Chapter 4

THE BOUNTY OF THE PIEDMONT STREAMS: INDUSTRIES SUPPORTED BY WATER POWER IN NORTHERN DELAWARE

A. INTRODUCTION

New Castle County milling was dominated by a few families, mostly Quakers, several of whom were active on Pike Creek. During the 18th and 19th centuries, the Canby, Mendenhall, Wollaston, Marshall, Springer, Phillips, Hersey, Lea, and Garrett families dominated merchant milling, and they consequently controlled much of the water power in the county. Sawmills, fulling mills, forges, and other local service industries typically shared mill seats with flour mills. Figure 4.1 shows the mill streams of the area. When new industries entered the market and required access to the power sources, established milling families were inevitably involved. Thus their control of flour milling facilities could provide an avenue into other power using industries. Table 4.1 shows the value of various industries in the county at a particular moment in time, 1820. At this point, flour and milling are in second place only to textiles, which were a recent introduction.

B. THE DELAWARE TEXTILE INDUSTRY (TABLE 4.2)

From first settlement, Delaware farmers raised sheep and flax for wool and linen, but textile processing was a home activity until the beginning of the 19th century. Estate inventories of Delaware farms of the 17th and 18th centuries mention numbers of spinning wheels and, less frequently, hand looms (Table 4.2).

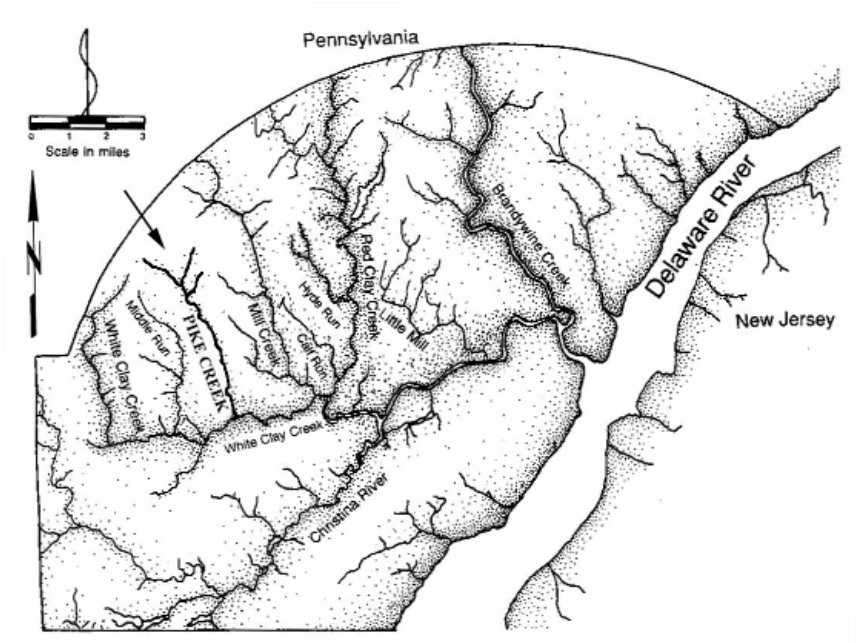

Figure 4.1. Regional Map Showing the Mill Streams of the New Castle County Piedmont.

Table 4.1.
The New Castle County Economy 1820

Product	Market Value of Products
Textiles	$146,000.00
Flour and Meal	$139,000.00
Barley	$5,000.00
Leather	$30,800.00
Paper	$101,000.00
Powder	(two companies, no figures available)

Source: Federal Census 1820.

Table 4.2.
Textile Manufacture in New Castle County 1820

Mill Name	Proprietor	Hundred	Stream	Product (s)	Working
Sharon	John Hirons Jr.	Christiana		cotton yarn	no
Simsville [Walkers]	Siddall & Co.	Brandywine	Brandywine	cotton yarn & cloth	yes
Endeavor	Thomas Lea	Christiana	Red Clay	cotton yarn	yes
Madison Factory	John Brown	Christiana ?	Red Clay	wool yarn & cloth	yes
[Henry Clay]	Duplanty, McCall	Christiana	Brandywine	cotton yarn	no
Rockford	J. & W. Maltby	Christiana	Brandywine	wool yarn & cloth	yes
	J. W. Carter	Christiana	Brandywine	cotton yarn & cloth	yes
Rocktown	J. Bringhurst	Christiana	Brandywine	cotton yarn	yes
	Charles duPont	Brandywine	Brandywine	cotton & wool yarn, cloth, dyeing cotton yarn	yes
	W. Almond	Mill Creek			yes
Roseville	Hart & Hamer	Mill Creek	White Clay	cotton & wool yarn, cloth, dyeing	yes
Brandywine			Brandywine	wool yarn & cloth	no
	W. Yonny & Son		Brandywine	cotton & wool yarn, cloth dyeing	yes
[Auburn]	Jacob Pusey	Christiana	Red Clay	cotton yarn	no

Brackets indicate uncertainty of name.
Source: 1820 New Castle County Census of Textile Manufactures Returns.

