

The Farm Debut of the Gasoline Engine

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Advertisements for internal combustion engines, commonly called gas engines, appeared regularly in farm magazines across the country starting in the mid-1890s. Sears, Roebuck & Company began selling farm gas engines in 1898. By the century's turn, one hundred companies, most of them in the Midwest, produced stationary or portable internal combustion engines for farmers. In 1908 a new magazine was launched – *Gas Review* -- by the publishers of *The American Thresherman*; farmers wrote questions to the editors and described their experience with this increasingly popular farm power.¹ Five years later, half a dozen books on the gas engine had been written for farmers.² By 1914, there were an estimated *one million* stationary and portable gas engines on farms.³

The skills gained by hundreds of thousands of farmers with these early gas engines played a critical role in the rapid adoption of the automobile on farms (beginning around 1908), and the more gradual adoption of the gasoline tractor (beginning in earnest during World War I). Yet the early farm use of gasoline engines has received little attention over the last 80 years.⁴ This paper first examines the demand for a better farm power in 1895 and traces the early development of the market for farm gas engines. Then evidence from *Gas Review* demonstrates that those farmers that owned gas engines became engine mechanics and facilitated the adoption of automobiles and tractors across rural America.

The Demand for Better Farm Power in 1895

Horses provided excellent draft power in 1895, but the demand for better stationary power – also called belt power -- was urgent. Stationary work averaged about 30 percent of farmer power needs. Threshing grain, pumping water, grinding feed, baling hay, shredding dry corn stalks, sawing wood, shelling corn, and chopping silage all needed stationary power.⁵ Various power sources, aided by gears, pulleys, and belts, were used interchangeably to power machines using a long drive belt attached to both the power source and the machine. Yet every available power source – horses, wind, steam -- had serious deficiencies.⁶ An internal combustion engine could drive the same belt and provide an attractive alternative.

Horses had at least two advantages among power sources: nearly every farm already had them and they were readily portable. But horses were awkward at best for stationary

power. Horses provided belt power either by a treadmill or by walking in a circle connected to a sweep power mechanism. These devices came into use in the 1830s. The treadmill offered only modest power and was often considered hard on the horses. Substantial sweep power could be generated with enough horses; in 1895 many threshers were sweep powered. For smaller jobs sweep powers were cumbersome, however. They were also subject to breakdowns and required clement weather and plenty of outdoor space. Some farmers believed that sweep power was also hard on horses because horse collars pulled and caused sores. In both tread and sweep power, converting the horse's forward motion to rotary power for the belt drained energy, inefficiently using the animal power.⁷

Windmills also had limitations. Steel windmills appeared on U.S. farms in the late 1800s and became common, especially in the west, by 1900.⁸ Windmills were inexpensive to run and fairly reliable. Although they were not portable, windmills provided power without an operator. In addition to pumping water, windmills could grind feed and saw wood if the wind was blowing hard enough at the right time. But the fickleness of the wind tended to limit windmill use to pumping water for stock.

Steam power was reaching its development height for farm work about 1900. Steam engines were produced in portable styles as early as 1850 and farmers used limited numbers before the Civil War.⁹ Within a few years, they were much less of a novelty. Once self-propelled, around 1880, they were even more useful for threshing grain. By 1895, steam traction engines pulled large grain harvesters in the west and were even used to plow. In 1903, at least thirty-six manufacturers produced steam traction engines, when only a couple produced gas traction engines.¹⁰ Steam's big advantage was its enormous power; and if the engine was used for long stretches of time, fuel cost per horsepower was cheap.

But steam engines had some big negatives. Although fuel cost was reasonable, the engine's initial cost was excessive for the ordinary farmer; so the engines were used primarily for custom threshing. Steam engines required skilled operators and constant attention, and they were very dangerous. Reynold Wik notes, "If the farmer was rather hesitant about embracing this monster, the paramount reason lay in the fact that he was alive and preferred to remain that way."¹¹ The steam engine boilers could explode and potentially kill five or six men. Others could be scalded and property damaged. Fires were caused by smokestack sparks or ash box coals. Fires destroyed hay stacks, grain fields, barns, and machinery, and killed animals. Although manufacturers made safety improvements and farmers bought insurance, the presence of an operating steam engine bore risks. Steam engineers also took risks moving the heavy engines over rural bridges which sometimes collapsed from the rig's weight.

While steam engines were cost effective for threshing and other large jobs, their efficiency dropped with small jobs. More than an hour (of time and fuel) might be needed to raise steam to begin work. When finished, the fire and steam still on hand went to waste. Extra hands were needed to provide bulky and inconvenient fuel and

water. At the height of steam's popularity, 1908-1915, only one in twenty farmers operated steam engines.¹²

Enter the Farm Gas Engine

Given the deficiencies of alternative sources of belt power in 1895, early promoters of gas engines could extol their virtues. W.W. Stevens writing in *Prairie Farmer* that year stated:

the power that leads all others on the farm is the gasoline engine. It is safest because it can not explode, and not a spark of fire is to be made so that it can be set in the middle of the hay mow without danger of burning anything. . . . It is most convenient, for at any time you enter the barn you can have your machinery all running at full speed inside of two minutes. . . . No expert is needed to manage it. . . . For use on the farm nothing has ever been invented that comes anyways near filling its place.¹³

Because the gas engine could be stopped and started quickly (on a good day) it had tremendous advantages over the steam engine – much farm work was done for short periods. Portability was an advantage over the windmill; and the fact that it could run safely unattended gave it additional advantage over steam. Unlike the horse, gas engines didn't consume fuel when idle. Moreover, weather conditions didn't significantly affect gas engines. They withstood the cold better than steam engines, and could be used safely inside ventilated barns.¹⁴

In the mid-1890s farm magazines began to run advertisements and articles with testimonials about gasoline engines. The Davis Gasoline Engine Co. of Waterloo, IA advertised regularly in *Prairie Farmer* beginning in 1895 and through the turn of the century; *Farm, Field, and Fireside* ran ads for Webster Gas Engines and Lambert Engines in 1896 and 1897.¹⁵ Mr. Davis of Harristown, IN had been using his gasoline engine for a year when interviewed by *Prairie Farmer* in 1895.¹⁶ His 6 HP engine, mounted on trucks for portability, cost him \$500 (about \$13,000 in today's dollars) and was used to grind feed, chop feed, and pump water on his farm and for some neighbors as well. Davis claimed the gas engine was cheaper to use than a steam engine. He estimated the fuel cost to be half that of the cost of coal; the engineer wages and the labor of lugging the water, necessary for the steam engine, were eliminated.

