New York State College of Agriculture.

‡ Minnesota data for 1921-26 were compiled from the following mimeographed reports published by the College of Agriculture, University of Minnesota:

Pond, G. A., Preliminary Report of the Steele County Statistical Route, 1925.

Pond, G. A., Preliminary Report of the Cottonwood- Jackson County Statistical Route, 1925.

Hoverstad, T. A., A Preliminary Report of the Farm Accounting Route at Askov, Pine County, 1928.

During the period of deflation, wages of farm labor decreased more in the West North Central states than in the Eastern states. This made it more necessary for the latter to save labor than for the former. The average April, July, and October wages of month labor with board, in the North Atlantic states in 1924-25[22] was $46.19; in the West North Central states, $41.86. For 1916-18, inclusive, the yearly wage per month with board was $28.10 in the North Atlantic states and $31.09 in the West North Central states. In the earlier period, wages were 11 per cent higher in the West North Central states. In 1924-26, the situation was reversed—wages being 10 per cent higher in the North Atlantic states.

Most eastern farmers have never used teams of 4 or 6 horses, so the high wages made tractors more worth while for them than for farmers who were accustomed to use 4 or more horses per team.

[21] New York State College of Agriculture, Farm Economics, p. 1097. June, 1929.

[22] Compiled from Monthly Crop Reporter, U. S. Dept. of Agr.

## Distribution of Tractors in Minnesota

Tractors are most numerous in the southwestern part of Minnesota and in the prairie sections of the Red River Valley (Fig. 2). In Kittson, Marshall, and Polk counties the percentage of tractors for the prairie portions is above the average for the county.

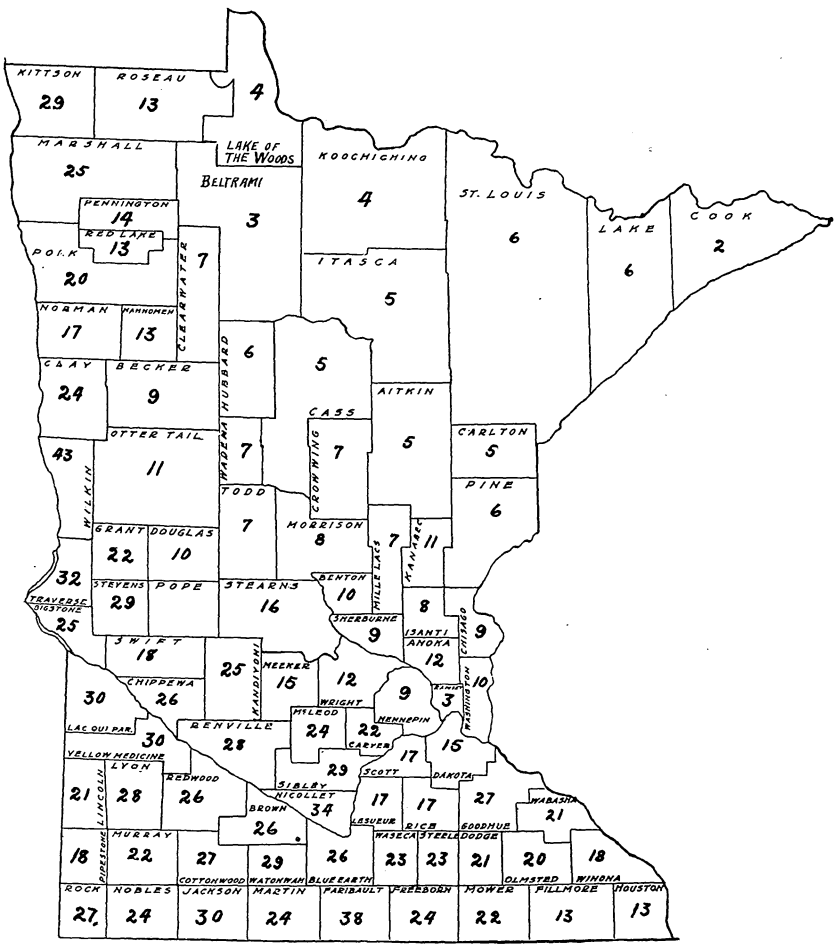


Fig. 2. Tractors per 100 Farms in Minnesota, Based on the 1927 State Census of Agriculture
Tractors are most numerous in southern and western Minnesota.

## Makes of Tractors

Of the 245 farmers owning tractors, 8 reported 2 tractors per farm, and 2 reported 3 tractors per farm, a total of 257 tractors. These are nearly all of the small or medium-size type, pulling 2-, 3-, or 4-plow bottoms. Only four tractors were reported with a rating of 20-40

horse-power or more (Table XXXII). Nineteen manufacturers are represented, but two firms made 71 per cent of the tractors.

TABLE XXXII

MAKES OF TRACTORS ON 245 MINNESOTA FARMS, 1929

| Make of tractor | Rated horse-power | Number |
|---|---|---|
| Fordson | ..... | 89 |
| McCormick-Deering | 15–30 | 29 |
| McCormick-Deering | 10–20 | 28 |
| Farm All | ..... | 15 |
| International Titan | 10–20 | 14 |
| Waterloo Boy | 12–25 | 10 |
| John Deere | 15–27 | 10 |
| Case | 15–27 | 8 |
| Rumley Oil Pull | 20–30 | 7 |
| Moline | 9–18 | 6 |
| Hart Parr | 15–30 | 4 |
| Case | 10–18 | 3 |
| International | 8–16 | 3 |
| Samson | 10–20 | 3 |
| Case | 20–40 | 2 |
| Cletrac | 12–20 | 2 |
| Twin City | 12–20 | 2 |
| Avery | 8–16 | 1 |
| Avery | 12–25 | 1 |
| Avery | 45–65 | 1 |
| Bates Steele Mule | ..... | 1 |
| John Deere | 10–20 | 1 |
| Hart Parr | 12–24 | 1 |
| Heider | 12–20 | 1 |
| Heider | 18–35 | 1 |
| Huber | 18–36 | 1 |
| Huber | 25–50 | 1 |
| Minneapolis | 17–30 | 1 |
| Russell | 20–40 | 1 |
| Twin City | 17–28 | 1 |
| Wallis | 15–25 | 1 |
| Wallis | 20–30 | 1 |
| Not reported | ..... | 7 |
| Total | | 257 |

## Type of Work Done by Tractors

Among 233 farmers reporting in detail the work done with tractors, 94 per cent used them for drawbar work and 88 per cent for belt work. Fifteen farmers used them only for belt work, and 29 only for drawbar work. Drawbar work amounted to 29.4 days, belt work 16.0, and custom work 4.2—making a total of 49.6 days per farm (Table XXXIII). The average working day was reported as 9.7 hours, making a total use of 481 hours per year.

Of these 233 farms, 93 per cent reported using tractors for plowing; 62 per cent for disking, 51 per cent for spring-tooth harrowing, and 21 per cent for dragging with the spike-tooth drag. Only 3 per cent used tractors for drilling (Table XXXIII).

Twenty-three per cent used tractors for cutting small grain and flax, one per cent for pulling the combine. Very few combines have been used in Minnesota (Table XXXIII).

Practically all the farmers raise hay but only one per cent cut it with a tractor. Sixteen per cent used the tractor to pull the mechanical corn picker for an average of eleven days. As corn pickers are not common outside of southwestern Minnesota, the figures indicate a decided tendency to use a tractor if one is operated. Nearly all these farmers raise

TABLE XXXIII

KIND AND AMOUNT OF WORK PER FARM PERFORMED WITH TRACTORS, 233 MINNESOTA FARMS, 1928*

| Type of work | Days per farm for all farms with tractors | Days per farm on farms using tractor for specific operations | Percentage of farms using tractor for specific operations |
|---|---|---|---|
| Drawbar work on home farm | | | |
| Plowing | 16.2 | 17.3 | 93 |
| Disking | 3.8 | 5 9 | 62 |
| Spring-tooth harrowing | 2.9 | 5.7 | 51 |
| Spike-tooth dragging | 0.8 | 3.6 | 21 |
| Duck-foot cultivating | 0.2 | 8.8 | 2 |
| Drilling | 0.3 | 8.1 | 3 |
| Cutting grain | 1.6 | 5.1 | 23 |
| Combining | 0.1 | 9.5 | 1 |
| Cutting hay | 0.1 | 8.7 | 1 |
| Picking corn | 1.7 | 10.9 | 16 |
| Digging potatoes | 0.1 | 2.9 | 5 |
| Pulling stumps | † | 1.8 | 3 |
| Cultivating corn | 0.9 | 18.9 | 5 |
| Cultivating potatoes | 0.0 | 1.0 | 0 |
| Miscellaneous | 0.7 | 4.4 | 17 |
| Total drawbar work and percentage using tractors for drawbar work | 29.4 | ... | 94 |
| Belt work on home farm† | | | |
| Grinding feed | 6.2 | 9.6 | 65 |
| Threshing | 4.7 | 12.2 | 38 |
| Filling silo | 2.6 | 4.3 | 60 |
| Sawing wood | 1.1 | 2.4 | 47 |
| Shredding corn | 0.7 | 5.1 | 5 |
| Shelling corn | 0.4 | 4.5 | 9 |
| Bailing hay | 0.2 | 14.5 | 2 |
| Miscellaneous | 0.1 | ... | .. |
| Total belt work and percentage using tractors for belt work | 16.0 | ... | 88 |
| Custom work‡ | 4.2 | ... | .. |
| Total days of work | 49.6 | ... | .. |

* Of 245 farms reporting tractors, 233 reported the amount and kind of work done with them.

† Less than one-tenth of a day. Six farmers pulled stumps for a total of eleven days.

‡ The records indicate that a certain amount of threshing, silo-filling, and other belt work done for neighbors was included as work on the home farm rather than as custom work. This was due to failure of the questionnaire to specify that all work done away from the home farm should be regarded as custom work.

some corn, but only 5 per cent used the tractor for cultivating it. The great majority of these farmers use the tractor chiefly for plowing, spring-tooth harrowing, and disking (Table XXXIII).

Grinding feed was the most frequent type of belt work, 65 per cent using tractors an average of 9.6 days for grinding feed. Sixty per cent used tractors for filling silos, 38 per cent for threshing. The average time for the latter was 12.2 days compared to 4.3 days for silo-filling. Wood-sawing was done with tractors by 47 per cent. As many of these farms are in prairie sections, wood-sawing is done with tractors on nearly all farms having any worth-while quantity of wood to saw (Table XXXIII).

All studies of farm tractors indicate that a large proportion of the drawbar hours are used for plowing and other heavy operations connected with the preparation of the seedbed. This has not changed greatly since tractors were first used in a large way. A study of 145 farm tractors in Minnesota, in 1918, showed 34.3 days of drawbar use.[23] Of these 23.2 days, or 68 per cent of the total, were devoted to plowing. In 1929 the figure was 55 per cent. The lower per cent for plowing in 1929 is largely accounted for by the average use of the tractor for 3.3 days in 1929 for picking corn and cutting grain. Practically no use was made of the tractor for these purposes in 1918.

A study of farm tractors in New York State[24] in 1919 reported that 42 per cent of the drawbar hours were devoted to plowing. Plowing, harrowing, and disking combined made up 87 per cent. In this study, plowing, harrowing, disking, and dragging were 81 per cent of the drawbar days.