1. The Cottage Industry Phase

Household production in a late 18th century New Jersey farmstead was described by Mary Patterson Moore (1981:5) in her reminiscences:

There was a window by the fireplace where stood Grandmother's wheel, and a wheel at the other side for one of my aunts while the other attended to housework. There were generally two wheels going around all winter; in summer one was spinning on the big wheel while the other carded ...

Both home weaving and small scale cottage weavers provided much of the local cloth supply. As late as the eve of the Civil War, some Delaware farm families were still making their own textiles by hand. Judge Walter Powell recalled that in the Farmington area, "Every farm had its loom, spinning wheel, candle mould, quilting frames, and sausage grinders. ..." (Hancock 1973:108).

2. Textile Industrialization (Table 4.3)

Most histories credit Samuel Slater with introducing powered textile machinery (e.g., spinning and carding) into America at a Pawtucket, Rhode Island, cotton mill in 1793. The Boston Manufacturing Company installed America's first water powered cotton loom in 1813 (National Park Service 1992:25; Wilson 1954:89; Hindle and Lubar 1986:63).

Wool processing requires a higher level of skill than cotton processing, even though the processes are similar (Gross 1981:23). Cotton mills were more common in New Castle County, as they were throughout America, during the first half of the 19th century.

Industrialization of the textile industry was not a sudden or uniform process. As each step or process was industrialized, bottlenecks followed. The over-

Table 4.3.
The Declining Cost of Cotton and Wool, 1800-1825
Wool and Cotton Wholesale Prices
(dollars per unit)

Year	Raw Cotton per Pound	Cotton Sheeting	Raw Wool
1800	0.24	17.38	-
1805	0.23	21.27	-
1810	0.16	21.58	-
1813	0.125	21.6	2.75
1815	0.21	20	1.333
1820	0.17	16	0.75
1825	0.186	10.52	0.53

Source: Historical Statistics of the United States, Colonial Times to 1957: 124

all effect of industrialization and other improvements on prices is, however, clear from Table 4.3. Most famous of the innovations was Eli Whitney's cotton gin, patented in 1794, which stimulated the output of cotton that, in turn, demanded new spinning capacity. Some of that capacity increase was accomplished by New Castle County power spinners, as well as by the New England mills. Spinning improvements then created backlogs of yarn for the weavers until weaving technology caught up (Hindle and Lubar 1986:81).

An American power loom was patented in 1816. By 1832, power looms had supplanted hand looms in Delaware's textile mills. The consequent increased power demands prompted improvements in machinery, notably the introduction of belt main drives and turbines. Eventually, however, seasonal stream fluctuations led to the installation of other power sources as they became available.

Oliver Evans, who lived a few miles from the current project area, was among the nation's foremost industrial innovators. His first major contribution was a machine for making wire teeth for hand cards used in the first step of wool processing (Wilson 1954:54).

As the Pike Creek mill seats were being developed during the last decade of the 18th century, Evans was also perfecting a suite of automated water powered machinery that would revolutionize flour milling. Undocumented legend states that Evans built the machinery in the merchant mill that stood in the project area (Brinton notebook D, Historical Society of Delaware).

3. Delaware Textile Mills to 1820

The transition from home craft to industrialization came gradually, at first. The first industrial textile factories were fulling mills, which used water power to convert stiff woven wool cloths into the soft textile product. A fulling mill could be an adjunct to a sawmill or a gristmill, as most were. The first documented fulling mill in Delaware was built on Wilson's Run in New Castle County by Jonathan Strange in 1733; by 1793 there were seven fulling mills on the Brandywine Creek alone (Gibson 1966:26). "Country cloth" from household producers or cottage weavers was taken to fulling mills for finishing.