Gasoline was certainly cheap and readily available. The commercial oil industry was born in Pennsylvania 1859 and within two years the United States was shipping barrels of oil to London. The first successful pipeline was completed in 1865 in the western Pennsylvania oilfields. By the late 1860s, railroad tank cars provided another alternative to floating barrels of oil down the river.¹⁷ Until 1895 most of the oil in the United States was produced in Pennsylvania but "wildcatters" exploring for oil moved west. Before the turn of the century, 15 states produced oil. Crude prices, extremely volatile in the first two decades of production, stabilized around a dollar a barrel on average by the 1880s.¹⁸

In the early days of oil, kerosene was its most important product, valued as an illuminant to replace increasingly scarce whale oil. Kerosene soon became common in rural homes. It was widely available in general stores, grocery stores, and hardware stores, delivered either by tank wagon or in barrels. Gasoline was one of a number of byproducts that became available at the same retail outlets that handled kerosene.¹⁹

Gasoline engines entered commercial production less than twenty years before they were advertised in farm magazines. The modern internal combustion engine was created when the German engineer, Nicholas A. Otto, introduced a four cycle engine in 1876. Within the year he filed for a U.S. patent and began selling engines in America. As of 1884, 14,000 Otto engines were already in use around the world (presumably in small industry), and the company operated a branch office in Chicago.²⁰ In late 1894, Otto Gasoline Engines were advertised weekly in *American Agriculturalist*: “Power from Gasoline . . . Cheaper than Steam . . . Best Power for Corn and Feed Mills, Baling Hay, Running Separators, Creameries.”²¹ The ads listed stationary sizes from one to 50 HP and portable models from eight to 20 HP. These engines were heavy – a six HP engine could weigh more than a ton.

When the Otto patents expired in 1890, development and production of gas engines surged in the United States, as hundreds of inventors and entrepreneurs, particularly Midwesterners entered the field.²² The *Farm Implement News Buyers Guide 1903* lists 100 manufacturers of gas and gasoline engines. Of these manufacturers, all but seven of them are in just nine states listed here in rank order by number of manufacturers: Illinois (18), Michigan (16), Indiana (12), Ohio (11), Iowa (10), New York (9), Wisconsin (8), Minnesota (5), and Pennsylvania (4).²³ Among those that became significant engine manufacturers are Fairbanks, Morse & Co., the Hart-Parr Co., Olds Motor Works, the Foos Gas Engine Company, the Waterloo Gasoline Engine Co., the Stover Manufacturing and Engine Co., the Charles A. Stickney Co., and Root & Vandervoort Engineering Co.²⁴

Fairbanks-Morse, an early competitor that is still an industry leader, entered the gas engine business in 1893 and gained a lasting edge by selling engines to the same clients (including railroads and farmers) who had bought their windmills and scales. Fairbanks-Morse advertised its engines regularly in farm magazines from 1897 to 1900. In a 1900 *Prairie Farmer*, Fairbanks-Morse claimed to be “The Best, Simplest, Most Economical, Most Reliable and Most Durable Gas and Gasoline Engines in the Market... Suitable for all purposes, Manufacturing, Pumping, Irrigation, Farming, Dairy Work, Cold Storage, Grain Elevators, Threshing, Corn Husking, Etc.”²⁵

After advertising the Davis Gasoline Engine throughout the previous year, in 1896 *Prairie Farmer* reported the success of this engine in Iowa. More than 200 Davis engines had been sold in Iowa in 1895; eight letters from satisfied Iowa farmers were published. These farmers had bought engines from 2.5 to 10 HP, mostly to grind feed and pump water. One liked his ability to use his four HP engine to grind feed while he did other things. Another used his 10 HP engine with a line shaft in his shop to simultaneously drive an emory wheel, corn sheller, and feed grinder. A third had a line shaft for his 2.5 HP engine that his boys (one of whom was 14) used to pump water for livestock, run the cream separator, and grind feed at the rate of 8 to 11 bushels per hour. “The boys would

not trade it for all the geared windmills in the township,” he said. Another used a six HP engine to run his “well-drilling machinery.” He found it preferable to steam power and believed it would pay for itself in a short time.²⁶

Because they could operate unattended, gas engines were quickly adopted for irrigation. A 1900 *Farm, Field and Fireside* article reported that they were rapidly replacing steam engines for irrigating orchards in California. According to the article, “the cost has reduced itself to such a small figure that it is possible for every man who owns a ranch or orchard property to have an irrigating plant.” A Yuba County farmer estimated that the expense for his gasoline engine was about one-fifth of the expense for steam power to irrigate his 30-acre orchard.²⁷

The same magazine ran a 1904 article illustrating the varied uses of the gasoline engine based on pictures and testimonials from a gas engine manufacturer. One picture showed a three HP engine running a washing machine while the lady of the house did other chores. In another, an engine ran a grain elevator, and a third photo showed hay unloading. One picture showed a farmer’s power plant: a two HP engine connected to a shop line shaft which pumped water and ran the cream separator, the washing machine, the churn, the wood saw, and the cider mill without moving the engine. Other farmers were pleased with their portable engines. A farmer from Olney, IL used a gas engine to spray his orchard. He said, “We have hauled it all over our orchard on all kinds of rough ground, across ditches, spraying with it and it will run just as well on a farm wagon as on a solid foundation. . . . The engine is far ahead of anything I have ever used or seen used for spraying.” Joseph Byers of DeKalb County, IL used a portable six HP engine to run his hay press. He said “I believe that I baled more hay in the same length of time than any other baler of the same size on the market.” Byers was pleased that his engine was lightweight (more so than a steam engine) for hauling from farm to farm. The editors concluded on the basis of such evidence: “The gasoline engine, therefore, fills a need, and is now rapidly superseding all other forms of power.”²⁸

The Development of the Gas Engine Market

Although knowing how many farmers bought gas engines in 1895 and how many farmers had bought them in 1904 would be interesting, that information is unavailable. Researchers of the day queried the larger manufacturers. U.S. Department of Agriculture (USDA) researchers Lucke and Woodward explained, in 1907, the difficulty in getting information “because of the unwillingness of manufacturers to tell their business.” They continued, “but when a single manufacturer (as is the case) is selling 425 [gas engines] per day, and there are in the United States alone some 300 manufacturers of importance, there can be no doubt as to the popularity of these machines.”²⁹ The Bureau of the Census first collected data on gas engine use on farms in 1930, when it had already become a moot point. By then 58 percent of U.S. farmers had at least one automobile; in Midwestern states like Iowa, 90 percent of farmers had automobiles, 30 percent had tractors, and 8 percent were already using electric motors for farm work.³⁰ Tractors were designed to provide both stationary and draft power for farmers, and automobiles also did

so. The latest recognized estimates of numbers of gas engines on farms prior to 1930 are those ballpark figures contained in a 1933 USDA Bulletin by Hurst and Church.³¹

Table 1
Gas Engines, Automobiles, Tractors, and Trucks on Farms, 1900-1930
(in thousands)

	1900	1910	1920	1930
Stationary engines	200	600	1000	1131
Automobiles	--	50	2146	4135
Tractors	--	1	246	920
Trucks	--	--	139	900
Total Farms in U.S.	5740	6366	6454	6295

Sources: For gas engines, W. M. Hurst and L.M. Church, *Power and Machinery in Agriculture*, USDA, Miscellaneous Publication, No. 157, April 1933, Washington, D.C. Table 8, p. 12. For automobiles, tractors, trucks, and farms, *Historical Statistics of the United States*, Millennial Edition Online, series DA 628, DA 623, DA 627, and DA16, respectively.

