

Pre-Frontier Reaper Adoption in the Shenandoah

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1 Introduction

Reapers --- mechanical grain harvesters --- played a key role in the evolution of small, diversified American farms into large, monocultural industrial farms. Traditional farming involved many crops, distributing labor needs over a wide period and supporting long-term hired labor. Wheat, however, requires significantly increased labor at harvest time, just a few weeks each year. Farmers purchased reapers for the potential reduction in the cost of grain, increasing short-term profits and reducing labor costs for wheat by 40%. In exchange, farmers were constrained to move to a model of large-scale monocultural wheat production, further increasing the price of labor during harvest time, making harvest workers more transient, and tying farmers to mechanization and wheat production. These effects yielded a strong dependence on one crop, not previously seen in American farms, and paved the way for tractors' later farm-enlarging effects.

The McCormick Harvesting Machine Company was one of the first and quickly the foremost of the reaper manufacturers, and played a critical role in advertising and building awareness of the new machines. McCormick probably invented the reaper in 1834, and sold about 90 reapers in the lower Shenandoah Valley before moving to Chicago in 1842. McCormick reapers spread across the Midwest over the next years, and eventually spread back to the Shenandoah Valley, the major grain-producing region of the eastern states. The Shenandoah Valley differed from the Midwest in several critical factors: wheat-centric farming had always been major, transportation infrastructure was well-developed before

the reaper's introduction, and farms generally were smaller than Midwest homesteads. While Midwestern reaper diffusion has been closely studied in relation to Midwestern settlement and development, the effect of these factors on Shenandoah reaper adoption have not been examined and are different in several key ways.

1.1 Significance of Reapers

A reaper was a major purchase for most farmers of this era. Contemporary farming guides recommended that a man devote \$475 in order to purchase farming equipment for a 160-acre western farm[Danhof, 1941, p. 348]. Of this, \$150 to \$180 was devoted to a reaper, and \$20 was devoted to blacksmithing tools to keep the reaper in repair. No other single piece of recommended farm equipment was worth more than \$70, and barn construction cost roughly \$250; a reaper was thus considered the largest 'essential' of a new farmer in the midwest, almost as valuable as a barn.

From an economic perspective, an 1851 reckoning said a reaper was worth 12 men[London, 1961, p. 89] at \$1.50 a day, meaning a reaper saved \$18 per day under ideal circumstances.[Young, 1983, p. 314] A reaper therefore paid for itself in just over 5 days of perfect harvest. However, reapers often broke down, necessitating lost time and blacksmithing tools to repair; these savings assumed a very high yield, attainable only 3 out of each 10 years, of 35 bushels/acre, instead of 20 bushels/acre typical during this period[Jones, 1983, p. 66]; and five days' harvest, at 8-15 acres per day[Census Office, 1864, p. xxiii], was much more wheat

than most people raised. In order to make a maximum return on a reaper, farmers were thus incentivized to plant as much wheat as possible: if the yield was poor, the reapers' capability would not be the limiting factor, and if the yield was good, they were incentivized to have planted the maximum amount harvestable by their reaper.

1.2 Patterns of Reaper Cooperation vs. Threshers

Because a reaper was such a large purchase, many farmers were unable to fully exploit their reaper with their labor capability. Data indicates that reapers were also one of the few collaborative purchases that farmers made with their neighbors: many Midwestern farmers without a high acreage in grain purchased a reaper with their neighbors. Olmstead found reapers were often purchased by large farms or groups of smaller farms, and traveled among these farms in a local area during the short harvesting period: he argues that 25% of McCormick purchasers of 1854 and 1859 listed two owners, usually with different last names, and that unrecorded sharing or hiring agreements were even more common [Olmstead, 1975].

An 1852 comment indicated that midwestern farms occasionally hired a reaper, at 50-75 cents per acre [Danhof, 1941, p. 348]; Olmstead has also found evidence of major reaper sharing and collaboration in purchasing. However, these have been insufficiently studied, and reapers seem to have been majority single-owner, even if multiple farmers used a significant fraction of reapers.