By the end of the American Revolution, there were a few professional "websters," or handloom weavers, in Delaware, working in the time honored cottage industry system. Some operators, like Rev. Philip Reading in Middletown, Delaware, operated workshops with large numbers of hand looms or spinning wheels. The hand weaving process continued into the 19th century, even after thread was being made in water powered factories. Many of the early cloth "factories" were actually such large workshops of hand workers, not necessarily water powered.

Powered woolen production in Delaware began in 1809 when Mordecai McKinney produced cassimere in Edward Marshall's mill (later called Kiamensi) near Stanton. The equipment consisted of one carding machine, a picker, a billie, two jennies, and five looms. The looms are likely to have been hand operated to process the thread output of the two hand turned jennies. The carder, the picker, and the billie probably were powered by the water wheel. In 1810, McKinney began making cotton yarn in Joseph Marshall's mill (Gibson 1966:33). Even when powered spinning machines were introduced in 1813, many mills preferred the older hand

powered jenny. Power was applied to the jenny for spinning wool after 1820. By 1815, within 20 miles of Wilmington, one observer calculated that there were 14 wool spinning mills with more than 3,000 spindles and 27 cotton mills with 25,000 spindles (Welsh 1973:83).

Power driven machinery largely employed imported European and English technology. English workmen, including the Pillings and Deans, who would later dominate the industry, came to New Castle County in the years between the War of 1812 and the Civil War. The most important import, however, probably was the Merino ram Dom Pedro, whose bloodline would revolutionize fleece qualities in the area. Before his arrival in 1805, the local sheep were producing a low quality fiber that was not commercially competitive with the finer fibers made from newer sheep breeds in European mills.

Dom Pedro came to Iränäe duPont's flock, and in his brief lifetime he impregnated enough local ewes to ensure a mostly Merino population. By 1814, three years after his demise, there were 4,200 sheep in the Wilmington area, of whom an estimated 700 were derived from Merino stock (Carr 1964:83).

When cheap English goods were barred from the American market first by embargo and by then war, U.S. manufacturers responded with a flurry of textile mill building. A wool bubble followed, which burst predictably when cheap imported goods returned to the market after peace was declared. The price of wool and cotton dropped, with disastrous effect on the industry (Table 4.3).

At Greenbank, John Phillips carded wool and spun thread from the rovings between 1812 and 1815, at the height of wartime prosperity. He took as partners John Butler and Charles Briggs, who were in the fulling and finishing businesses (Gibson 1966b:88).

Victor duPont, the powder maker's brother, formed a wool company in 1810, just in time to be ruined in the post war market collapse that would follow five years later. The company was never profitable, and duPont began to lose interest. Around 1818, he began turning over its affairs to his 16 year old son, Charles. Not only did Charles run the mill, but he also managed extensive textile manufacturing enterprises until his retirement in 1856. Down the Brandywine from the duPont mills, 14 other textile mills were established, mostly by Quaker millers (Gray 1961; Gibson 1966a).

4. The 1820 Federal Census

By 1820, when the first postwar federal census of manufactures was taken, Delaware woolen mills had fallen on hard times, and the owners were pleading for a federal bail out. A total of 14 textile mills were listed in New Castle County, of which only four
processed wool. Most were spinning cotton yarn, which enjoyed tariff protection and required less skill and expertise.

The 1820 census of industry (Table 4.2) provides a snapshot of the local economy. According to the census, wool and cotton factories represented a sizable part of the market value of New Castle County's output. The values listed in the printed census abstract emphasize the importance of wool and cotton in the New Castle County economy during the period following the War of 1812.

Mechanization was not universal. In 1820, some Delaware mills were using powered machinery to spin yarn for handloom weaving on the premises. The number of fulling mills outside this area gradually decreased, reflecting a decline of handwoven

Table 4.4.
Industrial Production in Delaware in 1832

Product	Market Value of Products
Cotton, woollen, powder makers	$347,682.00
Machinists, boots, saddles, trunks, coaches, paper	$36,250.00
Hatters, brick makers, lime burners, iron founders, etc.	$90,100.00
Tanners, curriers, quercitron bark grinders	$60,800.00
Flour, meal, bark and lumber	$485,692.00
Total New Castle County	$1,020,524.00
Kent County Total	$165,088.00
Sussex County Total	$40,000.00
Delaware Total	$1,225,612.00

Source: McLane Report 1832.