Table 1 contains these figures as well as the numbers of automobiles, tractors, and trucks on farms from 1910 to 1930. The figure of 600,000 engines in 1910 coincides with an estimate by Edward A. Rumely.³² *Gas Review* editors estimated one million gas engines on farms in 1914, 1.5 million in 1916, and two million in 1917.³³ A 1925 USDA Bulletin by C.D. Kinsman put the number of gas engines on farms at 2.5 million by 1924.³⁴ The 1930 census, however, found only about 1.1 million gas engines on farms. The 1933 Hurst and Church study took the Kinsman study as a starting point, but scaled back the estimates of engines for better alignment with the census figure. No doubt many of the early gas engines were sold for scrap iron before 1930. Scrap iron was urgently needed during World War I, and farmers needed cash in the 1920s. Farmers would often trade in an old engine when they bought an automobile, tractor, or other farm implement. Still the figure of one million gas engines on farms in 1920 seems low, as does the census figure.³⁵ Hurst and Church noted that “the use of the stationary gas engine for farm work probably reached a peak between 1920 and 1930.”³⁶

A richer sense of the development of the farmers’ market for gas engines can be found in the Sears, Roebuck & Co. catalog. The Sears history reflects the rapid change in the gas engine industry around the turn of the century. Sears began listing gas engines in the fall 1898 catalog, alongside the previously carried 2 to 4 HP vertical steam engines. Three sizes of Racine Gasoline Farm Engines were offered -- ¾, 1, and 2 HP -- in the catalog’s agricultural implement section. The following year, Burrell upright and horizontal gas engines were listed with sizes up to 10 horsepower in the horizontal styles. (Larger farm engines were typically horizontal which made them more stable for portability. Smaller engines, for pumping or for the dairy, were often vertical and were smaller, lighter weight, and ran at higher speeds.) In 1902 the Kenwood line of engines, produced by the Charles A. Stickney Co. of St. Paul, MN, replaced the Burrell line; Kenwood was offered through 1907. In 1908 Sears offered a new Economy line of engines.³⁷

Although comparing prices over the years, with various engines available, is subject to major caveats, certainly by 1905, prices had fallen significantly, and engine quality had improved. The Otto Gas Engine Works offered a four HP horizontal engine for \$680 in 1887; in 1900 a 3.5 HP Otto engine cost \$300.³⁸ That same year, 1900, Sears offered a six HP Burrell horizontal for the same \$300, likely lower in quality. In 1903 the Sears Kenwood 6 HP horizontal engine cost \$215; the 1905 “new model” six HP Kenwood cost \$199; and in 1906 the same engine cost \$179.³⁹ (The weight of the six HP horizontal engine had also fallen to just 1500 pounds by 1906.)

Until 1905 Sears had devoted no more than a page to farm gas engines. In 1904, however, the general catalog noted that the Sears line of engines (including gas and steam, farm engines and marine engines) was “so complete and so extensive that we find it necessary to issue a special catalogue.”⁴⁰ The main catalog featured just a small selection of gas and steam farm engines. In 1905, in addition to the Kenwood farm engine line in the agricultural implement section, a “great offer” on a three HP Harvard Gasoline Engine “for the farm or ranch . . . for only \$72.85” was given two pages to discuss the merits of the engine and the 60-day free-trial offer.⁴¹ Then in fall 1906, the complete line of engines went into the general catalog, with 12 pages devoted to farm gas engines and one page devoted to marine gasoline engines and vertical steam engines. The pages included in-depth specifications and illustrations of the smaller vertical engines used with pumps, cream separators, washing machines and churns, and the larger portable horizontal engines used with wood sawing outfits also available from Sears.⁴²

Sears sold many engines, no doubt; but most farmers preferred to buy farm equipment from trusted local dealers. According to C.H. Wendel, Fairbanks-Morse and International Harvester Company (IHC) were by far the industry leaders in farm engine sales. IHC was only created in 1902 from the McCormick and Deering merger. But IHC quickly positioned itself to sell farm engines in the increasingly hot market. In 1905 IHC listed gasoline engines among its many products in farm magazine advertisements. The following year IHC ran ads focused on gasoline engines; it offered vertical engines in 2, 3, and 5 horsepower and horizontal engines in 4, 6, 8, 10, 12, and 15 HP. The latter were available in either stationary or portable styles.⁴³ IHC produced the Famous, Mogul, and Titan lines of engines; all were popular with farmers in the early years of the 20th century. Wendel notes that “From the statistical viewpoint, these engines probably outsold anything on the market, and had few rivals in quality and dependability.”⁴⁴ Production of all three of these lines ended during 1917 and 1918.

In spring 1906, *Prairie Farmer* was already reporting that farmers in Indiana and Illinois were buying automobiles – especially lightweight “runabouts” but also heavier (and more expensive) touring cars.⁴⁵ By 1909 and 1910, automobile producers, Sears and IHC among them, were flooding the farm magazines with advertising. Sears introduced a 2-cylinder motor buggy in 1909 for as little as \$335; IHC had introduced a 2-cylinder auto buggy the previous year.⁴⁶ Hudson, Hupmobile, Maxwell, Mitchell, Overland, and Winton were a few of the other automobiles advertised in *Prairie Farmer* and *Farm, Field and Fireside*.⁴⁷ Ford, already an industry leader in 1910, scarcely needed to advertise, after introducing the Model N in 1906 for \$600 and the 4-cylinder, 20 HP

Model T in 1908 for the bargain price of \$850. Ford's success story with farmers is well known. By 1920, most cars in the United States -- 60 percent -- were Fords; and farmers, who made up 30 percent of the U.S. population, owned more than a quarter of all cars in America.⁴⁸

Excitement with automobiles, between 1908 and 1920, likely stimulated interest in small gas engines. While Table 1 indicates that farmers bought more automobiles than stationary gas engines during these years, the editors and authors of *Gas Review* indicated the contrary.⁴⁹ One such writer noted in September 1908 that small gas engines were "so numerous and so cheap" that many farmers were "seizing the opportunity to lighten the burdens of farm life."⁵⁰ Sears had a two HP Economy gas engine that sold for \$49.95 in 1908, and by 1912 the price had fallen to \$41.75.⁵¹

Many prosperous Midwestern farmers already had gas engines by 1908 and were the farmers most likely to buy automobiles. But those who had not yet bought a stationary engine found that a Ford could provide transportation as well as a versatile, lighter-weight substitute for stationary power. Some farmers borrowed power from their automobile by jacking up the rear wheels and attaching a belt. Experts advised against the practice, but as car prices fell and used cars came onto the market, such practices increased. In 1916 one farmer wrote to *Gas Review* about how he had turned a second-hand Ford into a stationary engine for use with a line shaft.⁵² The same issue reported on an attachment devised for the front end of a Model T that could be attached to the engine in about fifteen minutes and used to grind feed. Similar attachments could be adapted to any make of automobile, reportedly without injury to the vehicle.⁵³ Ron Kline notes that such conversion kits came out as early as 1912 and turned the farm auto into the most popular farm power source by about 1920.⁵⁴ Sears devoted considerable coverage to their stationary engine line during World War I, when farmers were flush with cash. By then the Sears engines came with built-in magnetos and could run on kerosene, which was much cheaper than gasoline during the war. Coverage diminished in the late 1920s and Sears began offering the more popular conversion kits for use with the Model T as well as electric motors, milkers, and cream separators. By 1932, less than a page of the Sears catalog was devoted to farm engines.⁵⁵