Interestingly, threshers, another piece of grain production machinery, had ownership patterns very different from reapers. Threshers were more expen-

sive and had higher labor requirements: a typical Midwestern thresher of 1869 could thresh 300-500 bushels per day, perhaps 10 to 15 acres production, cost \$500 to \$1000, and required 9 men and 10 horsepower to operate[Rogin, 1931, p. 185]. This cost and labor requirement strongly discouraged individual ownership, and itinerant threshing outfits unbound to any particular farm quickly developed. Threshers typically charged around five cents a bushel to thresh for wheat [Danhof, 1941, p. 348], requiring, thus, ten thousand bushels of wheat to be threshed without dealing with labor and power costs.

1.3 Influences on Reaper Diffusion

Several economic hypotheses have been proposed to explain the diffusion of the reaper across the Midwest, which took nearly twenty years after its invention. Paul David proposed a threshold hypothesis, where a farmer would buy a reaper given certain threshold conditions being fulfilled. David made several assumptions, catalogued by Olmstead, that farm sizes were normally distributed about the mean, reaper efficacy did not significantly change before widespread reaper adoption, farmers effectively only purchased reapers alone, land in grain is irrespective of reaper ownership, and that farmers would buy a reaper at a reasonable rate once it was economical to do so. He found that in 1849-53, the threshold was 21 acres greater than the average wheat production, but in the next four years, the average wheat acreage was only 5 acres less than the threshold for economy. As a result of the assumed mean distribution, he proposed this threshold hypothesis accounted for the precipitous rise in reaper ownership during the mid

1850s[Olmstead, 1975, p. 330].

Olmstead proposed David's hypothesis was based on inaccurate assumptions about reaper and farmer behavior. He took a sampling of randomly-selected listed reaper purchasers during 1854, 1858, and 1859 in the McCormick Archives, and established that a full quarter of reaper purchases were listed as jointly purchased. Some agents in the Midwest, in Wisconsin, Illinois, and Iowa, averaged nearly 40% joint purchasing[Olmstead, 1975, p. 337]. This data shows that there was at least partial farmer collaboration in reaper purchases, and this conclusion is backed up further with diary entries reflecting reaper sharing, thereby belying David's assumption of farmer ownership of reapers. Olmstead also pointed out that existence of a reaper might have made farmers inclined to plant more land in wheat, therefore making a reaper more economical; this feedback loop cannot easily be reflected in a economic model as David desires. Finally, Olmstead cites other scholarship, by Rogin and others, indicating the significant technological change the reaper underwent between its invention and popularization. These elements indicate David's hypothesis, while attractively simple, cannot be taken alone.

Several variables seem to have played a role in reaper diffusion, given current scholarship. Transportation, advertising, credit, farm size, labor cost, and crop size seem to all have played some role in reaper diffusion and farmers' individual decisions to purchase a reaper.[Williamson, 1976, p. 812] While each of these was locally variable, large-scale trends can be generalized for various areas.

1.3.1 Freight availability

In the west, transportation was expensive and difficult before the advent of the railroad. Rivers are scarce, and were the highways of the early 19th century, thus making it difficult to transport heavy equipment or goods long distances. This helped make wheat a more profitable crop, as wheat could be transported slowly without losing quality, unlike other common crops of that era. On the other hand, it made it more difficult to import reapers from far away, biasing McCormick sales to regions closer to the McCormick plant in Chicago. Thus, if a farmer was far away from a river or railroad, freight charges might make it more expensive to acquire a reaper, making adoption in rural regions slower. Freight charges ranged from \$10 in Illinois to \$55 in eastern states --- when a reaper costs only \$100, freight could easily be a significant portion of the cost. Iowa was industrialized with railroads in the late 1850s[Throne, 1949, p. 128], corresponding to a sharp increase in Iowan reaper purchases from McCormick,[McCormick Archives, 1870] and corroborating the influence of freight as an important factor.

1.3.2 Advertising

The McCormick Company sold its reapers through agents, who took orders and then sent a large collection of orders to the McCormick central office, who then shipped the reapers once produced to the agent to distribute to their customers. This, however, depended on the agents' efficacy, and not all agents were equally good at sales. Moreover, less populated regions would be more difficult to canvas

for orders, and therefore these regions would have less opportunity to purchase a reaper, especially a McCormick reaper. Newspapers and public demonstrations were agents' primary means of advertising, and thus in areas without newspapers exposure would be variable.