"country cloth." Fulling remained an important function of the woolen manufacture process, however, usually as part of the new weaving mills.

According to the abstract of the 1820 federal census of manufactures, New Castle County textile mills contained a total of 12,404 spindles, of which 5,728, or 46%, were in operation.

5. The McLane Report of 1832 (Table 4.4)

A few years later, in 1832, Louis McLane assembled a remarkable survey of American manufactures, known colloquially as the McLane Report, (22nd Congress, First Session, House Document 308, serial set volume 223). The industrial supremacy of Newcastle County, Delaware, is shown in Table 4.4, which provides a general breakdown of production .

The 1832 report reflected turbulent times. Of the 20 New Castle grist mills for which a founding date was reported, 15 operators claimed that they were established after 1820. The other five were old established mills that occupied the best seats. Most of the operators who had responded to the 1820 census were gone by the time that the 1832 survey was conducted. Perhaps it was a sign of the changing times when the 1832 report was tabulated. The data was arranged by stream drainage, reflecting the old dependence on water power. Some manufacturers, who evidently were liberated from water power, were listed in "Wilmington" or "Stanton" rather than along a stream. These factories included a gunpowder factory, two machine factories, and an iron foundry. Also among them were nascent industries that would come to dominate the urban scene.

Madison Factory at Greenbank Mill processed Merino and country wool into kersimers, satinets, and broad cloths. This mill was built adjacent to the Phillips family's Greenbank Mill on Red Clay

Creek. After several years of idleness, it had been reopened a year previously by John Brown, who complained that it was not profitable.

Rockford Woolen Factory, operated by Joseph and William Maltby, was a new operation designed to process Spanish wool or wool from full blooded Merino "when it can be procured."

The Charles duPont mill processed both cotton and wool and made a wide range of qualities, from superfine cloth to army cloth and coarse "Negro" cloths.

6. Area Textiles Before the Civil War

As long as mills relied upon water power to run their machinery and horses to haul their products, industry would remain dispersed across the countryside. The switch from water and animal power to steam power eventually allowed manufacturing to concentrate in cities near rail transport. Rural mills were concentrated along the fall lines of American streams during the time when the New England textile industry was developing a factory system. Cities
soon developed along the fall line, and railroads connected them. Even after the factories moved away from the mill races, the fall line corridor remained a feature of the East Coast landscape. The geographers' term "initial advantage" describes the boost received by town sites that were first developed. Wilmington enjoyed an initial advantage bestowed by the developed mill seats on the Brandywine, as did Lowell, Massachusetts, and Paterson, New Jersey.

At the beginning of the Civil War, only one woolen mill in Delaware used a power source other than water. This was the Franklin Manufacturing Company, established in Wilmington in 1857, powered by two steam engines. By 1870, however, steam produced a quarter of the horsepower in the Delaware woolen industry (Gibson 1966b:104).

7. Civil War Changes in the Industry

Wartime demands for iron ships and gunpowder brought prosperity to Wilmington and inevitably changed the character of the city that had 21,258 residents in 1860, about half the population of New Castle County (Hancock 1973). Wartime demands for cloth for uniforms and blankets encouraged new enterprises in the woolen industry, particularly in Mill Creek Hundred. War also led to the wholesale adoption of steam power, led by the heavy industries in Wilmington.

The Dean woolen factory located on White Clay Creek at Newark and the Kiamensi mill located on Red Clay Creek expanded during the war, but the smaller rural mills apparently did not share in the boom. Concentration in larger factories, closer to rail transport, meant that smaller isolated factories were no longer viable.

In 1882, there were only three woolen mills in Delaware. One, in Milford, burned in that year and never reopened. The other two were the Dean mill at Newark and the Kiamensi mill on Red Clay Creek, which were owned by the same two families. After the Dean mill burned on Christmas Day, 1886, only the Kiamensi mill survived. The Kiamensi mill, where Mordecai McKinney had made cotton thread, was the last to close, in 1923. Its survival can be attributed in no small part to its location on the B&O main line (Gibson 1966a:49).

8. Urban Migration of Industry

Urban manufacture, presaged by such massive water powered enterprises as Lowell and Paterson, could not happen unless there was adequate local motive power. Until the middle of the 19th century, this meant water power. Water power's gift of initial advantage continues to be felt along the fall line even today. Philadelphia and Wilmington were fall line communities with strong supplies of nearby water power to drive mills. Transportation corridors created to link these centers reinforced the initial advantage, creating the phenomenon known today as the Eastern Megalopolis, and ultimately Interstate 95.