A recent study[25] in a general farming region in New York State reports that 96 per cent of the drawbar work on the home farm was made up of plowing and seedbed preparation.

The 49.6 days, or 481 hours, of use per farm for 233 farms in Minnesota, is more than is reported for any study that has come to the author's attention except one in the Dakotas[26] in 1919. There the average, tho not given, was apparently slightly more than 50 days. The crop acres per farm were not given, but the data indicate that the farms averaged more than 300 acres. The study in Minnesota in 1918 showed an average use of 48 days. The farms included in that study averaged 305 acres. The crop acres per farm are not given, so a close com-

[23] Patterson, C. D., Mowry, J. L., and Cavert, W. L., Shall I Buy a Tractor? Minn. Agr. Ext. Special Bull. 31, p. 6. 1918.

[24] Myers, W. I., An Economic Study of Farm Tractors in New York, (Cornell) Expt. Sta. Bull. 405, p. 89. 1921.

[25] Gilbert, C. W., An Economic Study of Tractors and Motor Trucks on New York Farms, an unpublished manuscript, Cornell University Library, p. 63. 1929.

[26] Yerkes, A. P., and Church, L. M., The Farm Tractor in the Dakotas. U. S. Dept. Agr. Farmers Bull. 1035, p. 15. 1919.

parison is impossible, but apparently for farms of the same size there were in 1929 about 7 days more of belt and custom work. The drawbar work was about the same as in 1918. At the time of the earlier study, the bulk of the threshing was still done with steam tractors; it is now largely done with gas tractors, so a portion of the increased use for belt work may be attributed to the 4.7 days of threshing reported in 1929.

Twenty-one per cent reported that the tractor was kept principally for drawbar work; 15 per cent for belt work; and 64 per cent for both. Those keeping the tractor principally for drawbar work obtained 45.6 days of use; those keeping it principally for belt work, 39.8 days, and those for both, 52.9 days (Table XXXIV).

TABLE XXXIV

NUMBER OF FARMS REPORTING WHETHER TRACTOR IS KEPT PRIMARILY FOR FIELD WORK, BELT WORK, OR BOTH, 206 MINNESOTA FARMS, 1929

| Chief purpose for keeping tractor | No. of farms | Crop acres per farm | Drawbar work, days | Belt work, days | Custom work, days | Total work, days |
|---|---|---|---|---|---|---|
| Drawbar work | 43 | 179 | 37.6 | 4.3 | 3.7 | 45.6 |
| Belt work | 30 | 156 | 11.2 | 21.8 | 6.8 | 39.8 |
| Both | 133 | 199 | 32.1 | 17.7 | 3.1 | 52.9 |

## Effect of Size of Farm on Use of Tractors

On farms of similar type, the work available for tractors depends largely on the acres of crops per farm. On farms with 50 to 99 crop acres, the days of use per tractor were 27.8; with 100 to 199 crop acres, 46.7; and with 200 or more crop acres it was 69.1 days. Increasing the crop acres from 79 to 320 increased the days of tractor work per farm about two and a half times (Table XXXV).

TABLE XXXV

EFFECT OF SIZE OF FARM ON USE OF TRACTORS, 218 MINNESOTA FARMS USING TRACTORS FOR DRAWBAR WORK, 1928

| Crop acres per farm | No. of farms | Crop acres per farm | Tractor hours per year | Days of use per year on home farm | | | | Average hours used per day |
|---|---|---|---|---|---|---|---|---|
| | | | | Tractor | Belt | Custom | Total | |
| 49 and less | 5 | 35 | 461 | 14.0 | 9.8 | 31.6 | 55.4 | 8.3 |
| 50–99 | 26 | 79 | 258 | 16.2 | 9.1 | 2.5 | 27.8 | 9.3 |
| 100–199 | 121 | 151 | 441 | 28.4 | 15.7 | 2.6 | 46.7 | 9.4 |
| 200–740 | 66 | 320 | 708 | 44.5 | 20.5 | 4.1 | 69.1 | 10.2 |
| Total or av. | 218 | 190 | 501 | 31.5 | 16.2 | 3.7 | 51.4 | 9.7 |

If all reports were from farms having a similar type of farming, the tractor work per farm would be more nearly proportioned to the crop acres. On farms with 50 to 99 crop acres, 22 per cent used a tractor for drawbar work; with 100 to 149 crop acres, 42 per cent; with 150 to 199 crop acres, 58 per cent; and with 200 or more crop acres,

65 per cent. Apparently, it is only on farms of 100 or more crop acres that the tractor has a large place for doing field work (Table XXXVI).

TABLE XXXVI

COMPARISON OF NUMBER OF FARMS OF VARIOUS SIZES HAVING TRACTORS, DOING DRAWBAR WORK, WITH NUMBER OF FARMS NOT HAVING TRACTORS OR USING TRACTORS ONLY FOR BELT WORK, 525 MINNESOTA FARMS, 1929

| | Crop acres per farm | | | | | Total |
|---|---|---|---|---|---|---|
| | 49 and less | 50–99 | 100–149 | 150–199 | 200–740 | |
| | No. of farms | No. of farms | No. of farms | No. of farms | No. of farms | No. of farms |
| Farms using tractors for drawbar work | 5 | 26 | 60 | 61 | 66 | 218 |
| Farms not using tractors for drawbar work | 50 | 94 | 84 | 44 | 35 | 307 |
| Total | 55 | 120 | 144 | 105 | 101 | 525* |
| Per cent of farms using tractors | 9 | 22 | 42 | 58 | 65 | 41 |

* Total does not equal 538, as farms not reporting the detailed use of the tractor were not included.

## Variations in Amount of Drawbar Work

There is a wide variation in the days of drawbar use per tractor. Of 218 farms, 30.7 per cent used it for less than 20 days; 53.3 per cent 20 to 50 days; and 16 per cent 50 to 125 days. The farms having the most use were about four times as large as those having the least use.

The days of tractor drawbar work per horse varied from 1.1 in the group using the tractor for nine or less drawbar days to 11.9 for those using the tractor for 100 to 125 days of drawbar work. The crop acres per horse varied from 21.4 to 52.4 (Table XXXVII).

TABLE XXXVII

RELATION OF AMOUNT OF TRACTOR DRAWBAR WORK PER FARM TO TRACTOR DRAWBAR DAYS PER HORSE KEPT AND CROP ACRES PER HORSE, 218 MINNESOTA FARMS, 1929

| Drawbar work, days | No. of farms | Per cent of farms | Tractor drawbar work, days | Crop acres per farm | No. of horses per farm | Tractor drawbar days per horse kept | Crop acres per horse |
|---|---|---|---|---|---|---|---|
| 0– 9 | 16 | 7.3 | 5.9 | 119 | 5.6 | 1.1 | 21.4 |
| 10– 19 | 51 | 23.4 | 14.5 | 137 | 5.5 | 2.7 | 25.2 |
| 20– 29 | 50 | 23.0 | 24.1 | 170 | 5.7 | 4.1 | 29.1 |
| 30– 39 | 39 | 17.9 | 33.7 | 191 | 6.0 | 5.6 | 31.9 |
| 40– 49 | 27 | 12.4 | 43.2 | 224 | 6.2 | 6.9 | 36.0 |
| 50– 59 | 18 | 8.2 | 53.9 | 216 | 5.5 | 9.8 | 39.2 |
| 60– 99 | 13 | 6.0 | 70.3 | 371 | 7.1 | 9.9 | 52.4 |
| 100–125 | 4 | 1.8 | 116.5 | 476 | 9.8 | 11.9 | 48.8 |
| Total or average | 218 | 100.0 | 31.5 | 190 | 5.9 | 5.3 | 32.2 |

A part of the difference in crop acres per horse may be attributed to the fact that the farms having the most days of tractor drawbar work

were also larger. However, there is a wide diversity in the practice of farmers in regard to apportioning the work between tractors and horses. A considerable portion evidently use the tractor chiefly as a means of assisting the horses with the peak load in plowing and seed-bed preparation, while a few do everything with a tractor to which it is adapted.

### The Tractor in Relation to Displacement of Farm Horses

Farmers are finding that tractors can replace a much larger percentage of the horses on large farms than on small farms, because motor power has not displaced horses to any extent for mowing and raking hay, cultivating row crops, and hauling to and from the fields. Twenty-three farms having 50 to 99 crop acres, used only 0.2 horse less than would be required without a tractor; 106 farms having 100 to 199 crop acres used 1.9 horses less; those having 200 crop acres and more used 2.7 horses less. The average number of horses displaced per farm was 2 (Table XXXVIII).

The 23 farmers having 50 to 99 crop acres reported that the total displacement per farm is expected to be 0.9 of a horse by 1934; the 106 having 100 to 199 crop acres, 2.7 horses; and the 61 farmers having 200 crop acres and more, 4.7 horses. On the basis of these estimates the average displacement by 1934 will be 1.1 horses per farm in addition to the 2.0 already displaced (Table XXXVIII).

TABLE XXXVIII

NUMBER OF HORSES PER FARM, THREE YEARS OLD AND OLDER, REQUIRED WITHOUT TRACTOR, NUMBER ON HAND, MARCH, 1929, AND NUMBER THAT OPERATORS EXPECT TO USE IN 1934—195 MINNESOTA FARMS HAVING TRACTORS THAT ARE USED FOR DRAWBAR WORK

| Crop acres per farm | No. of farms | Av. crop acres per farm | No. of horses per farm | | | Decrease in horses per farm | | |
|---|---|---|---|---|---|---|---|---|
| | | | No. required without tractors | No. on hand March, 1929 | No. expected in 1934 | To March, 1929 | Expected further decrease to 1934 | Total displacement |
| 49 and less .. | 5* | 35 | 2.8 | 2.4 | 2.2 | 0.4 | 0.2 | 0.6 |
| 50– 99..... | 23 | 74 | 4.3 | 4.1 | 3.4 | 0.2 | 0.7 | 0.9 |
| 100–199..... | 106 | 153 | 7.3 | 5.4 | 4.6 | 1.9 | 0.8 | 2.7 |
| 200 and more.. | 61 | 319 | 10.6 | 7.9 | 5.9 | 2.7 | 2.0 | 4.7 |
| Total or av. | 195 | 192 | 7.9 | 5.9 | 4.8 | 2.0 | 1.1 | 3.1 |

* Not enough farms to be significant.

This total is 21 per cent of the number required without a tractor on farms having 50 to 99 crop acres; 37 per cent on those having 100 to 199 crop acres; and 44 per cent on those having 200 or more crop acres. The average is 39 per cent, of which 25 per cent have already been displaced.

In 1921 Tolley and Humphries[27] found that in the winter wheat belt of Oklahoma, Kansas, and Nebraska, on 354 farms, the number of horses and mules per farm was 8.3 compared to 11.7 that would be required without a tractor, a displacement by the tractor of 3.4 animals. These farmers estimated the necessary number of work animals per farm as 6.5, a total possible reduction of 5.2 horses per farm, or 45 per cent. The average crop area in these farms was 349 acres. This large displacement was probably due to the large size of the farms included in the study.

In Minnesota[28] in 1918, a farm tractor displaced 1.9 horses and 31 additional acres were being farmed, a displacement of about 2.9 horses compared to the 2.7 already displaced on the farms in this study having approximately the same acreage. In New York State Myers[29] reports that on 220 farms in 1919, 2.4 horses were displaced; Gilbert[30], in 1926, found the number to be 1.8 per farm.