1.3.3 Wealth and credit

A farmer's ability to purchase a reaper was also influenced by his disposable income: how good was last year's crop and could they get a loan to finance the purchase of a reaper? Few farmers of this era had \$100 disposable income, and McCormick usually required at least \$50 cash to purchase a reaper, making the purchase of a reaper dependent on disposable income and pushing reaper adoption away from the newest settlers who usually had no extra money left over from settlement.

1.3.4 Farm size

Purchasing a reaper, as shown previously, required a large farm with abundant wheat production. David's assumptions required a 46-acre wheat farm to make a reaper profitable at the beginning of the 1850s;[Williamson, 1976, p. 813] such large farms were not usually available in the East, pushing reaper adoption away from smaller farms. On the other hand, with collaborative purchasing, a group of farmers could potentially have purchased a reaper together, making their smaller acreage profitable.

1.3.5 Anticipated crop size

Finally, reaper adoption may have been influenced by freight speed and availability. If a farmer viewed his crop halfway through the year as likely to be extra-large and require more labor than expected to fully harvest, he may have decided to purchase a reaper if he believed it would arrive in time for harvest. Such adoptions, however, would be dependent on rapid transit, and McCormick became notorious for its track record of late shipments, so this was likely less important and strongly correlated with freight cost.

1.4 The Shenandoah as a Model System

Current studies of the diffusion of reapers have focused on the West, without regard to potentially different economics in the East. Instead of the West, where advertising, wealth, labor, and advertising were all very variable, the Shenandoah was a traditional grain-growing area, with strong advertising, abundant labor, relatively uniform wealth, and uniform freighting ability. By taking out these extra variables, we can observe their effect on reaper diffusion, and gain insight into the role of these factors in reaper diffusion in the Midwest.

The Shenandoah was exceptional in its willingness to adopt new technology and ideas. In 1839, the Shenandoah region was one of the foremost wheat-producing areas in the nation, and was the foremost eastern wheat-producing region by 1909 [Olmstead and Rhode, 2002, p. 935]. At the time, its farmers were among the most progressive in the nation [Danhof, 1969, p. 238]. It had excel-

lent access to its own natively-produced reapers: Hussey, McCormick's primary early competitor, had a factory in Baltimore until Hussey's death in 1860[Danhof, 1969, p. 238]. From these two factors, reapers were widespread very early, and were generally adopted by the late 1850s. As a result, the Shenandoah is a good model system for reaper diffusion in the absence of several Western factors: varying freight availability, relatively uniform farm size, and low advertising in less developed areas.

The Shenandoah was well-railroaded, unlike the West, making freight charges for McCormick reapers high but uniform throughout the region. Costs of McCormick reapers in early years in this period tended to be around \$155, and some reapers were sold for this price as late as 1854; however, due to competition from other reapers and lowered freight costs, this cost lowers to about \$120 on average by 1855[McCormick Archives, 1870]. This is only a little more expensive than in Iowa, making the inhibitory effect on diffusion lower.

Unlike the Midwest, the East featured high sole proprietorship of reapers, high farmer ownership of threshers, and decreasing wheat production. While initially focused around the Shenandoah, wheat production quickly shifted westward over the 19th century. In 1839, the geographic center of wheat production was directly in the Shenandoah Valley; over the next eighty years, the center of wheat production shifted to the center of the West, with 92% of wheat production lying west of the Appalachians.[Olmstead and Rhode, 2002, p. 936] Over the period of McCormick reaper adoption in the Shenandoah, 1850 to 1860, Pennsylvania, Maryland, and Virginia's combined wheat production rose

from 31074987 to 32276622 bushels,[Census Office, 1864, p. xxix] a rise of only 3%, while in the same period the nationwide production rose from 100485944 bushels to 173104924 bushels, an increase of 73%. As such, the Shenandoah's relative importance to the US grain production decreased sharply, which may have a confounding effect on the diffusion of reapers as the importance of the Shenandoah decreased.