The Farmer as Engine Mechanic

While reliable estimates of the numbers of gas engines on the farm in the early 1900s are elusive, the farm gas engine is significant not so much for the aggregate power it provided, but for the early training of hundreds of thousands of farmers in engine mechanics. Those who have studied the introduction of the automobile in rural America -- scholars like Wik, Flink, and Nevins -- have given considerable credit to the expertise of farmers trained on stationary gas engines.⁵⁶ Farmers were a ready market for a rugged, low-priced automobile, and Henry Ford did the best job of satisfying their needs. Just 12 years after the Model T was introduced, half the new cars in the world were produced by Henry Ford.⁵⁷ The well-trained mechanics on America's farms helped make the United States the leader in automobile production. An extraordinary record of the

training process of these mechanics appears in *Gas Review*, launched in January 1908 in Madison, Wisconsin.

Farmers, eager to learn more about their gas engines, welcomed the magazine. Articles provided troubleshooting guides, specific lessons on the workings of the gas engine, advice on how to set up a farm shop with a line shaft to run several machines at once, and advice on setting up a gas-engine powered electric plant for the farm. The question and answer department was popular: farmers wrote to ask technical questions, sometimes accompanied by diagrams, and the editors gave specific feedback. Questions dealt with problems such as remodeling an engine from a throttling governor to a hit-and-miss governor,⁵⁸ whether water or air-cooled engines were best for farm work, which fuel was most economical, and what size pulley to use with a line shaft. The correspondence section was equally popular with farmers who sent in pictures of their engine in use and wrote about their experiences. Within a few years, pictures and stories of homemade tractors became commonplace in the monthly issues of the magazine. In 1918 the magazine changed its name to *Tractor and Gas Engine Review* to more properly reflect its readership.

When farmers renewed their subscription, they included words of praise. Many wrote that they would not like to miss a single issue: “I consider each copy worth many times its cost to anyone who uses a gasoline engine.”⁵⁹ Others commented that the only problem with the magazine was that it did not come often enough, or they bragged that with the help of the magazine they were always able to overcome trouble without expert aid. A rural Kansas engineer, with some 20 years of experience with gas engines (already in 1908), called *Gas Review*, “one of the best if not the best paper of its kind ever published.”⁶⁰ A North Dakota farmer wrote that he had just recommended the magazine to a friend with a new automobile and noted: “I hope you will continue the lessons in gasoline engineering down to the minutest detail.”⁶¹ Few were more emphatic than the Wisconsin farmer, who said of the magazine, “I would rather read it than eat.”⁶²

The early engines were much more challenging than the advertisements and testimonials in 1895 suggested. In particular, many of the early engines were difficult to start and quickly developed a bad reputation. Experts who wrote for *Gas Review* in its debut year remarked on that poor reputation. H. M. Bainer, Professor of Farm Mechanics, said farmers had good reasons for not adopting gas engines more rapidly: “so many of the first engines proved so unsuccessful.”⁶³ Some blamed inferior engines for giving all engines a bad reputation; and many warned against cheap engines. One correspondent noted: “Nine times out of ten a cheap engine isn’t worth the powder to blow it up.”⁶⁴ Others blamed the poor reputation of the gas engine in part on salesmen that overhyped its potential.⁶⁵

Ignition systems were primitive in the early 1900s and notoriously problematic. By 1900, for most farm engines, batteries were replacing earlier “hot tube” ignition systems, that relied on metal tubes heated red hot.⁶⁶ Batteries, though an improvement, were far from perfect; they might be weak, faulty, or succumb to cold temperatures and often would need replacement at awkward times. Batteries were used with either spark plugs

or the simpler “make-and-break” igniter. (The latter relied on a circular current that when broken provided a spark.) Spark plugs systems were especially susceptible to moisture and short circuiting. Most early farm engines had make-and-break ignition. Although moisture could also confound make-and-break ignition, more often the problem was built-up carbon on the contact points.⁶⁷ By 1908, self-sparking magnetos were available that could eliminate the need for batteries. As the cost of magnetos fell, farmers updated their ignition systems. Two Kansas brothers wrote to *Gas Review* in 1913 that they had ordered a magneto for their eight HP engine, “because it uses up batteries too fast.”⁶⁸ An Illinois farmer wrote, “After your little magazine came out I got wise and bought a Hendricks magneto and since then my engine has been a dependable power.”⁶⁹

Fuel quality was also a problem in the early 1900s. The gasoline obtained from wells in different regions of the country differed significantly. Not all farmers had underground fuel storage tanks and some neglected removing the fuel when the engine would be idle for extended periods. Thus the gasoline was often contaminated with water. Moreover, farmers wanted to use the cheapest fuel possible. When gasoline prices rose, many switched to kerosene (or even naphtha or coal oil), but the heavier, less volatile fuels ignited less readily.

Whether or not the farmer could start the engine depended not only on the engine and the fuel, however; it also depended on the farmer. E.L. Vincent wrote, “When first made these machines were rather complicated for the average farmer. . . . The boys with inquisitive minds could unravel their mysteries,” but such boys, he said, were scarce. Vincent claimed that the machines were less complicated by 1908, so that “almost any farmer of ordinary intelligence,” could master them.⁷⁰ Others also remarked on this duality. A Pennsylvania farmer noted the need for “a hot spark and a cool head.” He thought every farmer with a bit of mechanical ability that subscribed to *Gas Review* and read it carefully should have a gas engine.⁷¹ J.B. Davidson, Professor of Agricultural Engineering, said that the “unfavorable reputation of the gas engine” had changed by 1908 and that by then most farmers understood that, “reliability depends on the skill of the engineer.”⁷²

Early farm engines required attention. Protection from the elements and regular cleaning and oiling were critical, as was care in break-in. According to George Cormack, “Too much care cannot be exercised in the starting up and operation of a new gas engine . . . Carelessness during the first few days running may cause damage that will discount the maximum efficiency of any machine for all time.” He recommended thorough reading and re-reading of instructions, thorough cleaning and oiling, several preliminary runs of the engine, appropriate adjustments and limited runs during the first week.⁷³ The same author in a subsequent issue wrote on overhauling the gas engine. Even if the engine were cleaned daily, he said, it would need a more thorough going over occasionally. He considered this task to be “well within the scope of the ordinary operator even if he is not a qualified mechanic.” According to Cormack, “There is really nothing difficult in taking a gas engine apart and fixing it up in good shape if reasonable care is exercised. . . . The greatest trouble generally arises with the inexperienced man being in too great a hurry and in being too careless in taking the machine apart.”⁷⁴