There is no evidence of any increase in the number of horses saved by a tractor in Minnesota between 1918 and 1929, or that the number displaced in New York State was more in 1926 than in 1919, but the shortage of horses and the use of tractors that are better adapted to harvesting and to cultivating row crops will cause a further displacement in the future.

TABLE XXXIX

RELATION OF SIZE OF FARMS WITH AND WITHOUT TRACTORS USED FOR DRAWBAR WORK TO NUMBER OF HORSES, 525 MINNESOTA FARMS, 1929

| Crop acres per farm | Tractor for drawbar work | No. of farms | Crop acres per farm | Horses three years old and older per farm | Crop acres per horse | Horses per 100 crop acres | Horses used per team for heavy work* |
|---|---|---|---|---|---|---|---|
| 49 and less | Used | 5 | 35 | 2.4 | 14.8 | 6.8 | 2.2 |
| | Not used | 50 | 34 | 2.5 | 13.8 | 7.2 | 2.4 |
| 50– 99 | Used | 26 | 79 | 4.0 | 19.9 | 5.0 | 3.1 |
| | Not used | 94 | 75 | 4.0 | 18.8 | 5.3 | 3.3 |
| 100–149 | Used | 60 | 126 | 4.6 | 27.3 | 3.7 | 3.6 |
| | Not used | 84 | 121 | 5.7 | 21.1 | 4.7 | 3.7 |
| 150–199 | Used | 61 | 176 | 6.3 | 28.0 | 3.6 | 3.8 |
| | Not used | 44 | 174 | 7.6 | 22.9 | 4.4 | 3.9 |
| 200–740 | Used | 66 | 318 | 7.8 | 40.9 | 2.5 | 4.0 |
| | Not used | 35 | 263 | 9.0 | 29.3 | 3.4 | 4.0 |
| Total or average | Used | 218 | 190 | 5.9 | 32.2 | 3.1 | 3.7 |
| | Not used | 307 | 116 | 5.3 | 22.0 | 4.5 | 3.4 |

* Usual number of horses driven per team for heavy operations—plowing, disking, dragging, spring-tooth harrowing, cutting grain, and hauling manure.

[27] Tolley, H. R., and Humphries, W. R., Tractors and Horses in the Winter Wheat Belt, Oklahoma, Kansas, Nebraska. U. S. Dept. Agr. Bull. 1202, p. 45. 1921.

[28] Patterson, C. D., Mowry, J. L., and Cavert, W. L., Shall I Buy a Tractor? Minn. Agr. Ext. Div., Special Bull. 31, p. 5. 1918.

[29] Myers, W. I., An Economic Study of Tractors in New York, Cornell Bull. 405, p. 105. 1921.

[30] Gilbert, C. W., An Economic Study of Tractors and Motor Trucks on New York Farms, p. 107. 1929. An unpublished thesis in the library of Cornell University.

The displacement of horses by tractors is greater if based on the estimates of farmers who use tractors for drawbar work than if based on the actual difference between the number of horses on farms with and without tractors (Table XXXIX). This is true of all groups of farms except those having 200 crop acres or more.

Of farms having 50 to 99 crop acres, the farms without tractors had 4.0 horses. Of farms having 100 to 149 crop acres, those with tractors had 4.6 horses and those without 5.7, a difference of 1.1 horses. Of the group having 150 to 199 crop acres, those with tractors had 6.3 horses, those without, 7.6, a difference of 1.3 horses. Of the group having 200 and more crop acres, those with tractors had 7.8, those without 9.0, a difference of 1.2 horses. The last group had 55 more crop acres (Table XXXIX), making a total displacement of about 3 horses on farms of 200 or more crop acres. The difference in the number of horses displaced is based on estimates of tractor users and on the number of horses used by a similar group without tractors.

Farms with tractors have a surplus of 0.21 horse per farm; those without needed 0.35 horse. Of 241 farms with tractors and having 1,442 horses, there was an average surplus of 3.4 per cent of the number on hand. On 261 farms not using tractors and having 1,394 horses, there was a shortage of 2.6 per cent (Table XL). Of the farms with tractors, 24 per cent reported a surplus of horses; of those without, 9 per cent. Of those having tractors, 11 per cent reported a shortage of horses; of those without, 20 per cent.

TABLE XL

SURPLUS OR DEFICIENCY OF HORSES ON FARMS WITH OR WITHOUT TRACTORS
502 MINNESOTA FARMS, MARCH, 1929

| Farms | No. of farms | Per cent of farmers reporting | | No. of horses three years old and older | | | Per cent of total no. of horses | |
|---|---|---|---|---|---|---|---|---|
| | | Surplus of horses | Deficiency of horses | Total horses | No. horses on hand not needed | No. additional horses needed | Surplus | Deficiency |
| With tractors ..... | 241* | 24 | 11 | 1442 | 51 | .. | 3.4 | .. |
| Without tractors.... | 261 | 9 | 20 | 1394 | .. | 36 | .. | 2.6 |
| Total or per cent.. | 502 | 16 | 16 | 2836 | 15 | .. | 0.5 | .. |

* In this group, 241 farms used tractors. In groups discussed in previous tables there were fewer because among 245 tractor owners, 241 reported as to a surplus or deficiency of horses; and a smaller number answered the other questions pertaining to tractors.

## Do Farms With Tractors Use Cheaper Horses?

There is no great difference in age, weight, or value of horses between farms with tractors and those without. On farms having 100 crop acres and more, the horses are of practically the same age and weight, but are worth $5 more per head. On farms having less than 100 crop acres, the differences are greater, but the averages are less

reliable owing to the fewer horses included, especially in the group using tractors (Table XLI).

TABLE XLI

COMPARISON OF AGE, WEIGHT, AND VALUE OF HORSES ON FARMS USING TRACTORS FOR DRAWBAR WORK WITH FARMS NOT USING TRACTORS FOR DRAWBAR WORK

| Factors | Crop acres per farm | |
|---|---|---|
| | 99 and less | 100 and more |
| Number of horses on farms without tractors | 426 | 854 |
| Number of horses on farms with tractors* | 85 | 873 |
| Age of horses on farms without tractors, yrs. | 12.96 | 11.06 |
| Age of horses on farms with tractors, yrs. | 11.55 | 11.13 |
| Weight of horses on farms without tractors, lbs. | 1,334 | 1,373 |
| Weight of horses on farms with tractors, lbs. | 1,287 | 1,384 |
| Value of horses per head on farms without tractors | $88 | $94 |
| Value of horses per head on farms with tractors | $82 | $99 |

*Horses on farms giving no data as to days of tractor use were not included.

## Larger Tractors Used More for Belt Work

Tractors of two-plow capacity were used for 30.5 days of drawbar work; those of three-plow capacity, 30.1 days. On farms having more than one tractor, the drawbar work dropped to 24.5 days per tractor altho the farms were about twice as large as those having two-plow tractors.

It is significant that farmers having tractors of three-plow capacity did 23.1 days of belt work; those having tractors of two-plow capacity 11.6 days—the larger tractors were used more than twice as many days (Table XLII). One advantage of the tractor that pulls three or four plows is that it has plenty of power for threshing, silo-filling, and shredding.

TABLE XLII

RELATION OF SIZE OF TRACTOR TO DAYS OF USE, 214 MINNESOTA FARMS, 1929*

| No. and size of tractors per farm | No. of farms | No. of tractors | Av. crop acres per farm | Days of use per tractor | | | |
|---|---|---|---|---|---|---|---|
| | | | | Drawbar | Belt | Custom | Total |
| One two-plow | 136 | 136 | 164 | 30.5 | 11.6 | 4.1 | 46.2 |
| One three- or four-plow | 70 | 70 | 226 | 30.1 | 23.1 | 5.0 | 58.2 |
| Two or three tractors pulling two, three or four bottoms each | 8 | 18 | 303 | 24.5 | 10.9 | 0.8 | 36.2 |

* Four of the 218 farms using tractors for drawbar work did not report the size of tractor.

## Sizes of Tractors Farmers Expect To Buy in the Next Five Years

Of 116 farmers now using two-plow tractors, 66 per cent reported that they expected to have the same size in 1934, and 34 per cent that they expect to have a larger one. Of 51 having tractors of three- and four-plow capacity, 78 per cent reported that they expect to have the

same size; 14 per cent a smaller one, and 8 per cent a larger one (Table XLIII).

TABLE XLIII

SIZE OF TRACTORS USED IN 1929 AND ESTIMATED SIZE THAT WILL BE USED IN 1934, 170 MINNESOTA FARMS USING ONE TRACTOR EACH

| Size of tractors in 1929 | No. of farms | No. of farms that will use same size | No. of farms that will use smaller size | No. of farms that will use larger size | Per cent that will have same size in 1934 |
|---|---|---|---|---|---|
| Two-plow..... | 116 | 77 | 0 | 39 | 66 |
| Three- or four-plow..... | 51 | 40 | 7 | 4 | 78 |
| Five-plow or larger..... | 3* | 2 | 1 | 0 | .. |

* Too few to be significant.

Of 293 farmers, not now using tractors, 64 expressed an intention of buying them in the next five years. Nine per cent stated that they would probably buy one having a rating of 8-16; 60 per cent thought they would buy a 10-20 or 12-24; and 31 per cent favored the 15-30 (Table XLIV). Evidently, prospective purchasers are looking with favor upon larger tractors than are now most used. Their replies may have been influenced by the fact that the manufacturer formerly leading in the output of two-bottom tractors had discontinued production shortly before the inquiry was made.

TABLE XLIV

RATING OF TRACTORS THAT FARMERS NOT USING A TRACTOR IN 1929 EXPECT TO BUY IN THE FOLLOWING FIVE YEARS

| Size of tractor | No. of farms | Per cent of total |
|---|---|---|
| 8–16..... | 6 | 9 |
| 10–20 or 12–24..... | 38 | 60 |
| 15–30..... | 20 | 31 |
| Total..... | 64 | 100 |

## Number of Tractors Equipped with Power Take-Off

One of the comparatively recent improvements in tractor construction is the power take-off, so the power can be used directly for operating the cutting and binding machinery on grain and corn binders, the cutting and threshing machinery of combines, the snapping and husking machinery for corn pickers, and any similar machinery. Aside from the fact that the direct application of power is more efficient, the power take-off may make possible the use of tractor-driven machinery on fields that are too muddy for the usual methods. As they become more generally acquainted with the power take-off, tractor owners may make more use of the tractor.

About half of the tractors owned by these farmers, that were manufactured in 1925 and subsequent years, are equipped with a power take-off (Table XLV).

TABLE XLV

RELATION OF YEAR OF MANUFACTURE TO PERCENTAGE OF TRACTORS WITH POWER TAKE-OFF, 184 MINNESOTA FARMS, 1929*

| Year manufactured | No. of farmers reporting on power take-off | No. of farmers having take-off | Per cent |
|---|---|---|---|
| 1914–20 | 27 | 0 | 0 |
| 1921–22 | 17 | 4 | 23 |
| 1923–24 | 32 | 9 | 28 |
| 1925–26 | 46 | 27 | 59 |
| 1927–28 | 58 | 28 | 48 |
| No data as to year of manufacture | 4 | 2 | 50 |
| Total or average | 184 | 70 | 38 |

* It was clear that some of those reporting were not familiar with the power take-off. A few replies showed that they considered a belt pulley to be a power take-off. Therefore the number equipped with a power take-off may be less than is indicated in the table.