Eastern regions also had different ownership patterns of reapers and threshers. [Olmstead, 1975] alludes that most cooperative ownership was western, and was much lower to nonexistent in the older wheatproducing areas like PA. Moreover, while not explicitly tied to reapers, [Rikoon, 1988, p. 21] states that thresher manufacturers were primarily eastern until the mid 1840s, encouraging faster adoption of Eastern-specialized threshers; while Virginia was hilly and rough and rainy and ill-suited for standard reapers. These seem to imply that Eastern reaper adoption should follow different patterns of reaper ownership, perhaps involving more individual ownership of reapers and threshers, increasing the farm size threshold for reapers to be adopted on Eastern farms, and encouraging more self-sufficient farms.

These ownership patterns may be studied by examining records of McCormick reaper purchases in the period 1850-1864 from the McCormick Archives to determine sales data across the US. In particular, McCormick purchasers in the greater Shenandoah Valley from 1854-1864 can be used to study reaper ownership in this area, as no other reaper company has thorough archival sale records. The purchasers of reapers can be identified, and then tracked against newspa-

pers in their area to find records of their farm, especially records of sales. Public sales, as advertised, provide useful, thorough data about the possessions of a single, named farmer, and aggregated, can provide data on length of ownership of a reaper, size of farms purchasing reapers, and other correlations between reaper ownership and other equipment ownership that are not seen without reaper ownership.

1.4.1 Limitations of Data

This data, however, has limitations, which leave the question not fully answered, and emphasize the importance of further archival research with the Census manuscripts for full understanding of purchasers.

Most reapers in the Shenandoah were locally-produced, non-McCormick reapers. Of 86 public sale records involving a reaper in the Hagerstown Herald and Torch Light between 1860 and 1880, the primary newspaper of this area, 29 of these records involved a McCormick reaper, and the remaining 57 involved named other brands of reaper. Of this body of public sale records, roughly a third of them involved McCormick reapers, a surprising quantity given the distance from Chicago.

Not all McCormick reaper purchasers are fully recorded in the McCormick archives. Several agents did not record the names of their customers, thereby making it impossible to further trace the purchased reapers; furthermore, sales from one farmer to another are not obtainable, so public sale records can only give information about the original purchasers of a reaper, and cannot specifically

track a single reaper. While it is possible to extrapolate that a "new" McCormick reaper sold two years after the farmer in question purchased a McCormick reaper is probably the same machine, it is not certain, and such information cannot fully track reapers.

Not all public sale data is equally precise, and there is no way to determine how variable the detail is. Furthermore, some of a farmers' possessions may have already been sold before the sale was advertised; if a neighbor desired to buy a farmers' reaper, they likely would do so, instead of listing it in the newspaper. Thus, not all possessions are listed, so it is impossible to determine the exact wealth of a specific farmer; however, a reasonable lower bound of their wealth can thus be obtained.

The Civil War occurred 1861-1865, and the Shenandoah was the site of considerable pillaging and destruction. Not only were farmers less likely to buy reapers from faraway during this period, they were unlikely to buy reapers for fear that they would lose them to opposing armies, and many reapers may have been destroyed during the war. Public sale records only exist for 1865 onward in the Hagerstown Herald and Torch Light, so it is impossible to know how many reapers were destroyed in the war.

Finally, the Shenandoah area has greatly different terrain than the West, in being much more mountainous; this may have discouraged reaper adoption in the area. Kellar, the foremost biographer of McCormick, states "Virginia [the Shenandoah included] was hilly and rough and rainy and illsuited for reapers.[Kellar, 1924, p. 46-7]" While true of much of the area, it is interesting to observe the wide

adoption of reapers that occurred despite this potential problem. On the other hand, Indiana also seems to have had areas too rough for reaper usage, due to stumps[Carter, 1946, p. 117], and was one of McCormick's primary markets throughout this period. Thus, while roughness and suitability for reaper operation varied across the Shenandoah, this variable was also present in some areas of the Midwest, making the variation less relevant to differences in reaper diffusion.

Despite these limitations, however, this data is an important first study of the Shenandoah region's reaper adoption, and may be combined in the future with other information to build a more complete model of reaper adoption, accounting for more variables than David or Olmsteads' models.