The availability of used engines afforded many men the opportunity to practice their skills. As better engines became available, farmers often traded their old engine for a newer more reliable engine, one with more horsepower, or even a tractor. Others were disappointed with the early gas engines and went back to steam power. An Iowa farmer wrote that his father had bought the area's first gasoline engine in 1901. He used it for threshing on his own and other farms. For five years he struggled with the hot-tube ignition but when he finally had to send for an expert from Waterloo, he got disgusted and traded it for a steam engine.⁷⁵ For such reasons, used gas engines came onto the market. Experts who wrote for *Gas Review* warned against buying them, but many did.⁷⁶ They might put on a new ignition system and get them running again. One Iowa farmer decided it was "no trick to fix a gas engine when you once get the knack of it." His experience with engines began around 1910, and by 1917 he had repaired several small engines that had cost him very little -- one had been through a fire, and he rescued it from the junk pile. His nine engines (one yet to be repaired) also included a tractor.⁷⁷

A guy with a knack could get an old engine cheap and fix it up, and the skilled and careful operator could avoid repairs and prolong the life of a new gas engine, increasing the return on his investment; but the operator's skill was also critical for the engine's efficient running. E.A. White stressed that careless operation could result in twice as much fuel as necessary being burnt. The skilled operator would check for proper compression, timing, proper adjustment of the exhaust valve to optimize performance and efficiency; then by listening carefully to the engine, the operator would set the needle valve to regulate fuel flow. "To sum up," wrote White, "the economical running of a gasoline engine depends almost entirely upon the skill of the operator."⁷⁸

Thus while the early farm engines were fairly simple, they required care and basic skills. With heavy use, cold, damp or dusty conditions, or months of storage, problems were sure to develop. The farmers who owned them needed to become engine mechanics; many readily rose to the challenge. A Kansas farmer summed it up this way: "To get along well with a gas engine one must have patience and common sense. When trouble arises one should stop and think a little before using a wrench or a pair of pliers or something that does more harm than good. I generally find some simple thing wrong with my engine, either fuel, ignition or timing, when I have trouble."⁷⁹

The Road to the Automobile and the Tractor

Those farmers who already had skills with gas engines were among the first to buy automobiles and tractors. Flink called farmers the "mainstay of the market for automobiles" by 1906. He reported that many agricultural states, like the Dakotas, Nebraska, Minnesota, and Kansas, in particular, had some of the highest automobile per person ratios in the country in 1910.⁸⁰ Meyer's recent case study records how quickly automobiles swept onto farms around Rockford, IL between 1909 and 1914.⁸¹ Farming was prosperous during those years and many farmers who bought automobiles then had bought gas engines between 1905 and 1907. Farmers who weren't early buyers of gas engines knew they could get assistance from their neighbors who had become engine

mechanics. Thus they felt comfortable buying an automobile, although the cost of \$850 or so for a touring car in 1910 amounted to 160 percent of average annual factory wages.⁸²

The correspondence section of *Gas Review* is full of letters from farmers with multiple stationary engines in addition to automobiles and tractors. A Washington state farmer was rather typical of those who wrote in 1916. He had two gas engines and an automobile.⁸³ A Kansas thresher man with four brothers wrote that they had four gas engines among them – at least one of those was a gas traction engine.⁸⁴ A young North Dakota farmer wrote in 1922 about how pleased he and his father were with their new IHC Titan tractor. He noted that his family also had a Maxwell car and two stationary engines of 1 ½ HP and 4 HP.⁸⁵

The gas tractor was introduced about the same time as the automobile, but it was adopted quite slowly.⁸⁶ Early tractors had the same ignition issues the stationary engines did in addition to many other problems; and since they were modeled after the big steam traction engines, they were expensive. As one Iowa farmer wrote in 1913, “After paying two to three thousand dollars for a [tractor] we are in no humor to help the manufacturer correct weaknesses and faults in design.”⁸⁷ Horses provided poor stationary power, but they were quite effective in the field. Farmers needed automobiles for rapid transportation, but speed was not an issue in plowing. Only when Henry Ford introduced the Fordson tractor in 1917 did tractor sales take off. In 1908 there were less than one thousand tractors on farms; by 1920 there were still fewer than a quarter million tractors on farms. (See Table 1.)

While few farmers had bought tractors in 1908, readers of *Gas Review* were already building their own. In August 1908, a 17-year-old wrote and sent a picture of the traction engine he built with a small pumping engine and “old junk and such stuff.” A farmer from Iowa Falls also wrote of the small tractor he had built with a three HP engine. It could travel up to five miles per hour and could carry two people.⁸⁸ These farmers had not intended to build a tractor that could perform in the field; they wanted tractors that could self-propel and provide belt power without hitching up the horses to haul the engine. Some built tractors that could also haul machinery – as did a farmer from Lincoln, KS. Like most, he built it of “old pieces of machinery, such as old binders, old mowers, and other things.” When he used his tractor for sawing wood and shelling corn, he could haul the saw or corn-sheller with him.⁸⁹

As months passed, more and more farmers wrote and sent pictures to *Gas Review* of their homemade tractors. Soon nearly every issue had two or more letters from farmers who had built their own tractors. One farmer wrote that he had built two tractors, and he was not the only farmer who advised against doing so. But these men enjoyed the challenge and were eager to share experiences. An Iowa farmer wrote, “I am going to build a tractor this winter. I have been drawing up plans for it but have been unable at present to perfect a differential gear to satisfy my needs. I am going to build [the tractor] out of old binder drive wheels and gearing. I would be glad to see some suggestions on this in your paper.”⁹⁰

The real trick was to build a tractor useful for fieldwork – even the large manufacturers struggled to build a tractor that could pull a plow through heavy soil. A Nebraska farmer wrote in 1913 of the tractor he made with a 30 HP E.M.F. automobile engine which he used for discing and harrowing.⁹¹ (The disc and harrow rode on top of the soil, breaking up the larger clods of dirt.) Another farmer wrote of the tractor he built primarily for stationary work; he was surprised and pleased to find that he could also plow with it. His story shows the mettle of these early rural engineers:

Having read considerable about homemade tractors in [*Gas Review*], . . . and having operated four different . . . tractors in North and South Dakota and Canada and owned five gasoline engines, I arrived at the usual conclusion that I could build a tractor, so I got some old steam engine wheels sixty inches high and twelve inches wide rear, forty-two inches by six inches front, and a 25-horse power four cylinder motor, shafting, gearing, angle iron, pipe fittings, bolts, rivets, etc., and went to it. . . . It took all my spare time, and some that wasn't just exactly spare, for twenty-two months from the time it was started until it was ready for use.⁹²

Others converted a Model T for use as a field tractor. One farmer wrote to ask about the advisability of doing so: “My idea is to get a good secondhand car of 1914 or 1915 model, take the back seat off and put a truck frame and a pair of tractor wheels on and have a farm tractor.”⁹³ The editors replied that many companies had already introduced kits to do exactly that. A kit called the Pullford was introduced in 1917. It featured steel tractor wheels that could be attached to a Ford in 30 minutes, according to the advertisement, and it sold for \$135.⁹⁴ That amounted to about \$2300 in today's dollars – not a trivial sum but considerably less than the \$750 a Fordson tractor would cost in 1918.⁹⁵ Given the deficiencies of the Fordson and other tractors of the day, the reliability of horses, the availability of used cars, and the resourcefulness of farmers, it is little wonder that real tractors arrived slowly on the farm.