Yerkes[81] gives the following information concerning the history of the power take-off:

"It is rather hard to say exactly when the first power take-off was actually placed on the market. So far as we know, the first tractors designed and built for the use of a power take-off were the McCormick-Deering 15-30's, which were first marketed in 1922. . . . the International 8-6 chain-drive tractor, which had been on the market for a number of years prior to the dates just mentioned, was provided with power take-off attachments as early as 1916, but these attachments were an after-thought and not provided for in the original design. . . . they were never sold in quantities and were considered merely an experimental proposition. I think the date of the power take-off should be given as 1916, although, as above pointed out, no tractors designed from the first for a power take-off were ever placed on the market until 1922."

## Old Tractors Used Less

The tractors that were more than four years old were used about 40 days a year; those less than five years old about 50 days. It is possible that after the tractor becomes about four years old the average farmer makes more use of horses because the tractor is less reliable than when it was new or the tractors manufactured more recently have a wider adaptability. It is interesting to note that 15 tractors that are 10 to 15 years old are still being used an average of 37.5 days a year (Table XLVI). This indicates that with proper care and with the ordinary amount of use, some of the early tractors had a period of usefulness about double that previously reported as the average life, but gives no light on the number that were worn out in less than 10 years.

[81] A. P. Yerkes, of the International Harvester Company, in a letter to the author.

TABLE XLVI

RELATION OF DAYS OF USE TO YEAR TRACTOR WAS MANUFACTURED, 219 MINNESOTA FARMS HAVING ONE TRACTOR, 1928

| Year manufactured | No. of farms | Crop acres | Days of use | | | |
|---|---|---|---|---|---|---|
| | | | Drawbar | Belt | Custom | Total |
| 1914–19 | 15 | 198 | 18.2 | 16.8 | 2.5 | 37.5 |
| 1920–21 | 21 | 183 | 26.0 | 9.7 | 4.1 | 39.8 |
| 1922–23 | 27 | 144 | 22.6 | 13.5 | 3.9 | 40.0 |
| 1924–25 | 61 | 183 | 26.1 | 17.5 | 7.6 | 51.2 |
| 1926 | 24 | 227 | 33.7 | 13.5 | 1.5 | 48.7 |
| 1927 | 39 | 173 | 33.0 | 14.5 | 3.1 | 50.6 |
| 1928 | 32 | 174 | 33.0 | 15.0 | 2.2 | 50.2 |

Gilbert,[32] in 1926, found that the total estimated life of 181 two- and three-plow tractors was 8.2 years. The study by Myers[33] in 1919 on similar farms reported an estimated useful life of 6.0 years. This comparison indicates that, as is usual with a new machine, the average life increases because with increasing experience the manufacturers put out better machines, and farmers become more experienced in their operation.

## Are Horses or Tractors Preferable for Hired Men?

For hired help, 107 farmers who had tractors preferred horses for use by hired men, 24 preferred the tractor, and 14 had no preference. Of 32 farmers having hired men to operate their tractors, 10 preferred horses, 12 preferred tractors, and 10 had no preference (Table XLVII).

TABLE XLVII

PREFERRED KIND OF POWER FOR FIELD WORK WHEN MEN ARE HIRED, 145 MINNESOTA TRACTOR OWNERS, 1929

| Kind of power | No. of farms | No. of farms with hired men to operate tractors |
|---|---|---|
| Horses | 107 | 10 |
| Tractor | 24 | 12 |
| No choice | 14 | 10 |
| Total | 145 | 32 |

Apparently, the general sentiment is that horses are preferable to the tractor for use by the average hired man, but that some may be entrusted with the tractor. The proportion of hired men who use tractors satisfactorily is probably rapidly increasing, as farm boys of the present generation seem more interested in learning the details of ignition, carburetion, and power transmission by tractors than in the care and training of horses.

[32] Gilbert, C. W., An Economic Study of Tractors and Motor Trucks on New York Farms, p. 31. 1929. An unpublished manuscript in the library of Cornell University.

[33] Myers, W. I., An Economic Study of Farm Tractors in New York. Cornell Bull. 405, p. 66. 1919.

Tractors are usually operated by members of the family, 235 reports indicating that 88 per cent of the operators are members of the farm family—the farmer himself, a son, or a brother.

### Steam Tractors Are Disappearing

Only 10 steam tractors were reported in use on 538 farms. Nine farmers reported that the steam tractors were used chiefly for threshing, and one, that it was used chiefly for wood-sawing. Seven reported the date of manufacture—all were made prior to 1917. Six of the 10 steam tractors had a belt rating of 18 to 30 horse-power and four a rating of 60 to 80 horse-power. The steam tractor has largely given way to the gasoline tractor as a source of power for threshing.

Many farmers who had purchased a gasoline tractor with a belt rating of 18 to 30 horse-power found that the purchase of a small threshing machine would enable them to do their own threshing from the shock. Formerly, they would either have gone to the extra expense of stacking the grain or would have run the risk of serious damage to the crop while waiting for a large machine to thresh from the shock. The extent to which the smaller threshing machines have replaced the larger ones is shown by the fact that in 1927, 7.6 threshers with a rear of 46 inches and less were sold in the United States for each one with a rear of 47 inches and more. In 1923 the number was 2.5 (Table XLVIII).

TABLE XLVIII

NUMBER OF THRESHERS SOLD IN THE UNITED STATES WITH REAR OF 46 INCHES AND LESS AND WITH REAR OF 47 INCHES AND MORE, 1921-27*

| Year | 47 in. and more | 46 in. and less | 46 in. and less to one 47 in. and more |
|---|---|---|---|
| | No. | No. | Ratio |
| 1921 | 2,529 | 6,873 | 2.7 |
| 1922 | 2,731 | 7,050 | 2.6 |
| 1923 | 2,340 | 5,843 | 2.5 |
| 1924 | 1,963 | 6,841 | 3.5 |
| 1925 | 2,399 | 9,539 | 4.0 |
| 1926 | 1,639 | 9,661 | 5.9 |
| 1927 | 1,703 | 12,959 | 7.6 |

* Annual reports on the Manufacture and Sale of Farm Equipment, U. S. Dept. of Commerce.

## THE AUTOMOBILE AS A SOURCE OF POWER FOR THE FARM AND FARM FAMILY

The automobile is second to the horse and mule as a source of farm power. It is about equal to the horse as a source of power for the farm and farm family (Table I). The use of the automobile as a source of farm power has developed since

1914. In 1895[34] only four cars were made in the United States, in 1910, 458,000 cars were registered. In 1914 there were 1,626,000; in 1927, there were more than 20,000,000.

## Farm Automobiles Became Important About 1914

Between 1914 and 1920 the high price of labor and the prosperity of farmers caused a rapid increase in automobiles. In 1920 there were 102,000 on 57 per cent of Minnesota farms.

In 1920, 48 per cent of the farms in the northern states were reported as having automobiles, and 14 per cent of those in the southern states. The average for the United States was 31 per cent. No data are available as to the increase since 1920.

Of the farms reported in this study 93 per cent had one or more automobiles in March, 1929. Two per cent had light trucks but no automobiles, so that 95 per cent had some form of motor transportation.

From 1921 to 1929 the regitsration of automobiles in Minnesota increased from 303,730 to 583,470, or 92 per cent. Comparable figures are not available prior to 1921, as before that time licenses were issued

TABLE XLIX

MAKES OF 594 AUTOMOBILES OWNED BY MINNESOTA FARMERS, MARCH, 1929

| Make | No. on farms with 1 car | No. on farms with 2 cars | No. on farms with 3 cars | Total |
|---|---|---|---|---|
| Ford | 151 | 82 | 2 | 235 |
| Chevrolet | 65 | 28 | 1 | 94 |
| Buick | 41 | 16 | .. | 57 |
| Dodge | 25 | 15 | .. | 40 |
| Overland, or Whippet | 21 | 10 | .. | 31 |
| Pontiac | 11 | 13 | 1 | 25 |
| Studebaker | 14 | 9 | .. | 23 |
| Hupmobile | 8 | 6 | .. | 14 |
| Essex | 9 | 4 | .. | 13 |
| Chrysler | 8 | 5 | .. | 13 |
| Oakland | 4 | 3 | 1 | 8 |
| Willys Knight | 6 | 2 | .. | 8 |
| Oldsmobile | 4 | 3 | .. | 7 |
| Nash | 5 | 1 | .. | 6 |
| Durant, Star | 3 | 1 | .. | 4 |
| Hudson | 0 | 3 | .. | 3 |
| Auburn | 2 | 1 | .. | 3 |
| Dort | 2 | 1 | .. | 3 |
| Franklin | 2 | .. | .. | 2 |
| Jeffrey | 1 | .. | .. | 1 |
| Flint | .. | 1 | .. | 1 |
| Packard | .. | .. | 1 | 1 |
| Allen | .. | 1 | .. | 1 |
| Jewett | .. | 1 | .. | 1 |
| Total | 382 | 206 | 6 | 594* |

* In addition, there were 14 cars of which the make was not reported.

[34] "Facts and Figures of the Automobile Industry," National Automobile Chamber of Commerce, New York City. 1928.

for 3-year periods. Since 1921 the number of automobiles on farms has probably not increased so rapidly as of those not on farms.

## Farm Cars Are Low-Priced Cars

Farm cars are predominantly the low-priced cars. Of 594 farm-owned cars, 71 per cent were Fords, Chevrolets, Overlands, Whippets, and Stars (Table XLIX).

Twenty-six per cent of all the cars were purchased as used cars. Less than 10 per cent were both higher priced than the cars named, and were purchased as new cars.

If data were available for all farm cars in the state, the percentage of cars in the low-priced group would probably be found considerably larger, as the farmers included in this study had much more capital than the average.

Of the low-priced cars,[35] 27 per cent were purchased as used cars; of the higher priced cars, 25 per cent.

## Wide Range in Miles Driven

The average miles per farm were 5,195, of which 2,483 were for farm business and 2,712 for other purposes. Forty-eight per cent was for business purposes. Sixty-two per cent were driven from 1,000 to 3,999 miles for farm purposes. Seven reported that no use was made of their cars for farm business. Farmers who drove their cars more than 8,000 miles showed a lower percentage for farm business (Table L), probably because some whose mileage per year was high took long pleasure trips or had other business than farming. On farms having one car, 58 per cent of the cars were driven 2,000 to 5,999 miles; 13 per cent, less than 2,000 miles; and 29 per cent, 6,000 miles or more (Table LI).

TABLE L

MILES OF FARM BUSINESS TRAVEL BY AUTOMOBILE PER FARM, 429 MINNESOTA FARMS, 1928*

| Miles driven | No. of farms | Av. crop acres per farm | Miles driven | | |
|---|---|---|---|---|---|
| | | | Farm use | Other use | Total |
| 0 | 7 | 101 | 0 | 1,957 | 1,957 |
| 50– 999 | 70 | 118 | 582 | 2,328 | 2,910 |
| 1,000–1,999 | 125 | 136 | 1,327 | 2,250 | 3,577 |
| 2,000–2,999 | 90 | 148 | 2,244 | 2,921 | 5,165 |
| 3,000–3,999 | 49 | 150 | 3,194 | 2,495 | 5,689 |
| 4,000–4,999 | 34 | 211 | 4,106 | 2,682 | 6,788 |
| 5,000–7,499 | 38 | 161 | 5,672 | 3,920 | 9,592 |
| 7,500–9,999 | 16 | 183 | 8,993 | 5,063 | 14,056 |
| Total or average | 429† | 147 | 2,483 | 2,712 | 5,195 |

* Includes 86 farmers having 2 cars and one having 3 cars.