2 Grain Production vs. McCormick Reaper Diffusion Across America, 1850-1865

Between 1850 and 1860, McCormick sold over 20,000 reapers across America, primarily in the Midwest. [McCormick Archives, 1870] In the tri-state Pennsylvania-Virginia-Maryland region in question, insofar as data is available, no McCormick reapers were sold before 1850, but totaled 2762 reapers and mowers by the end of 1860. Sales were significantly higher in the 1853 to 1856 period, particularly in 1854, and were somewhat depressed from 1857 onward (Figure 1); after 1860, the Civil War interfered with the free diffusion of reapers into this region, confounding the data entirely.

These years of good sales correspond well to the trend of wheat prices dur-

1849	0
1850	74
1851	61
1852	105
1853	226
1854	466
1855	402
1856	345
1857	286
1858	209
1859	280
1860	308

Figure 1: McCormick reaper total sales in Pennsylvania, Virginia, and Maryland, 1850-1860, by year. Data aggregated from [McCormick Archives, 1870].

ing this time period. In Ohio, wheat prices averaged \$.75/bushel in a poor year and \$1.25-\$1.75/bushel in a good year, and 1853-56 were good years due to the Crimean War causing European wheat shortages.[Jones, 1983, p. 71] In other words, in a poor year such as 1851, with \$155 for a reaper, it took 200 bushels of wheat, or more than 10 acres' production, to pay for the reaper alone, much less account for the cost of producing this wheat. On the other hand, by 1854, prices had fallen to roughly \$120, so it took only 80 bushels of wheat, about 4 acres, which was a significant reduction in price. Unsurprisingly, this made a reaper much more profitable, and is a possible explanation for the sharp increase in purchases of McCormick reapers in this period.

1854 was the best year of sales in this region, while McCormick reaper production had only a mild increase. This may have occurred as a result of farmers' good sales in 1853, the previous year, permitting ordering of reapers as a result

of high wheat prices. On the other hand, the high prices may have encouraged higher wheat production, making reapers more necessary; causation here is difficult to assess without more data on wheat production on a yearly basis, which are not currently available. It appears that increased reaper purchases lagged increased wheat prices by a year, however.

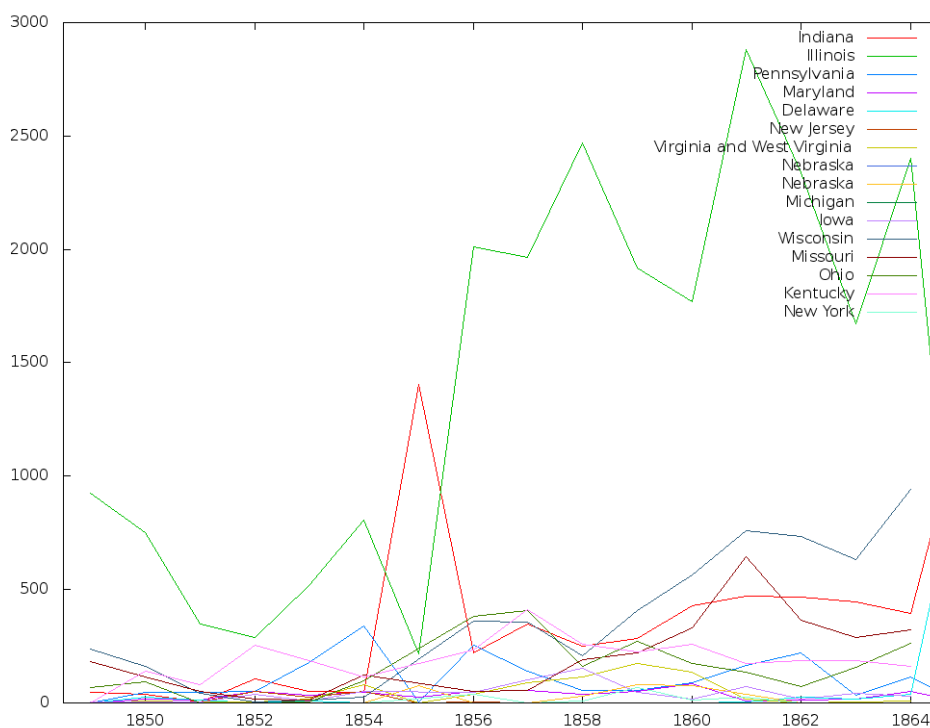


Figure 2: McCormick reaper sales across the US, 1850-1865.