The slow adoption of the tractor has been dealt with elsewhere, however. Most studies of the gasoline engine on the farm begin where this one ends – with the tractor. A few historians, like Wik and Kline, have also carefully considered the impact of the automobile on the farm. But, except as a small part of much larger studies, scholars have virtually ignored the role of the stationary gasoline engine on the farm. No doubt this is because the critical period for the gas engine was so short, the data on the numbers of gas engines were so poor, and the ultimate impact of the tractor was so significant.⁹⁶

This paper has made at least two points that are worth repeating. First, it was the demand for stationary power that first brought the gasoline engine to the farm. This fact has been overshadowed with the near exclusive focus (especially in the economics literature) on the transition from horses to tractors for draft power. Initially even the early tractors were valued largely as self-propelled stationary power sources. Second, the overpowering significance of the farm gas engine was the role it played in training many hundreds of thousands of farmers across the country as engine mechanics. It made the

rapid diffusion of the automobile across America possible and contributed to America's leadership in the automobile industry.

¹ *Gas Review* was published monthly in Madison, WI, beginning in January of 1908. Bascom B. Clarke was the editor and he was later joined by Philip S. Rose. Issues in 1908 are marked "Copyright, 1908, by *The American Thresherman*."

² A few of these books were written to help sell the engines, others were textbooks, but they all described how the engines worked. See H. R. Brate, *Farm Gas Engines*, (Cincinnati, Ohio: The Gas Engine Publishing Company, 1912.); C. F. Hirshfeld, & T.C. Ulbricht, *Farm Gas Engines* (New York: John Wiley & Sons, Inc, 1913.); Raymond Olney, *Power Farming* (La Porte, IN: M. Rumely Company, 1913.); Andrey A. Potter, *Farm Motors: Steam and Gas Engines, Hydraulic and Electric Motors, Traction Engines, Automobiles, Animal Motors, Windmills* 2nd Edition (New York: McGraw-Hill Book Co., Inc., 1917.) (1st edition published in 1913.); and Xenon W. Putnam, *The Gasoline Engine on the Farm: A Practical, Comprehensive Treatise on the Construction, Repair, Management and Use of this Great Farm Power as Applied to All Farm Machinery and the Farmer's Work Indoors and Out*, (New York: The Norman W. Henley Publishing Company, 1913). E. W. Longanecker, M. D. *The Practical Gas Engineer* (Anderson, IN, 1901) is a popular early handbook that appealed to farmers and others at the field level. It was used at short courses held at agricultural colleges and advertised in *Gas Review*.

³ This estimate was made by Philip S. Rose, who was editor of both *The American Thresherman* and *Gas Review* at the time. See "The Farmer's Power Plant" *Literary Digest* (November 27, 1915), p. 1220.

⁴ Many scholars since the 1950s have mentioned the use of gasoline engines in studies focused on the automobile or the tractor. See Robert C. Williams, *Fordson, Farmall, and Poppin' Johnny: A History of the Farm Tractor and Its Impact on America* (Urbana, IL: University of Illinois Press, 1987), 35-36; John T. Schlebecker, *Whereby We Thrive: A History of American Farming, 1607-1972* (Ames, Iowa: The Iowa State University Press, 1975), 194-95 mentions that stationary gas engines began to replace steam engines as early as 1900. Scholars of automobile history have recognized that farmers' familiarity with gas engines sped the adoption of automobiles in rural areas. See James J. Flink, *America Adopts the Automobile, 1895-1910*, (Cambridge: The MIT Press, 1970); Ronald R. Kline, *Consumers in the Country: Technology and Social Change in Rural America* (Baltimore: The Johns Hopkins University Press, 2000); Reynold M. Wik, *Henry Ford and Grass-roots America* (Ann Arbor: The University of Michigan Press, 1972); and Allan Nevins, *Ford: The Times, The Man, The Company*. New York: Charles Scribner's Sons, 1954.

⁵ C. D. Kinsman, *An Appraisal of Power Used on Farms in the United States*, USDA Department Bulletin 1348 (Washington, DC: Government Printing Office, 1925).

⁶ For the advantages and disadvantages of various power sources see W.W. Stevens, "Motive Power on the Farm", *Prairie Farmer*, July 6, 1895, p. 1; E.L. Vincent, "Power for Farm Work" *Gas Review* 1: 12, December 1908, p. 38; "Practical Farming: Farm Power," *Farm, Field and Fireside*, Dec 17, 1904, p. 8; Frank R. Case, "Power Problem on the Farm," *Prairie Farmer*, Aug 15, 1908, p. 4; J.B. Davidson, "The Gasoline Tractor," *Gas Review*, 1:12, December 1908, pp. 5-7; and C. D. Kinsman, *An Appraisal of Power*, pp. 46-47.

⁷ See C.H. Wendel, *Encyclopedia of American Farm Implements & Antiques* (Iola, WI: Krause Publications, 1997), 210-213; Davidson, p. 5; Case, p. 4; W.W. Stevens, p. 1; Schlebecker, p. 194; Reynold M. Wik, *Steam Power on the American Farm*, Philadelphia: University of Pennsylvania Press, 1958, p. 25.

⁸ Wendel, *Encyclopedia*, pp. 382-395.

⁹ Wik, *Steam Power*, pp. 20-22; Schlebecker, p. 192. See Wik for a full discussion of steam power on the farm.

¹⁰ Farm Implement News Co, *Buyer's Guide: Where to purchase farm implements, machinery, and repairs 1903*, Chicago: Farm Implement News Co., 1903 p. 65-69.

¹¹ Wik, *Steam Power*, p. 37.

¹² Wik, *Steam Power*, p. 210.

¹³ Stevens, p. 1.

¹⁴ Putnam, *The Gasoline Engine on the Farm*, 36-37.

¹⁵ See, for examples, *Prairie Farmer*, June 15, 1895, p. 16; *Farm, Field and Fireside*, June 27, p. 9 and Oct 2, 1897, p. 2. Webster was a Chicago company and Lambert produced in Anderson, IN. Wik, *Henry*

Ford, p. 20 records numerous advertisements in *Country Gentleman*, *Dakota Farmer*, and the *Nebraska Farmer* in 1900 for the Leffel, Foes, and Fairbanks-Morse engines.

¹⁶ *Prairie Farmer*, Aug 17, 1895, p. 7.

¹⁷ Harold F. Williamson and Arnold R. Daum. *The American Petroleum Industry: The age of illumination 1859-1899*. Evanston, IL: Northwestern University Press, 1959, p. 164.

¹⁸ For crude prices going back to 1859, see American Petroleum Institute, *Petroleum Facts and Figures, Centennial Edition*, New York: American Petroleum Institute, 1959, p. 9.

¹⁹ Harold F. Williamson, et al. *The American Petroleum Industry: The age of energy 1899-1959*, Evanston, IL: Northwestern University Press, 1963, p. 170-84.