† The total number of cars does not agree with figures in Table XLIX, as some of the reports did not give the miles driven.

[35] The low-priced group included Fords, Chevrolets, Overlands, Whippets, and Stars.

TABLE LI

DISTRIBUTION OF FARM CARS ACCORDING TO TOTAL MILES DRIVEN, 342 MINNESOTA AUTOMOBILES, 1928*

| Miles driven | No. of cars | Av. crop acres per farm | Miles driven | | Per cent of total for farm use |
|---|---|---|---|---|---|
| | | | Total | Farm use | |
| 270– 999 | 12 | 83 | 652 | 366 | 56 |
| 1,000– 1,999 | 34 | 140 | 1,344 | 810 | 60 |
| 2,000– 2,999 | 55 | 122 | 2,129 | 1,342 | 63 |
| 3,000– 3,999 | 68 | 139 | 3,115 | 1,640 | 53 |
| 4,000– 4,999 | 30 | 135 | 4,033 | 2,144 | 53 |
| 5,000– 5,999 | 45 | 142 | 5,033 | 2,640 | 52 |
| 6,000– 7,999 | 36 | 164 | 6,380 | 3,323 | 52 |
| 8,000– 9,999 | 18 | 198 | 8,278 | 3,733 | 45 |
| 10,000–11,999 | 25 | 147 | 10,040 | 4,102 | 41 |
| 12,000–15,999 | 14 | 154 | 13,085 | 5,371 | 41 |
| 16,000–19,999 | 0 | 0 | 0 | 0 | 0 |
| 20,000–24,000 | 5 | 118 | 20,800 | 4,799 | 23 |
| Total or average | 342 | 141 | 4,815 | 2,307 | 48 |

* Includes farms having one car only.

## Miles Driven When Two Cars Are Owned

On 86 farms having two cars each 6,657 miles were driven per farm (Table LII); on farms having one car, 4,815 miles (Table LI). The mileage was 38 per cent greater on farms having two cars than those having one car. The percentage used for farm business was 48 in each case.

TABLE LII

TOTAL AUTOMOBILE MILES PER FARM FOR FARMS HAVING TWO CARS, 86 MINNESOTA FARMS, 1928

| Miles per farm | No. of farms | Av. crop acres | Total miles | Miles for farm use | Per cent for farm use |
|---|---|---|---|---|---|
| 1,500– 4,999 | 36 | 146 | 3,424 | 1,693 | 49 |
| 5,000– 9,999 | 33 | 176 | 6,458 | 3,135 | 49 |
| 10,000–19,999 | 15 | 191 | 12,613 | 6,547 | 42 |
| 20,000–27,000 | 2 | 384 | 23,500 | 5,025 | 52 |
| Total or average | 86 | 166 | 6,657 | 3,170 | 48 |

Farms having two cars averaged 166 crop acres per farm; those having one car, 141 acres.

TABLE LIII

RELATION OF NUMBER AND SIZE OF AUTOMOBILE TO MILEAGE PER FARM, 419 MINNESOTA FARMS, 1928

| Type | No. of farms | Av. crop acres | Miles driven | | Total | Per cent for farm use |
|---|---|---|---|---|---|---|
| | | | Farm use | Other use | | |
| One Ford, Chevrolet, Overland, Whippet, or Star | 207 | 130 | 2,276 | 2,179 | 4,555 | 50 |
| One larger car | 125 | 159 | 2,365 | 2,974 | 5,339 | 44 |
| Two cars | 86 | 166 | 3,170 | 3,487 | 6,657 | 48 |
| Three cars | 1 | 359 | 3,500 | 5,500 | 9,000 | 39 |
| Total or average | 419 | 147 | 2,483 | 2,712 | 5,195 | 48 |

## Large Cars Driven More Miles

Those having one small car averaged 4,555 miles per farm, compared to 5,339 miles for those having larger cars, and 6,657 miles for those having two cars. The percentage of miles for farm use was 50 for small cars; 44 for larger cars; and 47 for two cars (Table LIII).

## A Larger Proportion of Small Cars on Small Farms

A larger proportion of the small cars are found on small farms (Table LIV). Seventy per cent of the farms having 49 or less crop acres have small cars, 60 per cent of those having 50 to 99, 46 per cent of those having 100 to 199, and 38 per cent of those having 200 and more. Twenty-six per cent of the last named have two cars, but only 8 per cent of those with 49 crop acres or less (Table LIV). The number of crop acres per farm, to some extent, measures the financial resources of the farmer as well as the need for transportation.

TABLE LIV

RELATION OF TYPE AND NUMBER OF CARS PER FARM TO CROP ACRES, 418 MINNESOTA FARMS, 1929*

| Crop acres | No. of farms with | | | Total | Per cent of farms with | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Small cars | Larger cars | Two cars | | Small cars | Larger cars | Two cars | |
| 0– 49 | 26 | 8 | 3 | 37 | 70 | 22 | 8 | 100 |
| 50– 99 | 58 | 26 | 13 | 97 | 60 | 27 | 13 | 100 |
| 100–199 | 93 | 61 | 49 | 203 | 46 | 30 | 24 | 100 |
| 200–616 | 30 | 30 | 21 | 81 | 37 | 37 | 26 | 100 |
| Total or average | 207 | 125 | 86 | 418 | .. | .. | .. | ... |

* Includes only farms reporting both the make of car and miles driven.

## How the Automobile Has Changed Rural Life

Village and city residents were formerly disposed to regard the farmer's automobile as a luxury that might well be dispensed with, especially by farmers who had a moderate to heavy indebtedness. There was a human inclination to observe the exceptional farmer who, while in debt, bought a more expensive car than he needed, and a failure to observe the great amount of time saved that could be credited to the automobile. Merchants in the smaller towns may have been more critical than would otherwise have been the case, for with the automobile the farmer was not so dependent on them. When the family desired to buy anything that could be easily carried in a car, they frequently drove to the larger centers, where there was a larger assortment.

A study[36] made in New York State of the purchasing centers of

[36] Canon, H., Sizes of Purchasing Centers of New York Farm Families, Cornell Expt. Sta. Bull. 472, p. 10. 1928.

farm families for various commodities reports that ordinary staple groceries were purchased at an average distance of 4 to 5 miles; the cheaper clothing, such as men's shoes, overalls, and socks, at an average distance of 7 miles; cotton dress goods, girl's shoes, and men's hats, at a distance of 9 miles; kitchen and living-room chairs, bedsteads, and dining tables, at a distance of 10 miles; women's shoes, men's suits, and tablecloths at an average distance of 12 miles; and such items as women's coats and silk dresses at an average distance of 17 miles. As the average distance to the towns where women's coats and silk dresses were purchased was about 17 miles, such articles may have been purchased by many at a distance of 30 miles or more.

With horses, a trip to a town 15 miles away and return, over the kind of roads formerly prevailing, made a strenuous day for man and beast. Today, one is far less rushed in a half-day trip to a town 30 miles away.

The automobile has not only saved time for the farm family and enabled them to do their buying in the most advantageous places, but it has set in motion far reaching educational and social influences. Without the automobile, the county extension work could have achieved but a fraction of its present effectiveness. Thousands of farm children are enabled to attend high school, who could not if board and lodging had to be hired in town. The circle of the farmer's acquaintance has greatly widened. Friends and relatives are visited more frequently. Trips are taken to distant parts of the country. While such trips may be primarily for recreation, they also have important but unmeasurable cultural and educational influences.

As a result of the automobile, medical talent and hospitals of the larger cities are available to the farmer. On the other hand, the country doctor, who formerly was found in nearly every hamlet, is disappearing. While medical service is more distant, it is of better quality, and when roads are good, is as close as or closer, in point of time, than in the days when the well-bred road horse was the fastest means of rural transportation. However, when the roads are impassable for cars because of snow or mud, many farm families are cut off from the medical service of the larger towns, and frequently none is available in the smaller villages.

## THE MOTOR TRUCK AS A SOURCE OF FARM POWER

The motor truck is surpassed in importance as a source of power by draft animals, automobiles, and tractors (Table I). However, the truck is more important than these data indicate. In addition to the custom work done by farmers, persons in nearly every village make a

business of truck hauling. Frequently a considerable part of their business is hauling such products as livestock, milk, and grain for farmers.

### Motor Truck Partly Replacing Railroad Transportation

The motor truck has not only largely replaced horses for hauling to and from farms, but is to some extent replacing railroads for the transportation of livestock, fruits, vegetables, and milk from the locality in which they are produced to the terminal markets. In 1928, on the Omaha market[37] 38 per cent of the hogs were received by truck; in 1927, only 28 per cent. At South St. Paul 13 per cent of the 1928 hog receipts arrived by truck. The percentage is lower at South St. Paul than at Omaha owing to the fact that the area within easy trucking distance of South St. Paul is not a heavy hog-producing section.

From Delaware and the eastern shore of Maryland and Virginia[38] in 1926, 2,862 cars of strawberries were shipped by rail and the equivalent of 1,086 cars by truck. In 1928, 2,121 cars were shipped by rail and 2,396 by truck.

In 1913, farmers in the vicinity of Northfield, Dennison, Nerstrand, and other points 15 to 40 miles from the Twin Cities shipped milk by rail; in 1929 practically no milk was shipped to the Twin Cities by rail.

### Motor Truck a Later Development Than the Automobile

The motor truck developed later than the automobile for both city and country use. The earliest figures available as to motor truck registrations are those for 1904. In that year, in the United States, 410 trucks were registered, and 54,950 cars—one truck to 134 passenger cars. In 1910 there was one truck to 46 passenger cars; in 1915 one to 17 passenger cars. Since 1925 the ratio of one to 7 has been fairly constant (Table LV).

TABLE LV

COMPARISON OF THE REGISTRATION OF TRUCKS AND PASSENGER CARS IN THE UNITED STATES FOR REPRESENTATIVE YEARS*

| Year | Passenger cars registered | Trucks registered | Passenger cars per truck |
|---|---|---|---|
| 1895 | 4 | 0 | .. |
| 1904 | 54,950 | 410 | 134 |
| 1910 | 458,000 | 10,000 | 46 |
| 1915 | 2,309,666 | 136,000 | 17 |
| 1920 | 8,225,859 | 1,006,082 | 8 |
| 1925 | 17,512,638 | 2,441,709 | 7 |
| 1926 | 19,237,171 | 2,764,222 | 7 |
| 1927 | 20,230,429 | 2,896,886 | 7 |

* Data from "Facts and Figures of the Automobile Industry." Published by the National Automobile Chamber of Commerce, New York City. 1928.

[37] Based on Annual Livestock Report for 1928, Union Stock Yards Company of Omaha.

[38] Edwards, Brice, and Park, J. W., Motor Truck Movement of Fruits and Vegetables from Delaware and the Eastern Shores of Maryland and Virginia, p. 2. 1928.