Across the United States, however, reaper sales were roughly constant during the 1850-1865 time period, as shown in Figure 2. Despite fluctuations in wheat prices, state-by-state sales numbers remained roughly constant, except Pennsylvania, Maryland, and Virginia's distinct aggregate uptick. On the other hand,

years of higher wheat prices did result in slightly increased sales across the board, lagged by one year, not just in these three states.

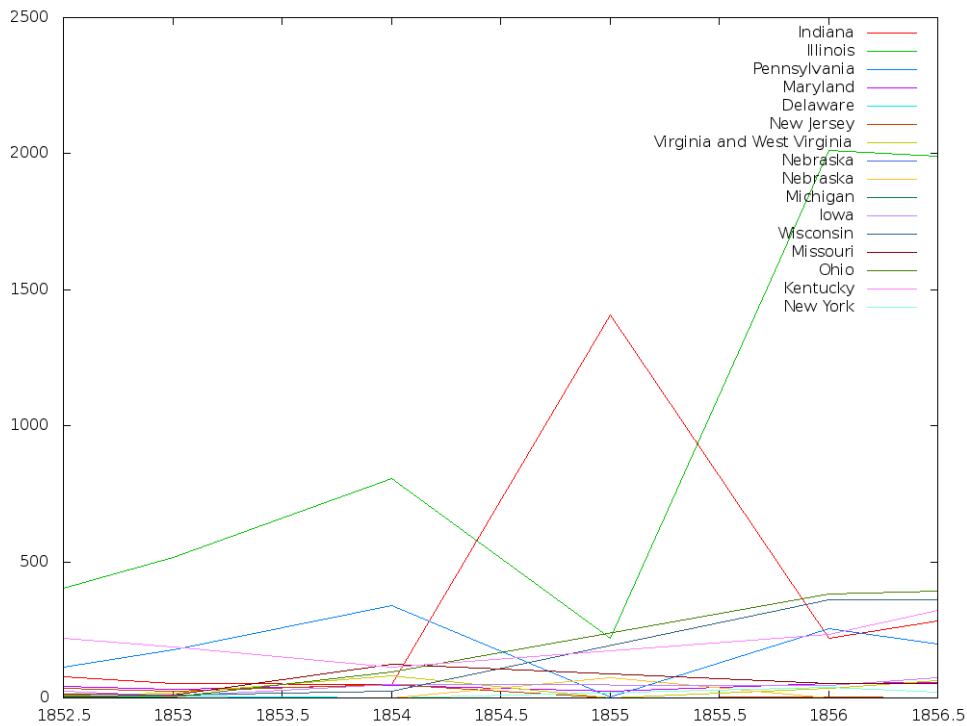


Figure 3: McCormick reaper sales across the US, 1853-1856.

Examining the 1853-56 period more closely, corresponding to elevated wheat prices due to a European shortage during the Crimean War, [Jones, 1983, p. 71] the 1854 uptick in sales appears to have occurred across all states. This matches the hypothesis of a year lag across the nation, meaning a high-priced wheat year must occur before reaper purchases increased. This response to increased disposable income due to higher wheat prices indicates that wheat production was likely constant without a reaper, but a reaper, by increasing profits, was purchased as soon as extra income was available. This points to reaper diffusion being money-constrained, not land, advertising, or freight-constrained, contrary

to current models implying growth as a function of land available.