Urban industrialization was a product of the high pressure stationary steam engine (another Oliver Evans innovation), which allowed production to move closer to the shipping points. Wilmington, with a port and a railroad, was a beneficiary of this transfer (Heite 1987).

C. IRONWORKS

Sheet iron production in the region peaked just after the time of the Civil War. By 1886, there were ten rolling mills in New Castle County. The boom can be attributed in part to the increase during that period of the canning industry, which consumed vast quantities of tinned sheet iron. Sheet metal had other industrial uses, including dozens of household utensils and architectural elements, that had not existed at the beginning of the 19th century. Shovels, for example, were stamped from sheet metal. Thicker rolled plates protected the warships built on the Christina River (Pursell 1958).

Two rolling mills powered by Red Clay Creek produced sheet metal at Marshallton and at Wooddale. The Marshallton mill, which operated from 1836 to 1906, could produce 2,500 tons of sheet iron a year by 1888 (Heite 2000). The Wood family, who owned the Wooddale mill, originally made shovels, but the company was eventually transformed into a steel company, today known as Alan Wood, based in southeastern Pennsylvania.

Much larger mills along the Delaware River were erected for steam powered operation during the later years of the 19th century. Wilmington's leading role in the new steel shipbuilding industry contributed to the need for local supplies of steel and iron.

D. VULCANIZED FIBER

In 1763, John Marshall built a saw and grist mill at the forks of Red Clay Creek, in Chester County, Pennsylvania. His son Robert carried on the business. Robert's sons John and Caleb moved downstream and built the rolling mill on the old Solomon Hersey mill seat at Hersey's Bridge, later known as Marshallton. In 1856, their brother Thomas converted the Chester County gristmill to make paper by the continuous process. The mill burned in 1865 but was rebuilt, to be used for a new emerging industry: vulcanized fiber (Northam 1934; Heite 1998; Heite 2000).

A few years later, an Englishman named Thomas Taylor introduced a revolutionary new refined cellulose product based on rag paper, for which he had obtained a British patent in 1859. This product, vulcanized fiber, is a water-resistant product that also proved to be an effective electrical insulator. With this invention, the modern plastics industry began.

The manufacture of vulcanized fiber begins with rag paper, which may be thick or thin. The paper is soaked in a zinc chloride bath, sometimes for months. This treatment changes the chemical com-

position of the paper. Under heat and pressure, the treated paper becomes a rigid mass with a finely finished surface. The zinc chloride is then leached out. In addition to sheets, vulcanized fiber is made in tubular and formed shapes for special applications, including printed circuit boards.

Arriving on the market almost simultaneously with electric lighting, this insulating material found an instant market in the new electrical appliance industry. Lightweight tools, such as roving cans for carding mills, were among the first products to use vulcanized fiber. The photographic industry used vulcanized fiber to create lightweight cameras, camera cases, and accessories; the applications seemed endless. The product could be used in place of leather as a sealant for bearings on wagons and railroad cars. Fiber washers replaced leather in plumbing fixtures.

The Vulcanized Fiber Company was incorporated in Delaware in 1875 and established its factory in Wilmington at Tenth, Wilson, and Walnut Streets. Cesar A. Rodney and Frank Taylor were the principal managers. The Marshall paper mill near Yorklyn responded to this innovation by providing a high grade of rag paper specially suited to vulcanized fiber production. The Marshall interests went through several re-organizations, eventually becoming the National Fiber and Insulation Company.

Vulcanized fiber companies proliferated in the Wilmington area. After the Dean Woolen Mill in Newark burned in 1886, the buildings were occupied by a new firm, called the Nunsuch Fiber Company. This firm failed, and was reorganized in 1892 under the control of John Pilling, a former Dean partner who also operated the Kiamensi Woolen Company. With Frank Taylor, he formed the American Hard Fiber Company. In 1901 this firm combined with several others to become the American Vulcanized Fiber Company. Pilling's son in law thereupon started yet another fiber company, the corporate ancestor of the Haveg division of Ametek at Marshallton. American Vulcanized Fiber in turn merged in 1922 to become National Vulcanized Fiber, now NVF, with J. Warren Marshall as president (Northam 1934). By the turn of the century, Delaware produced the entire world's supply of vulcanized fiber except for one small mill in Massachusetts (Northam 1934).