## Years Farmers Purchased First Trucks

Of 162 farmers who reported the year in which they bought their first truck, 2 per cent purchased one prior to 1916. Eighty-four per cent purchased the first truck since 1921 (Table LVI).

TABLE LVI

YEAR IN WHICH FIRST TRUCKS WERE PURCHASED, 162 MINNESOTA FARMS, 1929

| Year | No. purchasing first truck | Per cent of total |
|---|---|---|
| 1910–15 | 4 | 2 |
| 1916–20 | 23 | 14 |
| 1921–25 | 68 | 42 |
| 1926–March 1, 1929 | 67 | 42 |
| Total | 162 | 100 |

## Farm Trucks Most Frequent in Eastern and Pacific Coast States

For the United States as a whole, according to the 1920 census, 2 per cent of the farmers owned trucks. In the Middle Atlantic states, 4.8 per cent reported trucks; in the New England states, 4.7 per cent; in the Pacific Coast states, 4.6 per cent. As with tractors, the fewest trucks were found in the southern states. Less than one per cent of the farmers reported owning trucks in the South Central states. The Central West occupied an intermediate position (Table LVII).

TABLE LVII

PER CENT OF FARMERS IN THE UNITED STATES HAVING TRUCKS AND TRACTORS IN 1920*

| Division | Per cent reporting motor trucks | Per cent reporting tractors |
|---|---|---|
| New England | 4.7 | 1.4 |
| Middle Atlantic | 4.8 | 3.1 |
| East North Central | 2.3 | 5.1 |
| West North Central | 2.9 | 8.4 |
| South Atlantic | 1.3 | 0.9 |
| East South Central | 0.5 | 0.5 |
| West South Central | 0.9 | 1.8 |
| Mountain | 2.9 | 6.5 |
| Pacific | 4.6 | 7.5 |
| United States | 2.0 | 3.6 |

* Based on U. S. Census.

In all of New England, the Central Atlantic, and the South Atlantic states, and in Alabama and New Mexico trucks were more numerous than tractors. It is probable that the greater number of trucks in the East as compared to tractors is due to the better roads and the larger number of farms that sell whole milk and make frequent deliveries of fruits and vegetables to nearby cities.

## Farm Trucks Increasing More Rapidly Than Tractors in Minnesota

Minnesota[39] had 3,803 farm trucks in 1920 and 18,272 in 1927, an increase of 480 per cent. During this time the number of tractors increased from 15,503 to 31,496, an increase of 203 per cent. It is evident that the tractor found favor with Minnesota farmers before the truck, but since 1920 trucks have increased more than two and a half times as fast as tractors.

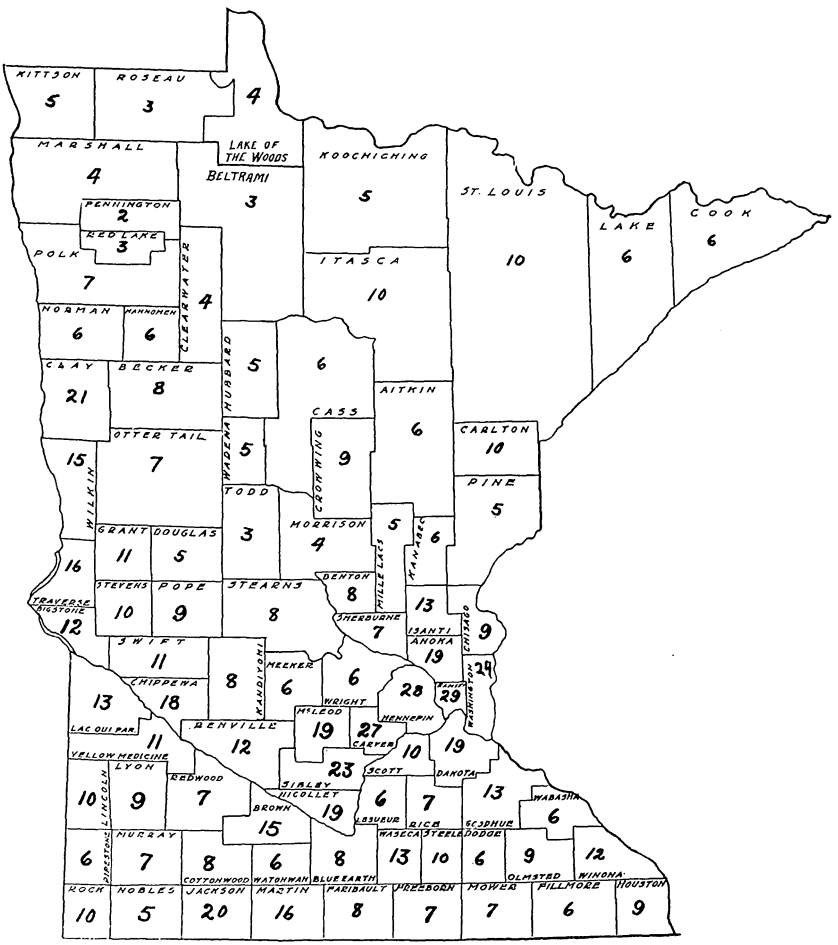


Fig. 3. Trucks per 100 Farms in 1927

Trucks are most numerous near the large cities. (Based on Minnesota Farm Census, 1927, Bull. 61, Minn. State Dept. of Agr.)

The percentage of farmers in each county in Minnesota having trucks in 1927 is shown in Figure 3. In Hennepin and Ramsey counties,

[39] Data for 1920 are based on the United States census; for 1927, on the Minnesota state census.

in which Minneapolis and St. Paul are located, more than 25 per cent of the farmers have trucks. In Carver County, which adjoins Hennepin, 28 per cent have trucks; in Washington County, which adjoins Ramsey, 24 per cent. All these counties have decidedly fewer crop acres per farm than the state average of 100. For the state as a whole, 9.7 per cent of the farms have trucks.

## Kinds of Trucks Used

About two thirds of the trucks on these farms were Fords; among the others, 13 different makes were represented. Five makes included 93 per cent of the trucks (Table LVIII). No report was received as to the number that were built-over passenger cars.

TABLE LVIII

MAKE OF TRUCKS OWNED ON 175 MINNESOTA FARMS*

| Make of truck | Number | Make of truck | Number |
|---|---|---|---|
| Ford | 120 | Federal Knight | 1 |
| Chevrolet | 23 | G. M. C. | 1 |
| Dodge | 12 | Hudson | 1 |
| International | 7 | Oldsmobile | 1 |
| Graham | 6 | Wilcox | 1 |
| Reo | 2 | Unknown | 1 |
| Republic | 2 | | |
| Samson | 2 | Total | 181 |
| Buick | 1 | | |

* Six farms had two trucks, giving a total of 181.

## Use of Trucks

The average distance driven per truck was 2,727 miles, of which 696, or 25 per cent, represents work done for others (Table LIX). The average is 13 per cent greater than the mileage reported by Gilbert[40] on 97 New York fruit and dairy farms in 1927. Hart[41] reported an average of 3,863 miles by 70 trucks on dairy farms in southern New York in 1921.

There is a wide variation in miles per year. Twenty-seven farmers, or 19 per cent, drove less than 1,000 miles and averaged only 415; 91, or 65 per cent, drove from 1,000 to 5,000 miles; 23, or 16 per cent, drove 5,000 to 15,000 miles (Table LIX).

Except for the first group, the percentage that custom mileage is of the total, increases with the total. For those driving 1,000 to 2,999 miles, custom mileage is 7 per cent of the total; for those driving 5,000 to 9,999 miles, 37 per cent (Table LIX).

If there is an opportunity to hire trucking done, truck owners who drive their trucks less than 15,000 miles, could probably hire it more

[40] Gilbert, C. W., An Economic Study of Tractors and Motor Trucks on New York Farms. An unpublished manuscript in the Cornell University Library, p. 26, 1928.

[41] Hart, V. B., Farm Motor Trucks in New York. Cornell Bull. 427, p. 27. 1924.

economically. Gilbert[42] found, in New York, that the cost of operating farm trucks per ton mile, with a mileage of 500 to 1,000 miles, was 34.1 cents, exclusive of the wages of the driver; for those driving 2,000 to 4,000 miles, 15.5 cents; and for those driving over 4,000 miles, 7.6 cents. These costs indicate that before buying a truck for a small amount of hauling, a farmer should carefully estimate the cost per ton mile, including interest, depreciation, insurance, etc., as well as gasoline and oil, and compare this with the cost of hiring a truck.

TABLE LIX

TRUCKS GROUPED ACCORDING TO MILES DRIVEN PER TRUCK
(Trucks on farms having two trucks not included)

| Miles driven | No. of trucks | Crop acres per farm | Miles driven | | | Per cent of miles for custom work |
|---|---|---|---|---|---|---|
| | | | Total | Farm use | Custom | |
| 100– 999 | 27 | 134 | 415 | 251 | 164 | 40 |
| 1,000– 2,999 | 61 | 181 | 2,106 | 1,953 | 153 | 7 |
| 3,000– 4,999 | 30 | 210 | 3,465 | 2,798 | 667 | 9 |
| 5,000– 9,999 | 16 | 144 | 6,312 | 3,990 | 2,322 | 37 |
| 10,000–15,000 | 7 | 98 | 11,457 | 7,558 | 3,899 | 34 |
| Total or average | 141* | 164 | 2,727 | 2,031 | 696 | 26 |

* The number of trucks in this and Tables LX and LXI differs from that given in Table LVIII, as not all the reports gave data as to miles driven.

## Truck Taxes Bear Heavily on Small Users

In a study of farm trucks in New York, Hart[43] found that an average of 10 gallons of gasoline was used per mile. If this figure is applied to a Minnesota truck that was driven 1,000 miles, 100 gallons of gasoline would have been used and the tax at 3 cents per gallon would be $3. The minimum license fee on trucks of one-ton rated capacity or less, except those made over from passenger cars, is $15. This would make a total tax of $18 per 1,000 miles or per 100 gallons of gasoline used. If all the tax were collected on gasoline, this would be equivalent to a gasoline tax of 18 cents per gallon of gasoline used. In the case of a similar truck, that was driven 10,000 miles the total license and gasoline tax would be $45, or 4.5 cents per gallon of gasoline used.

It is obvious that securing a large proportion of the total tax from gasoline would distribute the burden more equitably.

## Truck Miles Driven and Size of Farm

There is no consistent relation between the crop acres per farm and the truck miles driven per truck, but the small farms do a larger per cent of custom work (Table LX).

It is probable that the lack of relationship is due to the fact that available work for a truck depends more on the type of farming than

[42] Gilbert, C. W., An Economic Study of Tractors and Motor Trucks on New York Farms, An unpublished manuscript in the Cornell University Library, p. 67. 1928.

[43] Hart, V. B., Farm Motor Trucks in New York, Cornell Exp. Sta. Bull. 427, p. 27. 1924.

on the acres farmed. This is in line with the fact that trucks exceed tractors in the New England and Central Atlantic states, and in Minnesota in such counties as Hennepin, Ramsey, Carver, Dakota, and Anoka that contain large cities, or are within easy trucking distance. Thus, in Hennepin County, in which Minneapolis is located, in 1927 there were 1,212[44] trucks compared to 370 tractors, and in Ramsey County, in which St. Paul is located, there were 318 trucks compared to 30 tractors.