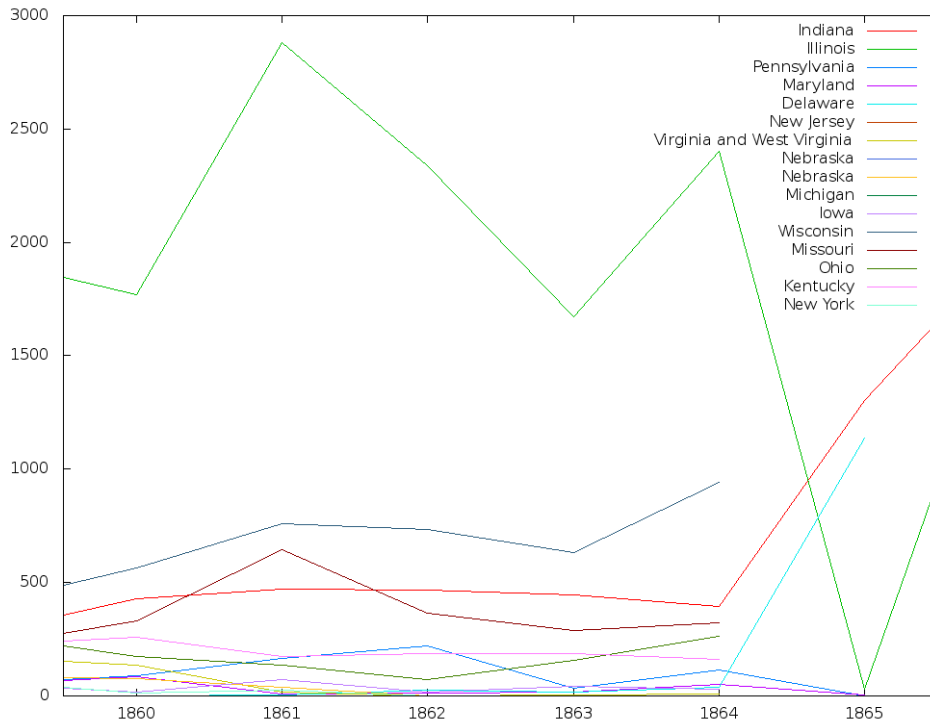


Figure 4: McCormick reaper sales across the US, 1860-1865.

During 1861 to 1863, a similar elevation of wheat prices occurred, although the Civil War's influence induced lower reaper production and less eastern purchasing of McCormick reapers. This again seems to correspond to a mild upward trend of reaper purchasing, although it is difficult to distinguish from regular variation in reaper purchases. This data again supports an increase in reaper purchases with a one-year delay from wheat price increase, although

2.1 Early McCormick Reaper Purchaser Farm Size

This paper defines the Shenandoah as Dauphin, York, Perry, Cumberland, Adams, Franklin, Juniata, Huntingdon, and Fulton Counties, Pennsylvania; Washington, Frederick, and Carroll Counties, Maryland; Berkeley and Jefferson Counties, West Virginia; and Frederick, Clarke, Warren, Shenandoah, Page, Rockingham, Loudoun, Fauquier, and Rappahannock Counties, Virginia.

Roughly 16% of the total Virginia, Maryland, and Pennsylvania McCormick reaper sales were to the Shenandoah region.[McCormick Archives, 1870] The first thirty reapers arrived in the Shenandoah in 1852-3, to a distributor who did not bother recording the names of his customers, and were followed by 73 reaper customers in 1854. Of these 73 reaper customers, few can actually be traced any further, but several are recorded in newspapers as having farms of at least 100 acres, and others are recorded as being political leaders of their communities. The sample size is too small for good generalizations, but this is significantly larger than the average 92-acre farm recorded by Olmstead in Illinois.[Olmstead and Rhode, 1995, p. 33] On the other hand, this data may be biased by being based on public sale records; public sales are more likely to occur for larger farms, so data from this is likely skewed toward larger farms. Census manuscript data is likely necessary to assess farm size with any degree of accuracy.

2.2 Early McCormick Reaper Joint Purchasers

Of reaper sales in the Shenandoah between 1850 and 1860, less than 5% per year are jointly purchased between two or more purchasers in the McCormick records. Compared to Olmstead's study indicating 25-40% joint purchasing in western states, this is a significantly decreased instance of joint ownership. Unfortunately, no further data on any joint purchasers could be found, but this limited data seems to indicate far less joint ownership than in more western areas, furthering the hypothesis that Shenandoah reaper diffusion was primarily through single-farmer, large-acreage farms.