As frequently happens in an emerging industry, a large number of competing companies were established, only to be combined into a few major players after a shake out period. NVF was one of the survivors, and the other major player was the Continental Diamond group with plants in Elsmere and Marshallton.

E. FLOUR IN DELAWARE HISTORY

Merchant millers bought grain and sold flour, whereas custom millers were paid in shares of the grain they ground. Generally merchant mills were larger and better financed, sometimes operating in combinations with one another. Wilmington was a center of merchant milling that developed rapidly from the establishment of Oliver Canby's Brandywine merchant mill in 1742 (Welsh 1973:84).

Best known of the merchant milling centers was the basin at the head of Brandywine Creek's tidewater, where 13 merchant mills primarily served the export trade (Welsh 1973:83). By 1790, annual production of the Brandywine mills amounted to

54,154 barrels annually. Merchant milling was second only to lumbering as the most profitable industry in 18th century America (Welsh 1973:90).

Delaware was identified as the breadbasket of the young nation during the Revolution. Shiploads of Brandywine superfine grade flour were exported from Wilmington from the mid-18th century onward. The early success of merchant milling owed much to geographical accident. The powerful mill seats at the edge of the Piedmont were easily accessible to the rich grain lands of northern New Castle County and southern Chester County.

The gently sloping roads down the valleys were an easy route for the great Conestoga freight wagons laden with wheat.

Immediately above the mill seats, Mill Creek Hundred's soils belong to the Glenelg Manor Chester associations, characterized by well drained, relatively level fields that could easily be planted and harvested by hand before the days of mechanized farming. The Springer/Little Farm examined in these investigations is one of these farm sites.

The merchant mills along Mill Creek Hundred's powerful streams consumed more grain than the Hundred's 14 square miles could produce. To tap the distant sources of grain and serve far off markets, the New Castle County millers were obliged to create a land network and a seagoing fleet.

The best sited mill seats, located near navigable water, were among the first to be developed as merchant mills. The best known of these were located at Brandywine Village, on Market Street in Wilmington. Merchant mills also were located near tidewater at Stanton, in Mill Creek Hundred, and at Richardson Park, in Christiana Hundred. Other merchant mills, located slightly inland, included the Greenbank Mill on Red Clay Creek and the Phillips mill in the project area.

Two subsidiary industries depended upon the merchant mills: Cooperage shops provided the barrels for carting the flour, and bakeries made ship biscuits for export. In 1789, Wilmington shipped 21,783 barrels of its famous superfine flour and 1,297 barrels of other products, all of which required cooperage (Welsh 1973:88). These two related trades have received insufficient attention in the many published articles concerning Wilmington area milling.

The Oliver Evans automated equipment reduced the workload in mills, and the turnpikes facilitated grain shipment from the hinterland. These innovations allowed the New Castle County milling industry to expand during the early 19th century Federal period. The patent for the Evans mill system was the third granted by the United States, in 1790 (Hindle and Lubar 1986:102 105).

In addition to the integrated efficiency of the Oliver Evans system, innovation in power technology also allowed millers to draw more energy from the same head of water. By the end of the 19th century, most grist mills were driven by horizontal turbines, which meant that more mills could be driven by the same streams. When electric power came into common use, generators were attached to factory turbines at Kiamensi and at the duPont powder mills, as well as at other seats. Electric motors eventually allowed millers to grind when the stream levels were down, and finally to leave the water power seats altogether.

Western milling cities, such as Milwaukee and Minneapolis eventually displaced the Wilmington area as America's wheat processing center. The reasons for this displacement are complex. Historians

have offered many explanations for the shift, but the most credible of these is scale. Western farmers aggressively adopted large machinery to plant and harvest their large government granted tracts of virtually free, level, grain land. Powerful huge mills driven by the Mississippi and other western rivers dwarfed the Brandywine's mills. Transportation in the west was facilitated by government subsidized rail lines. The scale of western cereal agriculture was beyond the grasp of the coastal farmers who were prisoners of their topography.

Cheap flour and other cereal products from western milling centers flooded the market in the later 19th century, and the local millers tried to catch up. Some installed rollers to replace or supplement their buhr stones. Others became dealers for the big national feed companies. Some gristmills became feed mills, custom grinding poultry feed from local corn, but as railroads became the center of commercial activities, steam powered mills were established near rail stations, further weakening the commercial dominance of the water powered mills.