²⁰ C.H. Wendel, *American Gasoline Engines Since 1872*, (Sarasota, Florida: Crestline Publishing Co., 1983), pp. 367-368.

²¹ See *American Agriculturalist*, Sept 8, 1894, Vol 54: 2, p. 58 as well as subsequent weekly issues through the remainder of the year.

²² C.H. Wendel's ambitious survey (*American Gasoline Engines Since 1872*) contains thousands of pictures and abundant details from over 2000 companies that produced engines at least briefly between 1890 and the early 1940s. The *Patent Office Gazette* was a primary source for Wendel. R.B. Gray, *The Development of the Tractor in the United States*, p. 11, notes that "In 1899 there were approximately 100 firms engaged in the manufacture of internal combustion engines in the United States; in 1911, 400 firms and in 1914, 549 (not including the automobile manufacturers)."

²³ Farm Implement News Co, *Buyer's Guide: Where to purchase farm implements, machinery, and repairs 1903*, Chicago: Farm Implement News Co., 1903, pp. 69-73.

²⁴ Olds began producing gas engines in 1891, Foes and Waterloo in 1893, and Stover in 1895. Hart-Parr, Stickney and R & V also began producing before 1899. These production dates are from Wendel, *American Gasoline Engines*, pp. 355, 176, 532, 489, 220, 485, 432. Wendel assumed that production began with the filing date of the patent.

²⁵ *Prairie Farmer*, Jan 20, 1900, p. 5; For other examples, see *Farm, Field and Fireside*, Apr 2, 1898, p. 2; Sept 10, 1898, p. 2; Aug 19, 1899, p. 19; Jul 7, 1900, p. 7; *Prairie Farmer*, May 29, 1897, p. 16; Sept 03, 1898, p. 4; Sept 23, 1899 p. 4.

²⁶ *Prairie Farmer*, July 4, 1896, p. 14.

²⁷ *Farm, Field and Fireside*, Mar 10, 1900, p. 7.

²⁸ *Farm, Field and Fireside*, Dec 17, 1904, p. 8.

²⁹ Charles E. Lucke and S. M. Woodward, *The Use of Alcohol and Gasoline in Farm Engines*, USDA Farmers Bulletin No. 277, (Washington, D.C.: Government Printing Office, 1907), 12.

³⁰ U.S. Census Data, as cited in *Statistical Abstract of the United States 1935*, Washington D.C.: Dept of Commerce, 1935, Table No. 556, pp. 582-583.

³¹ W.M. Hurst and L. M. Church, "Power and Machinery in Agriculture," U.S. Department of Agriculture, Miscellaneous Publication No. 157, Washington, DC, April 1933, Table 8, p. 12.

³² Rumely belonged to the same family that built steam engines and threshers in the 19th century and gas engines in the early 20th century. Edward Rumely introduced the popular OilPull tractor in 1910. See Edward A. Rumeley, "The Passing of the Man with the Hoe" *The World's Work* 20: 4 (August, 1910): 13246-58. (The name was misspelled in the published article.)

³³ Philip S. Rose, editor at *The American Thresherman* and *Gas Review* published the 1914 estimate in the *Literary Digest*. See "The Farmer's Power Plant" *Literary Digest* (November 27, 1915), p. 1220. See *Gas Review*, February 1916, p. 17 and *Gas Review*, October 1917, p. 15. for the other estimates.

³⁴ Kinsman, "An Appraisal of Power," p. 8.

³⁵ A gas engine manufacturer that contributed to the Correspondence Department of Gas Review in 1908 stated that "by the statistics of the refineries . . . over six times as much gasoline was used by the farmers of the United States during the season past, than was used by all the automobiles in the United States. "Correspondence Department," *Gas Review*, December 1908, p. 60. There were 194.4 thousand automobiles registered in the U.S. in 1908 as found in *Historical Statistics of the United States*, Millennial Edition Online, series DF340.

³⁶ Hurst and Church, p. 13.

³⁷ *Sears, Roebuck & Co. Catalogue*, Fall 1898, p. 926; Spring 1900, p. 1017; Fall 1902, p. 494; Fall 1908, p. 542. See also Wendel, *American Gasoline Engines*, p. 454 on the Stickney Co.

³⁸ Wendel, *American Gasoline Engines*, p. 368, p. 370.