2.3 Reapers and Threshers Together

Existing data shows that small horsepower threshers were widely owned in the late 1840s to late 1870s in the east, unlike Western models of itinerant threshers without a home farm; this period was followed by itinerant steam threshing[Rogin, 1931, p. 185]. Instead of a large thresher processing 300 bushels each day in the west, requiring 9 men and 10 horsepower, a typical Eastern thresher required 2 horses and five men, and could process only 135 bushels daily.

Based on public sales in the Shenandoah, McCormick reaper owners tended to own their own threshers: 45% of public sale notifications involving a McCormick reaper in the Shenandoah also involved a thresher. This may have been based on eastern farms being larger, as found above, thereby making a farm's own reaper more economical. Alternatively, this may reflect the apparently less

collaborative nature of Shenandoah reaper owners, who rarely partook in co-ownership of McCormick reapers, and may have therefore been less inclined to hire others to thresh their wheat. Data seems to indicate a thresher cost around 5 cents per bushel in western states;[Danhof, 1941, p. 348] given that these smaller threshers cost no more than \$250,[Rogin, 1931] these threshers would pay for themselves after about 2000 bushels, corresponding to about 100 acres of wheat. As several known McCormick reaper owners in the Shenandoah had farms of 100 acres or more, this meshes well with the economy of owning ones' own reaper, indicating rational behavior.

3 Conclusion

Shenandoah reaper purchases showed significantly different dynamics than Midwestern reaper purchases, in farm size, frequency of formal co-ownership, and in reaper-thresher owner correlation. Unlike Midwestern reaper purchases, characterized by smaller farms, frequent formal co-ownership, and completely untied to thresher ownership, Shenandoah owners had large farms, solely-owned reapers, and personal threshing machines. This data indicates potential additional elements in the spread of reaper ownership in the Midwest, indicating additional areas requiring study.

Shenandoah reaper-owning farms seem to have been larger than Midwest reaper-owning farms. However, the difference does not appear large, indicating similar economics were likely in play in farmers' choice to purchase a reaper. The

difference, however, is contrary to conventional wisdom implying that Eastern farms were smaller than Midwest farms, and that farm size played a significant role in reaper diffusion. Due to a small sample size, however, this data cannot be taken as authoritative, and needs additional confirmation for significance.

Shenandoah reaper-owning farms had a much lower rate of co-ownership than similar Midwestern farms. Olmstead reported about 20% co-ownership in Illinois, based on McCormick records of purchasers; [Olmstead and Rhode, 1995, p. 33] however, our data indicates only around 5% co-ownership in the Shenandoah. This lower rate of cooperation may indicate greater disposable income, larger farm size, or merely less cooperativity in the Shenandoah; Olmstead previously found an abundance of diary and other evidence pointing toward strong cooperativity even without formal co-ownership. More study is needed to determine the implications of this very low rate of formal co-ownership; however, as a preliminary conclusion, we can assert this technology spread in a much more individualist manner in the Shenandoah.

Shenandoah reaper-owning farms also had a high rate of thresher ownership, unlike Midwestern thresher patterns. Roughly 40% of Shenandoah reaper-owning farms, based on our data, owned threshers also, while very few Midwestern farms did. While it is difficult to assess the size of these threshers, Rogin's data on Eastern threshers indicates that they were economical on a per-farm basis relative to purchasing the services of a dedicated threshing crew and larger thresher. Since these Shenandoah farms were not extremely different in size from Midwestern farms, it is unclear why the different patterns emerged.

Shenandoah farms may have owned individual threshers as a result of the relative difficulty of transporting a thresher due to rougher terrain, or perhaps due to uneven ripening of grain necessitating more flexibility in a threshers' schedule.

This data demonstrates Shenandoah reaper diffusion was different from Midwestern reaper diffusion, indicating thresher or freight availability may have played a key role in Midwest reaper diffusion. The Midwest's reduced and uneven transportation relative to the Shenandoah may have reduced reaper penetration, delaying reaper adoption until railroads were widespread. The Midwest's lower frequency of thresher ownership may have been a result of this reduced transportation availability also, as most threshers of the time were produced in Pennsylvania and Wisconsin, and may have produced a culture of greater collaboration in the Midwest, both in threshing and in reaping. These changes indicate further study of Shenandoah patterns may produce further insight into the spread of reaper technology throughout the Midwest.

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