TABLE LX

TRUCK MILES PER FARM RELATED TO CROP ACRES PER FARM, 141 MINNESOTA FARMS, 1929
(Includes only farms having one truck)

| Crop acres | No of farms | Av. crop acres | Av. age of trucks | Total miles | Custom miles | Per cent custom miles |
|---|---|---|---|---|---|---|
| 49 and less | 10 | 37 | 3.5 | 3180 | 1587 | 50 |
| 50- 99 | 31 | 75 | 4.6 | 2319 | 598 | 26 |
| 100-199 | 63 | 140 | 4.1 | 2973 | 759 | 26 |
| 200 and more | 37 | 314 | 4.2 | 2528 | 432 | 17 |
| Total or average | 141 | 164 | 4.2 | 2728 | 697 | 26 |

There is a distinct tendency to buy larger trucks as the crop acres per farm increases. Among the farms of 50-99 crop acres, 61 per cent of the trucks are rated at less than a ton; among those having 100-199 crop acres, the trucks of under a ton capacity decrease to 30 per cent; and in the group of 200 crop acres and more, to 21 per cent (Tables LXI and LXII).

TABLE LXI

CROP ACRES RELATED TO THE NUMBER OF TRUCKS OF VARIOUS CAPACITIES, 141 MINNESOTA FARMS, 1929

| Crop acres | No. of trucks | Truck capacity in tons | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0.5 | 0.75 | 1.0 | 1.25 | 1.50 | 1.75 |
| | | No. | No. | No. | No. | No. | No. |
| 49 and less | 10 | 5 | 1 | 4 | 0 | 0 | 0 |
| 50- 99 | 31 | 14 | 5 | 11 | 0 | 1 | 0 |
| 100-199 | 63 | 17 | 2 | 38 | 0 | 5 | 1 |
| 200-740 | 37 | 6 | 2 | 23 | 1 | 5 | 0 |
| Total | 141 | 42 | 10 | 76 | 1 | 11 | 1 |

TABLE LXII

CROP ACRES RELATED TO THE PERCENTAGE OF TRUCKS OF VARIOUS CAPACITIES, 141 MINNESOTA FARMS, 1929

| Crop acres | Truck capacity in tons | | | | | |
|---|---|---|---|---|---|---|
| | 0.5 | 0.75 | 1.0 | 1.25 | 1.50 | 1.75 |
| | Per cent | Per cent | Per cent | Per cent | Per cent | Per cent |
| 49 and less | 50 | 10 | 40 | 0 | 0 | 0 |
| 50- 99 | 45 | 16 | 36 | 0 | 3 | 0 |
| 100-199 | 27 | 3 | 60 | 0 | 8 | 2 |
| 200-740 | 16 | 5 | 62 | 3 | 14 | 0 |

[44] Minnesota State Census for 1927.

## Custom Work with Trucks

Fifty of the 141 farms having one truck each did some custom work. The amount of custom work varied from practically none to 10,000 miles. Among the 22 trucks doing less than a thousand miles of custom work, the truck miles were 24 per cent of the total. On the farms driving 1,000 to 2,999 custom miles, the miles of custom work were 58 per cent of the total, and among the farms driving 3,000 to 10,000 custom miles, the custom miles were 74 per cent of the total. The extra miles driven in the high mileage groups is largely accounted for by the extra custom work (Table LXIII).

TABLE LXIII

RELATION OF TRUCK CUSTOM WORK TO SIZE OF FARM, 50 MINNESOTA FARMS HAVING ONE TRUCK, 1929

| Miles of custom work | No. of trucks | Crop acres per farm | Miles for custom work | Miles for farm work | Total miles | Per cent custom miles |
|---|---|---|---|---|---|---|
| 999 miles and less..... | 22 | 202 | 259 | 816 | 1075 | 24 |
| 1,000– 2,999..... | 16 | 198 | 1603 | 1163 | 2766 | 58 |
| 3,000–10,000..... | 12 | 134 | 5571 | 1919 | 7500 | 74 |
| Total or average..... | 50 | 185 | 1964 | 1194 | 3158 | 62 |

The farms doing custom work drove 1,194 miles of non-custom work compared to 2,489 miles for those doing only truck business connected with the home farm. These data indicate that a number of farmers with a limited amount of trucking are finding it possible to secure fuller utilization of their trucks by doing work for neighbors (Table LXIV).

TABLE LXIV

COMPARISON OF FARM TRUCKS DOING CUSTOM WORK WITH THOSE DOING NO CUSTOM WORK, 141 MINNESOTA TRUCKS, 1929*

| Use of trucks | No. of farms | Crop acres | Miles | | |
|---|---|---|---|---|---|
| | | | Farm use | Custom work | Total |
| Farm and custom work..... | 50 | 185 | 1194 | 1964 | 3158 |
| Farm only ..... | 91 | 153 | 2489 | .... | 2489 |

* Includes only farms having one truck.

TABLE LXV

NUMBER OF TRUCKS OF VARIOUS CAPACITIES AMONG THOSE DOING CUSTOM WORK AND THOSE NOT DOING CUSTOM WORK

| Use of truck | Truck capacity in tons | | | | | |
|---|---|---|---|---|---|---|
| | 0.5 | 0.75 | 1.0 | 1.25 | 1.5 | 1.75 |
| | No. | No. | No. | No. | No. | No. |
| Farm and custom work..... | 9 | 2 | 34 | 0 | 4 | 1 |
| Farm only ..... | 33 | 8 | 42 | 1 | 7 | 0 |

Among those doing custom work, 78 per cent of the trucks have a rated capacity of one ton or more, while among those not doing custom work, only 55 per cent have a rated capacity of one ton or more (Table LXV).

## Capacity of Trucks Related to Miles Driven

The larger trucks are driven more miles than the smaller ones. Half-ton trucks on farms having autos were driven 1,960 miles; ton trucks, 2,746 miles; and ton and a half trucks, 4,254 miles (Table LXVI). If there is only a small amount of trucking, it is more economical to spend more time in doing it, rather than to make the extra investment in a larger truck.

TABLE LXVI

CAPACITY AND MILEAGE OF TRUCKS, 139 MINNESOTA FARMS, 1929*

| Capacity | Number | Average crop acres | Total miles | Custom miles |
|---|---|---|---|---|
| One-half ton† | 42 | 145 | 2366 | 455 |
| Three-fourths ton | 10 | 108 | 1810 | 280 |
| One ton† | 76 | 179 | 2746 | 814 |
| One and a half tons | 11 | 278 | 4254 | 677 |

* Not including six farms having 2 trucks and two farms having 1¼- and 1¾-ton trucks.

† There were 5 farms in the half-ton group, and 4 in the one-ton group that reported no passenger car. In the half-ton class, elimination of the farms with no passenger car would reduce the average miles driven to 1960 and increase the miles for custom work to 515. The average would not be materially changed in the one-ton group.

## Tendency Toward Larger Trucks

There seems to be a distinct tendency toward trucks of one ton, and one and a half tons rated capacity. Of 43 farmers having one-half ton trucks, 30 expressed the intention of having trucks of a rated capacity of one ton or more by 1934. Among 71 farmers having one-ton trucks, only one expressed the intention of having a smaller truck in 1934; 45 intend to have the same size; 18 expect to have trucks of one and a half tons; six expect to have two-ton trucks; and one, a two and a half ton truck (Table LXVII). Among those that have one-ton trucks at present, the average crop acres of those who will continue to use one-

TABLE LXVII

NUMBER OF TRUCKS OF VARIOUS CAPACITIES THAT FARMERS INTEND TO USE IN 1934, 114 MINNESOTA FARMS, 1929

| Size of present truck | No. of farms | Truck capacity in tons | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0.5 | 0.75 | 1.0 | 1.5 | 2.0 | 2.5 |
| | | No. | No. | No. | No. | No. | No. |
| One ton | 71 | 1 | 0 | 45 | 18 | 6 | 1 |
| One-half ton | 43 | 10 | 3 | 22 | 7 | 1 | 0 |

ton trucks is 168; of those who will use one and one-half tons, 182; and of those who will use two tons is 272.

Among owners of half-ton trucks, the average crop acres of those who will continue to use one-half ton trucks is 104; of those who will use one ton, 126; and of those who will use one and a half tons is 144.

### Intentions of Non-Truck Owners Regarding Purchase of Trucks

Among 363 farmers not having trucks, 96 said definitely that they did not expect to own a truck in 1934, 110 reported that they hoped to own a truck in 1934 and 157 made no report.

Only 7 farmers among the 110 expect to buy trucks of less than one-ton rated capacity. Forty expect to buy one-ton trucks; 38, trucks of one and a half tons; and 19, trucks of two tons (Table LXVIII). Evidently, both those who now use trucks and those who are contemplating a purchase for the first time are giving little consideration to trucks of less than one-ton capacity.

TABLE LXVIII

CAPACITY OF TRUCKS THAT 110 FARMERS NOT NOW OWNING TRUCKS INTEND TO BUY, MINNESOTA, 1929

| Rated capacity of truck | Number of farms |
|---|---|
| Half ton | 3 |
| Three-fourths ton | 4 |
| One ton | 40 |
| One and a half tons | 38 |
| Two tons | 19 |
| No report | 6 |
| Total | 110 |

Among the 538 farms, 110 new truck owners are definitely in prospect compared to 64 new tractor owners. Apparently, in Minnesota, trucks will continue to increase in numbers more rapidly than tractors as has been the case since 1920.

## STATIONARY GAS ENGINES AS A SOURCE OF FARM POWER

Prior to the introduction of electricity, the only competitors of the gas engine for operations requiring a small power unit were the windmill and human muscle. Occasionally, one found a small animal tread power in use, but these were comparatively rare. The only extensive application of the windmill was for pumping water. The gasoline engine was and is used on many of the better equipped farms for such operations as separating cream, pumping water, sawing wood, grinding

tools, and washing the family clothes. Among 214 farms having one gas engine, 44 per cent were used for pumping water.

Of the farms in this study, 363 had one or more stationary gas engines. The average number of gas engines per farm was 1.5 and the average available horse-power per farm was 4.1, making the average horse-power per engine 2.7. There is no great difference in the per cent of farms having stationary gas engines according to the size of farm. The farms of 49 crop acres and less have 1.2 engines per farm compared to 1.7 for those having 200 crop acres and more (Table LXIX).

TABLE LXIX

POWER AVAILABLE FROM STATIONARY GAS ENGINES, 363 MINNESOTA FARMS, 1929

| Crop acres per farm | No. of farms | No. of stationary gas engines | Available horse-power per farm | Per cent of all farms having stationary gas engines |
|---|---|---|---|---|
| 49 and less | 33 | 1.2 | 3.3 | 58 |
| 50– 99 | 76 | 1.4 | 4.2 | 62 |
| 100–199 | 179 | 1.6 | 4.3 | 71 |
| 200 and more | 75 | 1.7 | 4.6 | 71 |
| Total or average | 363 | 1.5 | 4.1 | 68 |

Among the 363 farms, 59 per cent had one engine; 31 per cent, two engines; and 10 per cent had three engines or more. There is a tendency for the larger farms to have more gas engines. The horse-power per engine is about the same, regardless of the number of engines owned (Table LXX). The farms with one gas engine averaged 140 crop acres; those with two, 160 crop acres; and those with three, 195 crop acres.