- ³⁹ *Sears, Roebuck & Co. Catalogue*, Fall 1900, p. 959; Fall 1903, p. 349; Fall 1905, p. 570; Fall 1906, p. 544.
- ⁴⁰ *Sears, Roebuck & Co. Catalogue*, Fall 1904, p. 612.
- ⁴¹ *Sears, Roebuck & Co. Catalogue*, Fall 1905, pp. 930-31.
- ⁴² *Sears, Roebuck & Co. Catalogue*, Fall 1906, pp. 534-546; Spring 1907, pp. 700-712.
- ⁴³ See *Farm, Field and Fireside*, Mar 25, 1905 p. 5 and Apr 7, 1906, p. 5; and *Prairie Farmer* Mar 16, 1905, p. 9; Aug 23, 1906 p. 10.
- ⁴⁴ C. H. Wendel, *150 Years of International Harvester* (Iola, WI: Krause Publications, 1981), p. 113.
- ⁴⁵ *Prairie Farmer*, Apr 26, 1906, p. 3.
- ⁴⁶ See *Sears, Roebuck & Co. Catalogue*, Fall 1909, pp. 1150-51. Similar ads appears in *Farm Press*, Apr 1, 1909, p. 14, and in *Prairie Farmer*, Apr 15, 1909, p. 16. See Wik, Steam Power, pp. 173 on the IHC auto buggy. See *Farm Press*, Mar 1, 1909, p. 8 for an ad for the International Auto Buggy.
- ⁴⁷ See, for example, *Farm Press*, Nov 1, 1910, pp. 7, 9, 11; *Farm Press*, Nov 1, 1908, p. 16; *Farm Press*, May 1, 1909, p. 16, *Prairie Farmer*, Nov 15, 1910, p. 21.
- ⁴⁸ James J. Flink, *America Adopts the Automobile*, Cambridge: The MIT Press, 1970, p. 247; John B. Rae, *The American Automobile Industry*, Boston: Twayne Publishers, 1984, p. 38. See Table 1 for cars on farms in 1920, series Df399 *Historical Statistics* for cars registered in 1920, and series Aa716 and Aa764 for farm population as a share of total.
- ⁴⁹ George Townsend stated in 1913 that farmers were buying between 100,000 and 125,000 automobiles each year and an even greater number of gas engines. Geo. A. Townsend, Jr. "Gasoline and Oil Storage on the Farm" *Gas Review*, June 1913, p. 56.
- ⁵⁰ H. B. Bonebright, "Small Portable Gasoline Engines," *Gas Review*, September 1908, p. 72.
- ⁵¹ *Sears, Roebuck & Co. Catalogue*, Fall 1908, p. 542; *Sears, Roebuck & Co. Catalog*, Fall 1912, p. 1386.
- ⁵² Walter A. Bermingham, "Getting the Most Out of the Motor Car," *Gas Review*, March 1916, p. 68.
- ⁵³ F.E. Ross, "Who Should Handle Farm Tractors?" *Gas Review*, March 1916, p. 100.
- ⁵⁴ Kline, *Consumers in the Country*, pp. 72-79. Floyd Clymer, *Henry's Wonderful Model T, 1908-1927*, New York: Bonanza Books, 1955, p. 11 also makes note of the many uses that farmers made of their Fords, i.e. sawing wood, pumping water, grinding feed, generating electricity, etc.
- ⁵⁵ *Sears, Roebuck & Co. Catalog*, Fall 1917, pp. 1494-1501; Fall 1932, p. 1022.
- ⁵⁶ See Wik, *Henry Ford*, pp. 20-21; Flink, *America Adopts the Automobile*, pp. 66-67, 72-73, 230, 242; Nevins, *Ford: The Times, The Man, The Company*, pp. 385, 493-494.
- ⁵⁷ John B. Rae, *The American Automobile Industry*, Boston: Twayne Publishers, 1984. p. 38.
- ⁵⁸ The hit-and-miss governor was generally more economical for farm work. The engine would fire again only after it slowed down sufficiently. The "throttling governor" slows down the engine by controlling the amount of fuel.
- ⁵⁹ "Correspondence Department," *Gas Review*, July 1908, p. 56.
- ⁶⁰ "Correspondence Department," *Gas Review*, July 1908, p. 57.
- ⁶¹ "Correspondence Department," *Gas Review*, July 1908, p. 57
- ⁶² "Correspondence," *Tractor and Gas Engine Review*, February 1918, p. 20.
- ⁶³ H.M. Bainer, "The Gasoline Traction Engine," *Gas Review*, October 1908, p. 38.
- ⁶⁴ "Correspondence Department," *Gas Review*, Nov 1908, p. 62.
- ⁶⁵ A.S. Atkinson, "The Science of Selling Gas Engines", *Gas Review*, November 1908, p. 25; Chas Dawson, "Uncertainty of the Gas Engine", *Gas Review*, September 1908, p. 26; M. Beck, "Manufacturing Gas Engines," *Gas Review*, December 1908, p. 50. See also Lynwood Bryant, "The Internal Combustion Engine" in *A History of Technology*, Volume VII, Part II, Edited by Trevor I. Williams. Oxford: Clarendon Press, 1978, on the reputation of the gas engine for difficulty starting.
- ⁶⁶ E. W. Longanecker, M. D. *The Practical Gas Engineer* (Anderson, IN, 1901), p. 25.
- ⁶⁷ C.A. Ocock, "Gasoline Engine Troubles," *Gas Review*, August 1908, p. 64.
- ⁶⁸ "Correspondence," *Gas Review*, Oct 1913, p. 98.
- ⁶⁹ "Correspondence Department," *Tractor and Gas Engine Review*, July 1918, p. 28.
- ⁷⁰ E.L. Vincent, "Power for Farm Work," *Gas Review*, December 1908, p. 38.
- ⁷¹ "Correspondence Department," *Gas Review*, December 1908, p. 56.
- ⁷² J.B. Davidson, "Gas Engine Instruction for Agricultural Students," *Gas Review*, September 1908, p. 76.
- ⁷³ Geo. Cormack, Jr., "Operating a New Engine," *Gas Review*, July 1908, p. 52.
- ⁷⁴ Geo. Cormack, Jr., "Overhauling the Gas Engine," *Gas Review*, August 1908, p. 20.

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- ⁷⁵ Victor Reichs, "Seventeen Years of Farm Engine Experience" *Gas Review*, June 1913, p. 64.
- ⁷⁶ M. Beck, "The Secondhand Engine," *Gas Review*, November 1908, pp. 12-13.
- ⁷⁷ "Correspondence," *Gas Review*, May 1917, p. 46.
- ⁷⁸ E.A. White, "The Economical Operation of a Gasoline Engine," *Gas Review*, September 1908, pp. 56-58.
- ⁷⁹ "Correspondence," *Gas Review*, November 1916, p. 18.
- ⁸⁰ Flink, *America Adopts the Automobile*, p. 66, 78.
- ⁸¹ See Carrie A. Meyer, *Days on the Family Farm: From the Golden Age through the Great Depression*, Minneapolis: University of Minnesota Press, 2007, pp. 47-54, for the experience of Elmo Davis and the farmers in his community.
- ⁸² See *Historical Statistics*, series Ba4298.
- ⁸³ "Correspondence," *Gas Review*, June 1916, p. 22-23.
- ⁸⁴ "Correspondence," *Gas Review*, April 1916, p. 50.
- ⁸⁵ "Correspondence Department," *Tractor and Gas Engine Review*, April 1922, pp. 20-21.
- ⁸⁶ John Froelich is credited with producing the first gas tractor in 1892. See Gray, *Development of the Agricultural Tractor*. Other good sources on tractor history include Eugene G. McKibben and R. Austin Griffin, *Changes in Farm Power and Equipment: Tractors, Trucks, and Automobiles*, Works Progress Administration, National Research Project, Report A-9, Philadelphia, 1938; Allan G. Bogue, "Changes in Mechanical and Plant Technology: The Corn Belt, 1910-1940" *The Journal of Economic History* 43: 1, March 1983, 1-25; Alan L. Olmstead and Paul W. Rhode, "Reshaping the Landscape: The Impact and Diffusion of the Tractor in American Agriculture, 1910-1960," *The Journal of Economic History* 61: 3, Sept 2001, 663-698; Sally Clarke, *Regulation and the Revolution in United States Farm Productivity*, New York: Cambridge University Press, 1994; Robert E. Ankli, "Horses vs. Tractors on the Corn Belt," *Agricultural History*, 54 (Jan 1980), 134-48.
- ⁸⁷ "A Few Remarks about Horse Power," *Gas Review*, June 1913, p. 26.
- ⁸⁸ "Correspondence Department," *Gas Review*, August 1908, pp. 52-53.
- ⁸⁹ "Correspondence Department," *Gas Review*, November 1908, p. 62.
- ⁹⁰ "Correspondence," *Gas Review*, December 1916, p. 30-34.
- ⁹¹ "Correspondence," *Gas Review*, October 1913, pp. 90-98.
- ⁹² Jas I. Gerstbauer, "Putting a Good Tractor Together" *Tractor and Gas Engine Review*, October 1918, p. 26.
- ⁹³ "Question and Answers," *Tractor and Gas Engine Review*, March 1918, p. 58.
- ⁹⁴ *Better Farming*, Aug 1, 1917, p. 11. Kline, *Consumers in the Country*, p. 76. During the Great Depression, Sears sold such kits for \$99.50. *Sears Roebuck & Co. Catalog*, Fall 1932, p. 990.
- ⁹⁵ Wik, *Henry Ford*, p. 91.
- ⁹⁶ See Olmstead and Rhode, "Reshaping the Landscape," and William J. White, "An Unsung Hero: The Farm Tractor's Contribution to Twentieth Century United States Economic Growth," (Ohio State University: Economics Ph.D. Dissertation, 2000).