TABLE LXX

AMOUNT OF POWER AVAILABLE ON FARMS WITH FROM ONE TO FIVE STATIONARY GAS ENGINES, 363 MINNESOTA FARMS, 1929

| No. of gas engines per farm | No. of farms | Crop acres per farm | Total horse-power available | Average horse-power per engine |
|---|---|---|---|---|
| One | 214 | 140 | 2.5 | 2.5 |
| Two | 114 | 160 | 5.7 | 2.8 |
| Three | 31 | 195 | 8.3 | 2.8 |
| Four or five | 4 | 146 | 15.9 | 3.5 |
| Total or average | 363 | 151 | 4.1 | 2.7 |

## USES OF ELECTRICITY ON FARMS

Electricity was little used on farms prior to 1917, altho an occasional farm had electricity as early as 1909. Of 178 reports as to

the year in which electricity was installed, 7 per cent installed electricity from 1909 to 1916; 34 per cent, from 1917 to 1920; 19 per cent, from 1921 to 1924; and 40 per cent installed it from 1925 to March 1, 1929 (Table LXXI). These limited reports indicate that the electrification of farms has made rapid progress since 1925.

TABLE LXXI

YEAR IN WHICH ELECTRICITY WAS INSTALLED, 178 MINNESOTA FARMS, 1929

| Source of electricity | No. of reports | Year of installation | | | |
|---|---|---|---|---|---|
| | | 1909–16 | 1917–20 | 1921–24 | 1925–Mar. 1, 1929 |
| | | No. | No. | No. | No. |
| Power line ..... | 88 | 9 | 34 | 18 | 27 |
| Private plant ..... | 90 | 3 | 26 | 16 | 45 |
| Total ..... | 178 | 12 | 60 | 34 | 72 |

## Uses Made of Electricity

Electricity is the one source of energy that is suited to a wide range of household operations. A farm family that lives in an electrified home, that has an automobile, and an all-season road, and that has modern plumbing is able to enjoy a standard of living equal to that offered by the better residential sections of large cities.

Aside from lights, the most general use of electricity in the home and on the farm is for running the washing machine. Ninety per cent do their washing with electricity. The electric iron is next in popularity, 85 per cent using it. The battery charger, vacuum cleaner, and toaster are used in more than 25 per cent of the farm homes. Small portable heaters, electric fans, and electric radios were each in use on 8 to 12 per cent of the farm homes. Waffle irons, percolators, and refrigerators were each in use in about 6 per cent of the homes. Electric ranges were in use in 2 per cent of the homes (Table LXXII). It is probable that the well-equipped rural home of the future will have all of the appliances listed in Table LXXII and additional ones such as the electric sewing machine and mangle.

Bucknam,[45] in a study of rural electrification in New York, reports that in 1,181 farm homes, the iron was found in 90 per cent of the homes; the vacuum cleaner, 67 per cent; the washing machine, 65 per cent; the toaster, 18 per cent; the battery charger, 11 per cent, and 34 other appliances were in use in 0.1 to 6 per cent of the homes.

The uses of electricity in farm homes in New York is evidently similar to that in Minnesota. The list of uses is greater owing to the fact that more farms were included.

[45] Bucknam, R. F., Use of Electricity on New York State Farms. New York State Col. Agr. Farm Economics Bull. No. 51, p. 873. 1928.

TABLE LXXII

NUMBER AND PER CENT OF FARMS REPORTING HOUSEHOLD AND FARM USES MADE OF ELECTRICITY, 204 MINNESOTA FARMS, 1929

| | No. reporting operation or appliance | Per cent reporting operation or appliance |
|---|---|---|
| Household appliances | | |
| Washing machine | 183 | 89.7 |
| Iron | 173 | 84.8 |
| Battery charger | 71 | 34.8 |
| Vacuum cleaner | 66 | 32.4 |
| Toaster | 53 | 26.0 |
| Small heater | 25 | 12.3 |
| Fan | 17 | 8.3 |
| Radio | 17 | 8.3 |
| Waffle iron | 13 | 6.4 |
| Percolator | 10 | 4.9 |
| Refrigerator | 10 | 4.9 |
| Range | 5 | 2.4 |
| Curling iron | 4 | 2.0 |
| Unclassified | 13 | 6.4 |
| Farm operations | | |
| Cream separating | 93 | 45.6 |
| Pumping water | 88 | 43.1 |
| Milking | 64 | 31.3 |
| Fanning grain | 32 | 15.7 |
| Running emery wheel or grindstone | 30 | 14.7 |
| Running feed grinder | 17 | 8.3 |
| Shelling corn | 7 | 3.4 |
| Elevating grain | 5 | 2.4 |
| Brooding chickens | 5 | 2.4 |
| Churning | 4 | 2.0 |
| Filling silo | 4 | 2.0 |
| Shearing sheep | 4 | 2.0 |
| Sawing wood | 2 | 1.0 |
| Grading potatoes | 1 | 0.5 |
| Cooling milk | 1 | 0.5 |
| Grading corn | 1 | 0.5 |
| Operating drill press | 1 | 0.5 |
| Unclassified | 4 | 2.0 |

Separating cream is the most common farm use of electricity; 46 per cent of the farms use it for this purpose. Forty-three per cent use it for pumping water and 31 per cent for milking. About one farm in every six use electricity for fanning grain and for running grinding machinery such as emery wheels or grindstones. Eight per cent use it to grind feed; 3 per cent, to shell corn; and 2 per cent, for brooding chickens, churning, filling silo, and shearing sheep. Other uses on one or two farms were sawing wood, grading potatoes, cooling milk, grading corn, and operating a drill press (Table LXXII). In addition to using lights for buildings and motors, 51 farms, or 25 per cent of those having electricity, reported using electric lights an average of 3.7 months to lengthen the winter days for the poultry flock.

The list of operations indicates the wide adaptability of electricity to a larger number of farm operations. Since 40 per cent of these farms have had electricity for only three years, it is likely that many will expand the use as money is available for buying equipment and as they become better acquainted with the multitude of ways in which it will save labor or add to the pleasures of farm life.

## Relation of Size of Farm to Electrification

Twenty-five per cent of these farms with 49 or less crop acres have electricity; 35 per cent of those with 50 to 99 crop acres; 42 per cent with 100 to 199 crop acres; and 39 per cent of those with 200 crop acres or more (Table LXXIII).

TABLE LXXIII

CROP ACRES PER FARM IN RELATION TO PER CENT OF FARMS WITH ELECTRICITY, 538 MINNESOTA FARMS, 1929

| Crop acres | Total No. of farms | No. reporting electricity | Per cent reporting electricity |
|---|---|---|---|
| 49 and less | 57 | 14 | 25 |
| 50– 99 | 123 | 43 | 35 |
| 100–199 | 253 | 106 | 42 |
| 200 and more | 105 | 41 | 39 |
| Total or average | 538 | 204 | 38 |

There is some relation between the crop acres per farm and the number with electricity, but the difference is not as great as might be expected. It is probable that if only the farms operated by owners were included, the relation between size of farm and per cent of farms with electricity would be more marked than is indicated in Table LXXIII, as farms operated by tenants are larger than those operated by owners, and few farms operated by tenants have electricity.

The average number of motors for other than household use varies from 1.5 for the farms having 49 crop acres or less to 2.0 for those having 100 to 199 crop acres. The total horse-power of the farm motors varies from 0.9 for the farms having 49 crop acres or less to 1.4 for those having 100 to 199 crop acres. The average number of operations done with electric motors is 1.5 on farms of 49 crop acres or less, and 2.2 on farms of 100 to 199 crop acres (Table LXXIV). There is not the increased use of electricity with increasing size of farm that one might expect. Probably the relationship would be much more striking if the farms were all located in a region having the same type of farming.

TABLE LXXIV

CROP ACRES PER FARM IN RELATION TO NUMBER AND SIZE OF ELECTRICAL MOTORS, AND NUMBER OF USES OF ELECTRICITY

| | Crop acres per farm | | | | Total or average |
|---|---|---|---|---|---|
| | 49 and less | 50–99 | 100–199 | 200 and more | |
| Number of farms | 14 | 43 | 106 | 41 | 204 |
| Average crop acres | 36 | 74 | 150 | 332 | 163 |
| Average number of farm motors | 1.5 | 1.6 | 2.0 | 1.8 | 1.8 |
| Total horse-power per farm motor | 0.9 | 1.0 | 1.4 | 1.4 | 1.3 |
| Number of farm operations for which electricity was used* | 1.5 | 1.8 | 2.2 | 2.1 | 2.1 |
| Number of household uses of electricity* | 3.3 | 3.3 | 3.4 | 3.4 | 3.4 |

* Does not include lights.

## Comparison of Farms Obtaining Electricity from Power Lines and from Private Plants

One hundred two farms had private plants and 93 purchased electricity from a power company. On farms obtaining electricity from a power line more use was made of electric current than on those with private plants. The farms using a power line have 2.3 motors for farm use, compared to 1.5 of those with private plants. The total horse-power available in farm motors is 1.9 for those using a power line and 0.7 horse-power for those with private plants, or over two and a half times more. The number of operations done with electric motors per farm is 2.6 for those with current from a power line and 1.7 for those with private plants. The number of household uses per farm was 4.2 for those with current from a power line, compared to 2.7 for those with private plants (Table LXXV). The more extensive use made of electricity on farms obtaining current from a power line, suggests that where available, power lines are proving more satisfactory than private lines.

TABLE LXXV

COMPARISON OF FARMS OBTAINING ELECTRICITY FROM PRIVATE PLANTS WITH THOSE ON POWER LINES, 195 FARMS*

| Source | No. reporting | Crop acres per farm | Motors for farm use per farm | Total horse-power of farm motors per farm | No. of operations with motors per farm | No. of household uses per farm |
|---|---|---|---|---|---|---|
| Power line | 93 | 163 | 2.3 | 1.9 | 2.6 | 4.2 |
| Private plant | 102 | 168 | 1.5 | 0.7 | 1.7 | 2.7 |

* Nine of the 204 farms did not report the source of electricity.

Until recently, power companies have shown little interest in increasing their business through the electrification of farms. During the last two years, several Minnesota companies have been actively soliciting rural business where groups of farmers can be interested in elec-

trifying their farms. There is also a tendency to adjust charges in such a way that there is a strong incentive to make use of current in addition to that required for lighting.

### Plans to Install Electricity by 1934

Of 334 farms not having electricity, 106 reported that they expect to install electricity in the next five years; 65 stated that they did not expect to, and 163 made no report. It seems probable that most of those making no report had no definite intentions. The reports indicate that electrification of farms will go forward rapidly in the next few years, if farmers are able to secure the money required for the investment. It is interesting to note that the prospective users have in mind only 1.0 motor per farm compared to 1.8 reported on farms with electricity (Table LXXVI). The prospective users reported the average intention to use electricity for 0.6 household operations aside from lights compared to 3.4 operations on farms having electricity. Evidently those not having electricity do not fully realize its wide adaptability to uses on the farm and in the home.

TABLE LXXVI

INSTALLATION PLANS OF FARMS WITHOUT ELECTRICITY FOR 1929-34, 171 MINNESOTA FARMS

| | Do not expect to install | Expect to install |
|---|---|---|
| Number of reports | 65 | 106 |
| Crop acres | 138 | 152 |
| Number of farm motors planned | .. | 1.0 |
| Number of household uses | .. | 0.6 |